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An investigation into the feasibility of introducing a marine engine simulator into the Algerian MET [Maritime Education and Training] system

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AN INVESTIGATION INTO THE FEASIBILITY OF INTRODUCING A MARINE ENGINE SIMULATOR INTO THE ALGERIAN MET SYSTEM

By

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In

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(Engineering)

2000

DECLARATION

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

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

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DEDICATION

Dedicated to my wife

Fatim

And my son

Fares

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Finally, I would like to dedicate this paper to my mother, my loving wife (Fatim), my son (Fares),for their support and understanding during my two years absence from home.

ABSTRACT

Title of Dissertation: **An investigation into the feasibility of introducing a marine engine simulator into the Algerian MET System.**

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The proper operation of the ship equipment is a key problem of the ship management and safety. Simulator based education and training for ship officers will be used to solve the problem. Today the use of simulator in the education and training of ships engineer officers has became very important because of the following changes in the marine industry during the last decades:

- Stringent environmental protection rules and regulations.
- Intense international competition, which requires ships at optimum efficiency.
- Highly rate marine power plants, using very poor quality fuels.
- Extensive use of automation and reduction of personnel onboard.
- Qualified personnel with skills and experience for ship safety operation.

The recent development and restructuring of the MET System in Algeria by adopting new approach educational and training, POLYVALENCE, requires the students to follow both deck officer and engineering programs. An appreciable amount of work has been done, but, in the triangle of facility, course, and lecturer, it was the facility that was the weakest element. This paper will mainly discuss the technical aspects of simulators and analyze the effectiveness of engine room simulators (ERS) in order to select the appropriate one which will complement the existing facilities, and thus enhance the educational and training program at Institut Superieur Maritime (ISM) in Algeria.

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LIST OF ABBREVIATIONS

ARPA	Automatic Radar Plotting Aids
CC	Crude Oil Carrier
CBT	Computer Based Training.
CNAN	Compagnie National Algérienne de Navigation
ENAATM	Entreprise Nationale des Activités Auxiliaires et des Travaux Maritime
ENMM	Ecole Nationale de la Marine Marchande de Nantes.
ENTV	Entreprise Nationale de Transport des Voyageurs
ERENAV	Entreprise de Réparation Navale
ERS	Engine Room Simulator
GPS	
GMDSS	Global Maritime Distress Safety System
IFE	Institute of Energy Technology (Norway)
INFS	Institut National de Formation Supérieur
ISM	Institut Supérieur Maritime
IMLA	Convention of International Maritime Lecturers´Association
IMO	International Maritime Organization
JICA	Japanese International Co-operation Agency
LAN	Local Area Network
LCC	Large Crude OIL Carrier
LNG	Liquefied Natural Gas
MER	Marine Engineering Review.

MET	Maritime Education & Training.
METE	Maritime Education & Training Engineering.
MMI	Man-Machine Interface.
OTISS	Operational Training Industrial Simulator System
P&ID	Process & Instrumentation Diagrams.
PPT	Propulsion Plant Training
PTS	Part Task Simulator
SAR	
SAST	Special Analysis & Simulator Technology.
SOLAS	International Convention for the Safety of Life at Sea
SNTM/HYPROC	Société National de Transport Maritime des Hydrocarbures et des Produits Chimiques.
STCW	International Convention on Standard of Training, Certification and Watchkeeping for Seafarers.
TEC	Training & Evaluation Control System.
USMMA	United States Merchant Marine Academy.
VLCC	Very Large Crude Carrier
VTS	Vessel Trafic System

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The impact of costs, economies of scale and profit maximization, lead shipping companies to keep pace with technological innovations by using sophisticated equipment on board ships. These latest technologies such use of specialized cargo ships, port and cargo handling equipment, and sophisticated engine room make faster turnaround time in ports and allow usually reduction of the workload of the crew. But these aspects change the attitude of seafarers, which have been seen to become high specialized to develop mastery of all sophisticated equipment. Then it is essential today seafarers be skilled in both automated and manual operation of ships and its equipment. To keep up with this trends the Maritime Education and Training (MET) should not lose sight of that. It obvious that to meet the job requirement by education and training, the educational system should to be close to the actual knowledge and performance to which they relate. Therefore all MET institution should improve their curriculum in order to provide planned learning opportunities and experience to students.

It is recognized that computer based training including computer supported simulation training, does differ, effective and over take in a fundamental way from the traditional instructor based training. Because, in the traditional case, assurance of quality is usually found in the credential of the instructor, not in the instruction itself, but electronic training and simulation can be certified effective.

Before the simulator technology for training purpose was utilized in the maritime field, it was been a feature for many year in several industries and particular in aircraft industries where it was a well-established science.

The first simulators in the marine field were used for research purposes in Goteborg, Sweden in 1967 (Professor P. Muirhead report: ship simulator, Historical Growth and Development, September 1999). They were used manly to predict the behavior of crew, ship designs, new material and procedures as well as for port design. But simulators have had long since a history on the training of operators for dangerous and inaccessible places in industries.

Today, because it is technically possible, the simulators are widely and intensively used in many fields such as aeronautics, medicine, automobile industries, universities, space research and operations. And it still continues to be employed manly to predict the behavior of humans and equipment in large complicated, dangerous and expensive systems.

The latest simulators have high performance, and could interact using multiple variables, which duplicate phenomena likely to occur in the real life. Any complex equipment requiring equally complex procedures in its operations could be simulated. Specifically engine simulators are now able to generate environments where groups of trainees can be trained in operational procedures, routines, corrective measures, fault directions, and much other process.

In the training area the engine room simulators play an important role in producing the impossible situation related to the real life. It can provide the trainees with the required experience to handle or at least minimize the effects in considerably fewer practice hours than traditional methods. A simulator running in real-time can compress year of experience into a few weeks.

1.2 METHODOLOGY

The content of this dissertation will be based on relevant literature from World Maritime University Library, information from simulator manufacturers such as NORCONTROL, POSEIDON, MARINE SOFT, TRANSAS SIMULATOR and experience gained from field trips in Norway, USA, Poland, Netherlands, France and UK. The study will focus on investigation of an adequate engine room simulator (ERS) able to complement the teaching facilities and to enhance the existing program of duel-purpose at ISM Bouismail in Algeria.

The proposed methodology applied to achieve these main objectives is on steps as outlined below:

1- To examine the existing practical methods of marine engineering education and training at ISM in Algeria.

2- To investigate prospective current ERS technology through different manufacturers.

3- To examine a number of users of ERS and compare methods used in training.

4- To examine and analyze the outcomes of the simulators by comparing between reliable types of ERS investigated and effectiveness in training from selective users.

The application of simulator in MET institution has brought a lot of insight in the training process and their outcomes have been highly commented on by students and instructors. Speed of delivery and student interactions have been made faster because of a reduced time and cost in achieving the necessary operational experience.

The influence of STCW78 and revised in 1995 (STCW95-code) on MET system in Algeria will be analyzed, and the recommendations on the effectiveness of engine room simulators will be remarked upon in the conclusions.

CHAPTER 2

MARITIME EDUCATION AND TRAINING IN ALGERIA

2.1 BACKGROUND

Since the independence of Algeria in 1962, Maritime Transport has been recognized as a strategic sector of economic development of the country taking into consideration that the quasi totality of foreign trade is conducted by sea.

In order to consolidate its sovereignty, Algeria decided to acquire a national fleet for the transportation of passengers and goods.

The mother Compagnie Nationale Algerienne de Navigation (CNAN) has made the main acquisition of the fleet. Created in 1963 and operating under the auspices of the ministry of transport. This operation has been accomplished in a short period of time, about ten years, in order to respond to the increasing needs of the country.

The CNAN possessed five (5) ships in 1969,42 ships in April 1976,

- 63 ships at the end of 1977,
- 68 ships in 1983, and
- 72 ships in 1989 together with 10 oceans going tugs and 12 pilots launch.

The personnel of the maritime sector is represented in table 2.1.

More over, the complexity and the variety of tasks lasted the national fleet to take on the requirement of a better management and at the same time have led the CNAN to undergo:

- In 1982 the first restructuring into:

- One Company dealing with the transport of general cargo and passengers.
- One Company dealing with the transport of oil such as gas and chemical cargoes.

- And a second restructuring also in 1982 leading to the creation of four companies:
  - The SNTM/CNAN dealing with the transport of general cargo.
  - The ENTV dealing with the transport of passengers.
  - The ENAATM dealing with auxiliary activity.
  - The ERENAV dealing with ship repair and maintenance

The rapid expansion of the fleet and the acquisition of such highly sophisticated and expensive vessels indicated in table 2.2. It has required parallel strengthening of the maritime infrastructure and personnel of the ministry responsible for transport, specifically in the field of preparation and implementation of legislation and related measures for the safety of navigation and maritime training.

COMPANY	**SEAGOING PERSONNEL**	**SHORE BASED PERSONNEL**	**TOTAL**
1, -SHIPPING COMPANY - **SNTM/CNAN** - **SNTM/HYPROC** - **CALTRAM** - **ENTVM**	 **2607** **1235** **158** **937**	 **839** **391** **107** **600**	 **3446** **1629** **262** **1537**
2, - AUXILIARY ACTIVITY - **GEMA** - **MTA**		 **1211** **711**	 **1211** **711**
3, - SHIP REPAIR AND MAINTENANCE **- ERENAV**		**631**	**631**
TOTAL			**9427**

Table 2.1: Personnel distribution in the maritime sector. (Annual report, December 1998)

In order to meet the urgent needs of qualified seafarers and replace gradually the expatriate crewing the vessels, the necessity to establish an appropriate Maritime Education and Training institution was strongly felt.

Consequently the Institut Superieur Maritime (ISM) was created at Bouismail in 1975. The objectives of the change introduced each time is to elevate the standard of training by the following actions:

- Elevation of the entry requirement.
- Updating of teaching syllabuses.

Table 2.2: Composition of the merchant fleet. (Interview, 1999).

TYPE OF SHIP	Nb. OF SHIPS	DEAD WEIGHT
- General Cargo	26	258. 998. 61
- Ro/Ro	14	42. 525. 91
- Cereal Carrier	08	189. 890
- Wine tanker	03	10.800
- Oil tanker	05	46. 951
- Bitumen tanker	06	5. 815
- LNG Carrier	02	347. 557. 96
- Ethylene Carrier	01	7. 940
- LNG Carrier	02	11. 360
- Bulk Carrier	01	-
- Car-Ferry	05	10. 583. 2
	73	997. 119. 68

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- Elevation of the entry requirement.
- Updating of teaching syllabuses.
- Increasing the duration of the theoretical and practical training ashore.
- Reducing practical training at sea in favor of more accelerated curriculum.

From 1975 to 1984 figure2.1, the students are enrolled by national examination at the age of 19 years among holders of the Baccalaureate Diploma. They join ISM for two years pre-sea training. After graduation with a Watchkeeping Diploma they have to fulfill their practical training requirements on board ship for three years. An additional year of post-sea training at ISM is conducted for the issue of higher Diploma of Master Mariner or First Class Marine Engineer.

In 1984, a few changes have been introduced. The pre-sea training has been increased to three years duration whilst the practical training on board has been reduced to two years (figure 2.2).

In 1988, major reforms have been made to the training scheme following the decision of the government to include Maritime Training with in the University System whilst still retaining it as a maritime discipline (figure 2.3).

The changes were as follow:

- Enrolment of student in ISM by National Examination from those who have completed a two year course at the University. This provides them with basics in technology and general sciences.

- The admitted students will join ISM in their third year of studies. They will then specialize during two year pre-sea training, two year practical training and one year additional post-sea training.

Deep-sea Master mariner/First Class Marine Engineer Certificate

24 months sea service

3rd year

9 months theoretical studies leading to examination for

Deep-sea Master Mariner/ first class Mar./Eng. Diploma.

24 months sea service as W/K

Foreign going mate/First Class Mar/Eng.

Watchkeeping certificate

12 months sea training

2nd year

9 months theoretical studies leading to examination for

Deep-sea Master/first Class Mar/Eng. Watchkeeping diploma

2 months sea training

1st year

9 months theoretical studies

Common admission requirements: 1- 12 years general education (baccalaureate)

2- Entrance examination

3- physical fitness

Figure 2.1: High-level education training scheme leading to master mariner/first class marine engineer certificates of competency from 1975 to 1984.

Deep-sea Master Mariner/First Class Marine Engineer Certificate

24 months sea-service

4th year
9 months theoretical studies leading to examination for deep-sea Master Mariner/First Class Marine Engineer diploma

12 months sea service as W/K

Deep-sea Master Mariner/First Class Marine Engineer Watchkeeping Certificate

12 months sea-training

3rd year
9months theoretical studies leading to examination for
Deep-sea Mate/ First Class Marine Engineer Watchkeeping Diploma

2nd year
9 months theoretical studies + 2 months sea-training

1st year
9 months theoretical studies + 2 months sea-training

Common admission requirements: 1- 12 years general education (baccalaureate)
2- Entrance Examination
3- Physical fitness

Figure2.2: High-level education training scheme leading to master mariner/first class marine engineer certificates of competency from 1984 to 1988.

Deep-sea Master Mariner/First Class Marine Engineer Certificate

24 months sea-service

3rd year
9 months theoretical studies leading to examination
for Master Mariner/First Class Marine Engineer Diploma

12 months sea-service

Deep-sea Master/First Marine Engineer Watchkeeping Certificate

12 months sea-training

2nd year
9 months theoretical studies leading to examination
for Master Mariner/First Marine Engineer Watchkeeping Diploma

2 months sea-training

1st year
9 months theoretical studies

Common admission requirements:

1- 12years general education (Baccalaureate)
2- 2years University studies in sciences & technology
3- Entrance examination
4- Physical fitness

Figure2.3: High-level education training scheme leading to master mariner/first class marine engineer certificates of competency from 1988 to 1995.

The advantages of such a scheme are:

- On satisfactory completion of their training the graduates will be awarded a Diploma recognized nationally.

- The classification of the ISM as INFS (Institut National de Formation Superieur) is able to help the administration to improve the status of teachers and assist in upgrading them.

- The increase of the output of qualified officers from ISM during the sixties led to the gradual replacement of expatriates, and at the present time the totality of the crew is Algerian.

- The stagnation of Algerian fleet during the latest years due to the economic recession of the country has forced ISM to reduce gradually the recruitment of new students during the last five years.

- The change in the technology has triggered also a new line of thought on ship management. The new inventions together with the electronic module and automation system introduced in the ship accordingly on the bridge and in the engine room respectively made it possible for less manpower required than on conventional ships. So with reduced tasks, we are moving toward the provision of a small team of personnel, which will operate in a safe manner and contribute, of course, to the economic viability of companies.

And to keep pace with the development of the training of sea going personnel in advanced Maritime Nation, ISM has decided to review once again the training system, and to set up a new curricular system called “POLYVALENCE”. The system allows the grouping together of the two vocational training systems of the deck officer and engineer as seen in figure 2.4. This integration of officers in a dual-purpose role became possible today, due to the using of modern methods of teaching such as video, slides, handouts, and the modern equipment.

Keeping the same entry requirements (two years at the University) the students spend three years pre-sea training at ISM and gradually with a dual- purpose Diploma, Nationally recognized. Twelve months at sea are required to obtain a dual Watch officer certificate. When graduated the students will seek the accomplishment of his required sea-service either on board Algerian ship, or use the foreign flag after establishing bilateral agreement by the Ministry of transport.

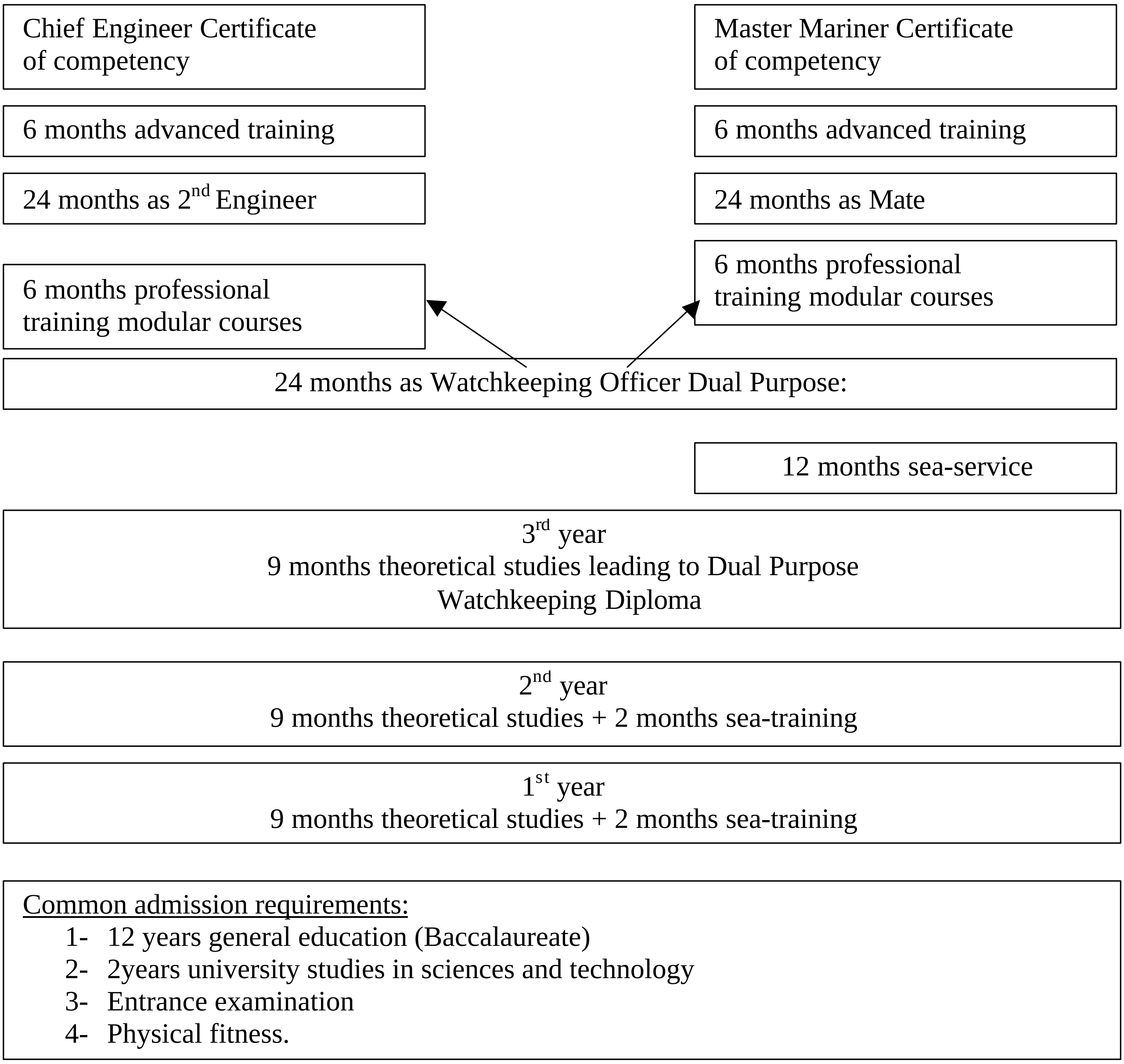

Figure2.4: High-level education training scheme leading to master mariner/first class marine engineer certificates of competency since 1995.

2.2 FACILITIES AND SPECIALISED TRAINING

2.2.1 TRAINING FACILITIES AND EQUIPMENT

Institut Superieur Maritime constitutes an integrated training complex containing most of the appropriate facilities necessary for Maritime Education and Training such as:

- Navigation bridge
- Radar simulator laboratory
- Radio station
- GMDSS simulator
- Marine diesel plant
- Automation laboratory
- Electricity and electronics laboratory
- Welding workshop
- Machining workshop
- Maintenance workshop
- Computer laboratory
- Lecture rooms
- Lecture hall
- Library

- Fire fighting center survival center
- Students housing of 315 single rooms
- Restaurant
- Cafeteria
- Medical center
- Sport complex (football, handball, basketball, volleyball, and tennis…)

2.2.2 SPECIALISED TRAINING.

Due to its dynamism, its qualified teaching staff and adequate teaching facilities and equipment, ISM has been designed in 1988 as a Regional Branch of the World Maritime University (WMU) among 14 others in the world. Within this frame work ISM has embarked on a diversification program of its training activities by conducting a whole range of specialized short courses towards seagoing and shore based personnel of the shipping companies and other maritime activities by the use of the IMO model courses.

The priority was given to the conduct of IMO mandatory short courses with include the following:

- Fire fighting courses
- Basic survival courses
- ARPA courses
- Gas carrier safety courses

- Chemical tanker safety courses
- Petroleum tanker safety courses

As far as the fire fighting and basic survival courses, ISM has established fire fighting and survival centers, which have been operational since 1987.

In addition to these specialized short courses ISM has developed several tailor-made courses to update the knowledge of some personnel such as:

- Anatomy of shipping
- Draft survey
- Welding techniques
- Machining-tools
- Ship construction

Combining the experience of graduate and specialized training, ISM has set up four

POST-GRADUATE courses of one-year duration in the following fields:

- Shipping: a course provided for shipping companies and related activities management personnel.
- Port Management: for managers and operators.
- Maritime Administration: for maritime administration and regulation enforcement.
- Maritime safety: for the coastguard officers, and maritime safety personnel.

ISM and French Institute at Marseille run the first three mentioned courses jointly through a co-operation project. The fourth course is taken in charge completely by group of ISM teachers whom graduated from WMU. The course is composed mainly of several IMO model courses dealing with maritime safety.

2.3 IMPACT OF INTERNATIONAL RULES (STCW)

The STCW convention is the main impetus to address this aspect of safety at sea. The convention aims to provide an international standard for training and testing of seafarers. It set minimum requirement for all levels of persons employed on board ship. It also outlines in clear terms the obligation of states to ensure compliance with its regulations. It also makes provision for reports to IMO in order that monitoring for compliance can be accomplished easily. The need for quality system of training is addressed and guidelines are given as to how these can be achieved. The revised convention is a major improvement over the old one, which often left standards to the “satisfaction of the administration”.

Today, sailing conditions are different than some years ago. Now new ships are equipped with satellite navigation systems and sophisticated radar. Many of tasks, which were conducted by humans in conventional ships, are now executed by handling system, which are mainly composed of computers. And also technological innovations have been introduced and emphasize improvement in vessel’ engine. All these new technologies allow one to spend less time on nautical calculations and lectures. These drastic innovations upon ship handling systems make a big change on ship operation tasks. But these different tasks require a wide range of skill levels, from basic skills of technician to ingenious knowledge, which requires experience and skills in the diagnostic evaluation of problems and decision-making.

Nevertheless, the systematic structure of Education and Training for ship operators who use this new handling system has been fully organized in developed countries. If the developing countries cannot cope with the new system in a timely manner, it will be evident that operators from these nations cannot adapt themselves to the system, and eventually there will be a danger maritime accidents being caused frequently. Therefore, the details of education need to be examined as soon as possible in these countries.

At Institut Superieur Maritime Bouismail, the STCW and SOLAS conventions are seriously taken into the training of students for them to be safety conscious and competitive. Many laboratories have been renovated, such as marine electric and automation laboratory. Also ISM has benefited from Japan trough its International Co-operation Agency (JICA) in an important aid project consisting of the:

- A modern 4 own Ship Radar Simulator
- Sophisticated Marine Diesel engine Plant

And more recently ISM has installed a GMDSS Simulator of 1 instructor, and 4 student stations.

Since its establishment in 1975, ISM is fulfilling its mission in a very satisfactory manner. ISM graduates are holding their position both at operational and managerial levels within shipping companies and auxiliary activities such as maritime administrations, ports, and training. It also plays a very important role in implementing the STCW convention in order to maintain the quality standard for the training a qualified and competent seafarers in accordance with the STCW 95 Convention.

The main roles of ISM are:

- Improvement of the maritime safety and the prevention of marine environment.
- The endeavoring to be in line with national and international development.
- Establishment at the teaching syllabus of Maritime Education and Training and curriculum for each course under the requirement of STCW 95.
- Establishment of appropriate Quality Standard System and examination requirement for Maritime Education Training and Assessment.
- Effectively coordinating use of maritime instruments, equipment, simulators, and seagoing training ships for training seafarers.
- Development of teaching methods such as the use of computers and simulators for training and assessments purpose.
- Creation of Maritime Training Committee composed of representation of Maritime Training Institutions and Maritime Industries
- Creation of Regional Examination Center at ISM for the conduct of training, and assessment of seafarer's competency. Establish procedures for the issuance of documents of compliance for Algerian flag ships.
- Improvements upgrading and continuing the education program by providing qualify teaching staff through WMU and other advanced institutions.
- To make the intensive use of IMO model courses either as short courses or integrated into regular curriculum.

CHAPTER 3

TECHNICAL ANALYSIS OF SIMULATORS

3.1 INTRODUCTION

In the shipping industry today economic factors play an important role, thus, reducing of number of crew on board ship is vital for shipping companies. This lower number of crewmembers has not been able to overcome the technical maintenance demands of these sophisticated ships, which incorporate high degree of automation.

Today the situation is different than it has been in the past, there is no time to train on board, but the shipowners or companies demand well-trained engineer officers. Using simulator facilities can be very useful partially replacing the traditional training done on board ships.

The requirements of the ISM code have been implemented in the amendments to the STCW Code. Standards for training have been enhanced, and those responsible for the training clearly identified (Regulation I/14 of STCW convention, states that the management of the company is responsible for the competency of seafarers serving on their ships). And the chapter III of the STCW Code stipulates the minimum training required for marine engineer officers and all personnel directly involved in operation of the engine room.

The STCW code clearly defines the competence of these marine engineer officers. However the code recommends training in the classroom, workshops, and simulators. Even if the engine room simulator is only recommended, using ERS for training is an excellent tool to ensure a safe and efficient operation of engine plant.

To be competent, the engineer officers have to be prepared to perform properly their tasks such as,

- Maintaining a safe engineering watch
- Operation of the main and auxiliary machinery and associated control systems
- Operation of pumping system and associated control system
- Operation of alternators, generators and control systems
- Safety and emergency procedures
- Prevention and pollution
- Maintaining seaworthiness of the ship (ship stability)

Maritime training institutions have to train and to prepare operational skills of shipboard personnel in order to meet the requirements of modern machinery space technology. But to cover all training needs on real machinery in laboratories is considerably restricted by requirements on:

- Safety environment protection,
- Training time, and
- Working costs.

Fortunately, simulator facilities can provide favorable training at Maritime Education and Training institution especially when its training allows of reacting to accident situations, and emergencies. Simulator becomes superior to real machinery in this regard.

IMO recommends training on simulators and has published model courses in their use. The revised STCW convention includes standards governing use of simulators training. And the safety management system in compliance with the ISM code seems hardly to be practicable without simulator support.

3.2 FULLMISSION

3.2.1 INTRODUCTION

A full mission engine room simulator consists of an electric switchboard, a control room console and large touch screens for the engineers' engine room action. As an example of Norcontrol Simulator a full mission engine room simulator. It is a complete engine room system where all the machinery has been reproduced through the application of a computer programmed to represent a complete propulsion plant including all auxiliary system.

The simulator models are based on real time programming, which enable to replicate the dynamic behavior of the engine room plant and all its vital parameters as well as the interactions between the sub-systems of a propulsion plant.

The control room equipment is built up from ship-shape control console and a model of the main switchboard. From the control room the students may operate the main engine and its auxiliary systems including the alternation. Equipment running lights and indicators for all main operational parameters are mounted on the console showing the operational status of the machinery. An alarm monitoring system consists of a buzzer and a flashing lamp from the alarm group affected will alert the operator to any abnormal conditions.

Full mission simulator is arranged over the separate types of simulator configurations mainly the operational configurations, workstation configurations and combined operational and workstations configurations. The engine room simulator can also be coupled with full-mission bridge simulator through Local Area Network (LAN).

3.2.2 OPERATIONAL CONFIGURATIONS

As an example of a configuration of Norcontrol Simulation is shown in (Fig. 3.1): The full mission consists of an Engine Room System created by the interaction of computer hardware and software and computer net work linking all parts of the Engine Room Simulator. The Full- mission ERS may comprise the following sections:

- Workstation
- Engine Control Room
- Main Switchboard
- Engine Room

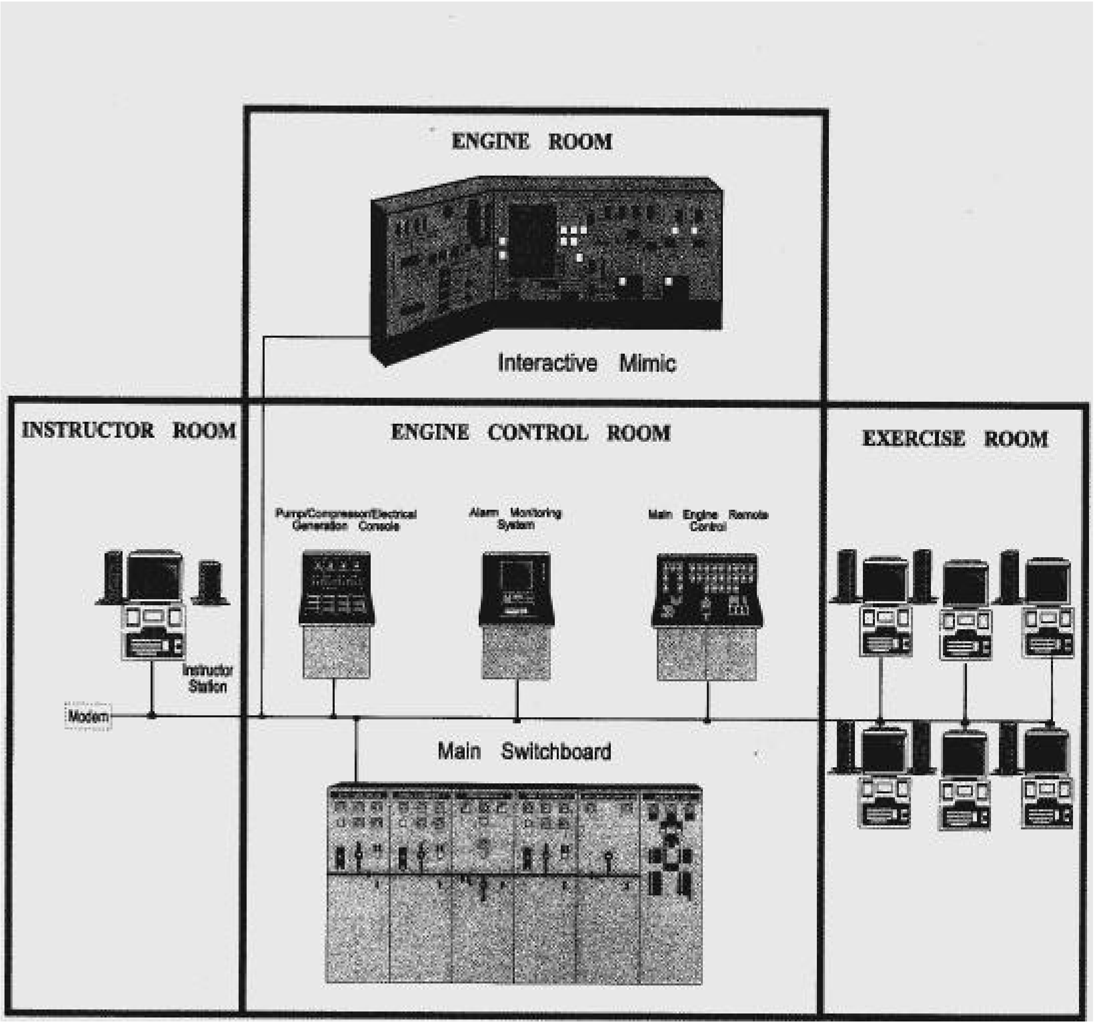

Figure3.1: Full mission ERS "Combined operational Workstation Version Simulator"

Source: Propulsion Plant Training PPT 2000. Manual, Kongsberg Norcontrol.

3.2.2.1 WORKSTATION

The workstation configured Propulsion Plant Trainer can include the following facilities:

Instructor room facilities

The instructor room can comprise the following separate units:

- Instructor workstation training
- Training and Evaluation Control (TEC) System
- Printer (event log and hard copy printer)

Students facilities

Students' facilities comprise the following separate units:

- Student workstations
- Printers

This equipment has the capability to interface with the simulator or to stand-alone for separate exercises. It will also function at the same time as exercises are in progress on the simulator reporting the trainee activities and playing back the trainee exercise to assist in the correction of errors in procedure. The instructor is provided with a composite set of facilities which will effectively enable him to prepare exercises in advance, to supervise exercises in progress and to debrief the trainee at the close of an exercise.

3.2.2.2 ENGINE CONTROL ROOM.

The simulated control room is an extension of the engine room to be employed as a remote sensing and control center for the propulsion machinery systems as formed on board today's diesel engine driven ships.

The control room simulation units' interface can operate the functions of the engine room and at the same time provide a link in the remote plan/energy management configuration. The control room is also the prime link in the bridge, control room/engine room and unmanned simulated process may be monitored and controlled by the students from the local panels as well as from the consoles in the engine room. The remote monitoring and control systems are in full classification societies for unmanned remote operation of a real engine room. The control room can be configured to include the following.

- Main switchboard
- Engine Control Room Console
- Boiler console
- Communication
- Alarm/ Log Printer

Main switchboard

The main switchboard consists of the following sections

Diesel generator sections

- Shaft generator sections
- Turbo generator sections
- Synchronizing sections
- Miscellaneous sections

Engine Control Room Console

The engine control room console includes the main engine's remote control system. The functions and design of the control room console are based on the "Data-Chief" ship's instrumentation system manufactured by NORCONTROL. The engine control room console consist of the following sections:

- Generator/pump/compressor control section (Power-Chief)
- Monitoring/alarm and control section (Data-Chief)
- Main Engine remote control section (Auto-Chief).

Boiler Console

The steam generating system is based on a typical dual pressure type, auxiliary boiler, and includes the following sections:

- Condenser consists of vacuum condenser and all necessary pumps and valves.
- Steam Generator consists of steam generator (secondary steam drum) with an advanced and flexible feed water level control.
- Oil fired boiler consists of oil fired boiler with primary steam system, super-heater and burner system with automation and manual control.
- Exhaust boiler consists of exhaust boiler with economizer, evaporator, and super-heater. The exhaust boiler has automatic and manual control of the exhaust gas by pass dampers. There is a circulation pump, circulating water from the steam generator through the exhaust boiler evaporator.

3.2.2.3 ENGINE ROOM.

The operation of the subsystem can be carried out on consoles/panels, interactive mimic panels or local operational stations. The engine room can be configured as combination of the above mentioned solutions. The most flexible solution because of these is the workstation solution because it is then possible to run more than one engine model.

The engine room can also be configured to include main engine local control and the entire interactive mimic panel may comprise all the relevant subsystems in the propulsion plant. However it represent the various engine room system for single screw propulsion system by distinctive color outlining of each system in line/block diagrams. Each system contains the filers, header tanks, and pressure measuring devices, temperature control, and valves essentials to the operation of the system.

The mimic panel interacts with facilities for local operation of pumps, valves, auxiliaries and main engines. The state of operation is indicated by lights (running lights, trip lights), and also by indicating instruments. Instruments are of the analog readout type and more some may be of the dual scale face to accommodate readings appropriate to the engine characteristics.

3.2.3 ADVANTAGES OF FULL–MISSION ERS.

The advantages are immense because their outwards appearance resembles actual installation in full details and sound and light effects available. One of the major advantages are advanced graphic capacities, which contribute greatly to study engine room system and mechanism. The panel, which represent machinery, equipment and pipelines in the engine room, a full consideration is given to the arrangement of equipment symbols on the panel to permit full understanding of the various systems to facilitate maximum training effectiveness. Full-mission ERS are very convenient for mastering skills in limited circle of time.

The operation of ERS has no risk of accident to trainees' lives, to environment and equipment damage. Hence it is a good place to learn and to make mistakes without giving detrimental effect of cost.

The dynamic real time of ERS has real-time response of engine room systems besides

having some replica hardware. This facility allows the trainees to see the cause-and-effect of their own performance immediately. This also directly influences the enthusiasm of trainees and promotes motivation to learn.

3.3 COMPUTER-BASED TRAINING.

3.3.1 INTRODUCTION.

The Computer-Based Training (CBT) simulator is designed as software-driven PC-based training facility with machinery controls and indicators being reproduced on the screen. The simulator software simulates a ship engine room system including main engine, boilers, fuel oil system, cooling water system and electrical power distribution system. (Marine Soft, 2000)

The CBT simulator is able to perform normal operations such as trouble shooting, watchkeeping and emergency operation scenarios. The computer-based training is able to combine simulations with multimedia techniques such as audio, video and animation. With realistic control consoles and panels, CBT can provide acoustic alarms, warning lights and machinery sound in order to make a more realistic approximation of simulation environment. (Norcontrol, 1999).

The high expression ability of multimedia techniques makes CBT suitable for education and training of students on-board and on-shore. The training potential of the CBT may be used as stand-alone simulator or networked to form a training class.

Today it is more used as an individual training aid to students working at their own pace, so many functions make these system an adequate tool for training and enhancing student's learning. One of these features is to be able to save any situation and the subsequent repetition and corrections of errors and mistakes in operation. These features allow trainees and students to develop skills and thinking processes necessary for facing their real life at sea.

The use of CBT allows the student to be involved and to be motivated to learn. It provides a facility for the development of competencies that cannot generally be acquired in the workplace.

The computer-based training CBT uses a amount large of storage memory, which enables the system to save a great number of situations and incidents. This allows students and instructor to instantly replay or clarify and discuss the training during debriefing and also repeat the exercise if that is needed. CBT can also allow performance comparison between teams training under identical input. This is important because it opens the possibility to use the simulator for assessments and examinations.

3.3.2 OPERATIONAL CONFIGURATION.

As an example of Marine Soft Machinery Space Simulator is shown in (Fig.3.2). CBT consist of:

- Desk top-PC configuration in the best way capable for self-instruction within,

- On the job training to get familiarized with new machinery, refresh and coach operational procedures, prepare pre-promotion assessments of competency, etc
- Institute-based training to deep on lessons, repeat exercises, prepare examinations, etc.

- PC-network configuration are appropriate to instructor guided group training, with PC terminals being,

- Either autonomous with identical situations, i.e. multi-station training on identical problem
- Or inter connected with different situation e.g. interactive training of the whole engineering watchkeeping team.

The computer-based training simulator use covers procedures such as:

- Familiarization scenarios aimed at getting known with the machinery space

system, where it is arranged aboard and how reproduced for simulation, what indicators and controls are used, and where to find them aboard and on the simulator screen.

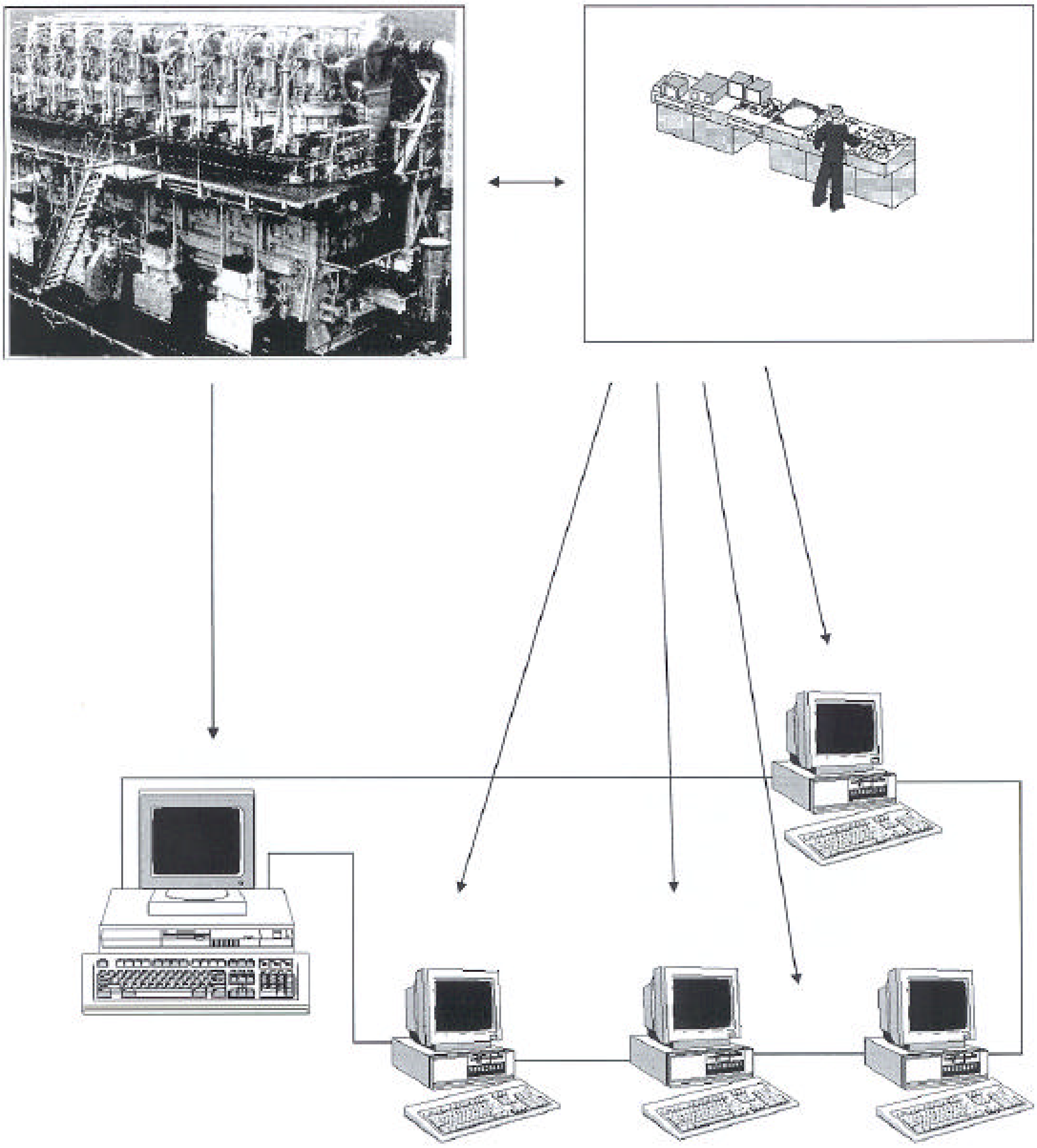

Figure 3.2: PC- Net Version with Instructor Workstation.

Source: Machine Space Simulator Manual, Marine Soft.

•Normal operation scenarios aimed at learning how correctly to start up machinery space system, put them on line, and set the normal operating modes.

- Watch keeping scenarios aimed at learning how to take over and accept an engineering watch, what watchkeeping routines are in use, and what duties must be observed.

- Trouble-shooting and anti-accident scenarios aimed at how to identify, localize and remedy faults and malfunctions in machinery space system, and how to handle alarms.

- Emergency procedure scenarios aimed at skills and confidence in handling of machinery space systems in emergencies.

3.3.3 ADVANTAGES

All teachers lecturing in the subject of maritime diesel engine operation maintenance and diagnostics require a teaching aid to support the lectures or illustrate certain aspects of a diesel engine operation. A real engine to make the demonstrating directed to basic training is out of the question. It takes a great of time to set up and to monitor faults. The same applies to more advanced courses when the knowledge of operational conditions is required and subjected to more pressures.

According to Roy Johanson, instructor on engine room simulator at Tromso Maritime high school Norway; there are three obvious advantages with the marine soft machinery space simulator.

- The built-in CBT environment gives instructors appreciation about the different systems.

- The dynamic in the active process.

- And with a view to capacity, that the simulator can be run on PC.

The latter point makes the students able to use the simulator, at any time, in discussions, in exercises or just in pursuing interest in the subject.

Computers e.g. PCs desktop and laptop are today relatively low cost tools that can be applied to training, as stand alone or in network environment. At the level of basic training the use of CBT- programs could be used in their own time at their own pace.

3.3.4 COMPARISON BETWEEN "FULL MISSION AND CBT"

Table 3.1: comparison full mission & CBT.

Full mission		CBT	
Advantage	Disadvantage	Advantage	Disadvantage
Provides: - More realistic environment for training. - Sound, light - Vibrations. - Highly effective form of training. - Team training level.	- High capital equipment cost. - High experience instructor need. - High skill maintenance support need. - Large spaces required.	- Low price. - Takes up less space. - Effective way of self-study. - large library of subject modules. - Easy to maintain.	- It simulates only a specific and limited aspect of main engine or sub-system. - Less hands-on.

3.4 PART TASK SIMULATOR.

Part task simulator (PTS) is an intermediate instrument or facility between Full mission Engine Room Simulator and Computer Based Training. PTS can simulate a single ship's system or limited combination of tasks relating to a system (from single task to multi-task).

Part task Simulator can replicate, for example:

- Marine Diesel Engine
- Electrical Power Plant
- Sea Water Cooling System…etc.

This type of system is particularly appropriate to provide multiple trainee station for familiarization training in preparation of a more comprehensive simulation to practice part of tasks before acceding to a Full-mission ERS.

3.5 MARKET PENETRATION.

With respect to the economic change and technology change have triggered a new line of thought on ship management. The new inventions of advanced machinery and automation system have been installed on board ship. The impact of modern technology on shipping industry and high technology ships has raised need of new training aids like the engine room simulator.

Marine simulators have matured over a period of more than 25 years and have now proven to be a reliable tool. Maritime Education and Training institution throughout the world also recognized the value of simulator systems as a training tool.

Since the revised STCW convention and code have officially promoted the use of simulators to enhance training, many manufacturers appeared on the market and propose their new products such as ship- handling simulator, engine room simulator and cargo handling simulator.

KONGSBERG NORCONTROL, MARINE SOFT, TRANSAS MARINE, are today one of the leading pioneers of world successful marine simulator manufacturers.

3.5.1 KONGSBERB NORCONTROL

KONGSBERG NORCONTROL AS (KNC) is a marine automation system specialist. Its main office is located in Horten, Norway. The company introduced the world's first introducing commercial automatic radar plotting aid (ARPA), integrated navigation system, computerized engine room automation and electronic monitoring and control of ship's cargo. In 1972 the company ventured into simulation and it become the world's leading supplier of maritime training and simulation systems, offering a full range of IMO-recommended trainers, from computer-based training systems to full-mission simulators. The various types of simulators delivered to the maritime training community include: radar/ARPA simulator, GMDSS and SAR trainers, shiphandling simulators, cargo handling trainers, propulsion plant trainers and communication plant trainers. "The company has delivered more than 550 simulators to more than 65 countries around the world." (http://www.norcontrol.com, March 10 2000).

- **Propulsion plant trainers**

The Propulsion Plant Trainers (PPT) incorporates the main engine, the control system and all relevant sub-and auxiliary systems. Accompanied by comprehensive hydrodynamic models, these translated into realistic ship-like trainers.

The software engineering of the entire propulsion plant is based on sub-models of the main engine and the various auxiliary systems such as the fuel system, seawater system, etc. These sub-systems consist in turn of basic models of pumps, pipes, filters, etc. All systems are fully interactive, forming a dynamic real-time software model. The PPT software models include a number of vessels with corresponding propulsion configuration and main engine(s). Models range from Very Large Crude Carriers to trawlers, and engines range from two-stroke low-speed diesels to four-stroke high-speed diesels. The trainers simulate a large number of different engine makers, for example, MAN B&W, Sulzer, Pielstick, MaK and MTU.

¦ **Simulator engine room models**

The following models of simulator engine configurations PPT 2000 are available both as workstations and full mission trainers.

- Very Large Crude Carrier (VLCC), Diesel MC90
- Very Large Crude Carrier (VLCC), Diesel MC80
- Very Large Crude Carrier (VLCC), Steam
- Large Crude Oil Carrier (LCC), Diesel RND90
- Crude Oil Carrier (CC), Diesel RLB66
- Multipurpose Ship, Diesel Pielstick
- Ferry, Diesel MaK
- Ferry, Diesel Pielstick

- River Vessel, Diesel MaK
- Trawler. Diesel Caterpillar
- Research Vessel, Diesel Electric
- Auxiliary Oiler (tanker), Diesel
- Naval Vessels, Diesel M11
- Naval Vessels, Diesel M44

Naval Vessel, Combined Diesel/Gas Turbine

- Cruise Vessel, Diesel Electric
- High Speed Craft (Catamaran/diesel/water jets
- Large Container Ship 2RTA (C) – Coming
- Container Vessel, Diesel Pielstick
- Gas Turbine Training Package – Coming soon

These simulation models are configured by means of the OTISS software concept (Operator Training Industrial Simulation System) developed by SAST, Special Analysis and Simulation Technology Ltd, England.

The operator Man-Machine Interface (MMI) is realized by means of the EMULA Graphic Software Package developed in Institute of Energy Technology (IFE), Halden, Norway.

The simulator can be split into two parts:

- The simulated Engine Room
- The Instructor System

The simulated engine is arranged as sub-systems identical to those found onboard a real ship. The engine room sub-systems are presented as Process and Instrumentation Diagrams (P&ID) on the workstation by means of EMULA Graphic Software. The sub-systems are further broken down into units (tanks, valves, pipes etc.) configured by the OTISS System.

Parts of the engine as well as engine room equipment can be simulated in normal operating condition or in fault/deteriorated conditions. The engine room models are connected to a malfunction library controlled by the Instructor System.

The Instructor System, denoted the TEC System (Training and Evaluation Control), comprises the facilities and features needed for the instructor to prepare, control and evaluated the simulator training.

The OTISS-/EMULA- environment is very flexible. The mathematical models and the man-machine interface are run as separate programs. The communication between them is established by UNIX sockets. The Man Machine Interface program, EMULA, drives the graphic pictures, and is installed individually on each workstation. The OTISS-program can run on any of the involved computers.

When more than one EMULA station is connected to one OTISS program, the actions taken at the one station will influence the shared process and the changes are observed on all the workstations. This way of running the simulator is controlled by the instructor to avoid chaos if different operators take inconsistent actions.

The simulator runs in one of two modes:

- In full simulation mode, the OTISS- program is run on the server.
- In part task simulation mode, the workstations are isolated from each other. The OTISS-program and the EMULA-program will run on each workstation. This mode is normally used for detailed studies of sub-systems of the simulator. For instance part task mode can be used for running the Electric Power Plant. Each workstation is also capable of running the complete simulation model i.e. several workstations can control the simulation without interference with the others. Independent of what simulation mode is used, the workstations need access to the hard disk.

¦ **Computer Based Training**

The company provides all a standard PC with a CD-ROM drive required to run the wide selection of Computer Based Training CBT (Programs), The onboard library of multimedia courses are on CD-ROM, and they cover an expanding number of subjects.

The following courses are an example of the main marine engineering module available:

- Inert Gas Generator
- Marine Fuel Handling
- Operating Diesel Auxiliary, Engine
- Fuel gas Generator
- Marine Fuel Properties
- Auxiliary Steam Boiler

• Fuel Oil System

• Cooling Water System

• Steering Gear

• Propulsion System Familiarization

• Marine Lubricants

• Operation of Generators.

3.5.2 TRANSAS MARINE Ltd

Transas Marine Limited comprises several associated international companies. Transas produces a high-technology range of Integrated Marine Navigation System, Vessel Traffic Management Information System, Oil Spill Response Management System and a wide range of Marine Simulator. It main office is located in Southampton, UK. Transas simulators are available on standard PC or with real consoles.

The product range includes:

• Navi-Trainer Simulators - simulator is based on the concept of the integrated professional environment. The trainee’s work place (e.g. the bridge) may include, Ship controls and Conning display module, ARPA/radar module, Electronic Chart System module, Navigation aids module (GPS, Decca, DF, Loran, etc).

• GMDSS Simulators – full range of systems varying from full-size consoles including actual Sailor GMDSS equipment.

• Engine room simulators: for the training of Engine Room watch-keeping personnel in the proper operational of the ship diesel propulsion plant and electrical power plant.

• Liquid Cargo handling – for the comprehensive training of personnel responsible for operation with any type of liquid cargo.

• Oil-Spill Simulator: for both training and actual response purposes.

¦ **Transas engine room simulators**

Transas Engine Room Simulators are implemented in three versions:

• ERS 2000 (Basic Version):

It a PC-based networked simulator, which includes up to 12 interactive Trainee workstations operating under the instructor control and monitoring. The simulator can be used for both, individual and team training.

• ERS 3000 (Enhanced Version):

The system is fitted with consoles containing built-in monitoring and control panels. Engine Room Simulator 3000 consists of an Instructor workstation and one trainee workstation, presented as a set of full-size Engine control Room consoles. The equipment allows the replication of an actual Engine Room environment, including the Main and Emergency Switch Boards of the Electric Power Plant.

• ERS Solo (Simplified Version):

This is a stand-alone desktop simulator, which requires no local network. ERS Solo is designed to provide an instrument for a high-level training and education whilst minimizing costs of soft and hardware.

All these above Engine Room simulators include the following main component:

- Ship Diesel Propulsion Plant Simulator (SDPP)

(2-stroke Diesel Engine- Fixed propeller; 4-stroke Diesel Engine- Controllable Pitch Propeller), comprises the following principal parts:

. Main Engine Remote Control System

. Fresh Water Cooling System

. Sea water Cooling System

. Fuel Oil Supply System

. Lubricating & Piston Cooling System

. Compressed Air System

. Exhaust Gas & Turbocharging System.

- Auxiliary Systems and Machinery Simulator (AS)

. Steam plant with combined fire-tube boiler

. Steering gear

. Engine Room bilge system with purifying system.

- Ship Electric power Plant Simulator (SEPP)

. Two Diesel Generators

. One Shaft Generator

. Emergency Diesel Generator

. Main &Emergency Switchboard including Synchronizing & Short Supply sections

. Consumers.

3.5.3 MARINE SOFT

Marine Soft was founded 1990 in Rostock Germany. It specializes in the development of Marine Software Solution and supports the seafaring community in its daily business in accordance with the requirement of ISM code and STCW 95 convention.

It provides its solutions and concepts in the field of marine logistics, simulations, training and navigation. The applications are used both onboard and ashore.

Marine Soft has designed the Machinery Space Simulator as a software package with all essential operational system available as:

- Single PC version
- Networked PC version,
- Operating console version,
- Trainee/instructor station,
- Full Mission Simulator.

The Simulator use covers all-purpose engine room exercises such as:

- Normal operation condition training

- Watch keeping training
- Trouble shouting and hazard prevention training
- Emergency procedures training.

The Simulation Software Package enables the user to reproduce a specific shipboard system, as desired:

- Energy producers: (main engine, boiler, electric power station, compressors.)
- Supply system: (fuel oil system, lubricating oil system, fresh water system, salt water system.)
- Energy consumers:
    - Propulsion: (hydrodynamics of propeller and ship)
    - Heat: (refrigeration, air conditioning, heating)
    - Electric consumers: (non-rotating and asynchronous loads)
    - Working air: (compressed air bleeding).

CHAPTER 4

EFFECTIVENESS AND USE OF SIMULATORS FOR EDUCATION AND TRAINING

4.1 SIMULATOR AS AN EFFECTIVE TEACHING TOOL.

Traditional classroom teaching has for generations been an effective method for teaching theory. Teaching methods usually include the instructor lecturing to the class, with the possibility of using an overhead projector, chalkboard, or sometimes a movie or video to amplify training objectives. In traditional setting the instructor is in direct control and may or may not invite questions and discussion.

With the addition of simulation to the course curriculum, the instructor can fill the gap between theory and application. The instructor can create an interactive environment where instructor and students actively participate in a demonstration applying theory to the real world (Capt. Cross, 1999).

It is true there is no substitute for the real thing and undoubtedly the best method of training for seafarers is still the actual sea experience. Nevertheless, simulation, particularly for shipboard operation, may offer many advantages. Over the last thirty years, and particularly during the early 1970´s, the maritime world has witnessed a rapid technological change in the shipping industry, as evidenced by the development of large and sophisticated special purpose ships such as fast container ships and bulk carriers, gas and chemical tankers. This change gave rise to the widespread perception that the maritime education and training establishment was failing to keep abreast of the development in the industry.

Today simulator-based training permits hands-on training to be conducted in a realistic marine environment without interfering with the vessel's operation or exposing it to the risk. Training can continue independent of adverse weather conditions, engine room noise and vibrations, vessel operating schedules, and other training conditions encountered in a real shipboard operating environment.

Risks associated with training on operational equipment are a concern in any industry (i.e. within the commercial air carrier industry, the widespread use of simulator in training has reduced training accidents). (Marine engineering review, May 1993).

Simulators allow students to repeat a risky operation several times if needed. Unlike training on operation equipment, where an instructor must be prepared to intervene at all time, risky maneuvers can be safely practiced on simulator.

This teaching situation is different from that aboard a ship, where an instructor chief engineer is ultimately responsible for the vessel's safety and must necessarily intercede and tutor as appropriate in each situation.

In on- the -job training, concerns for safety of the vessel might cause an instructor to intervene earlier than is desirable for efficient progress of learning. During the operation, it may be necessary to interrupt training to avoid a real life accident. In simulator-based training, as we learn from mistakes; the instructor can allow students to make limited mistakes within reasonable parameters, to see the consequences, and possibly to practice recovery procedures.

Simulators, when compared with real systems have the advantage of offering a great range of scenarios which are easier to realize, record and reproduce; furthermore, they can be interrupted at any time without problems. (Willi Wittig, Marine simulators as a tool for studies in experimental psychology, International Conference on Maritime Education and Training- IMLA, Kobe, Japan, September 1996.)

Using simulation, the instructor can control a training scenario according to learning objectives and terminate it as soon as its point has been made or repeat it until the lesson has been well learned. During the sea training the opportunities of repetition are very limited or impossible: because, the opportunity to repeat an exercise in training aboard ship may not occur for weeks or months.

Another important feature of simulator-based training is the ability to record and play back the just completed scenario for review, evaluation, and debriefing purpose. As a teaching tool, recording and playing back empower the instructor to let mistakes and accidents happen for instructional emphasis and allow trainees to review their actions and their correct and incorrect decisions and experience the results of their performance after the exercise is accomplished.

"Simulator-based training permits flexible and systematic scheduling of instructional conditions as desired by instructional staff or as desired in the training syllabus. It permits also the use of innovative instructional strategies that may increase speed learning, and enhance retention"(Capt. Cross 1999). Figure 4.1.

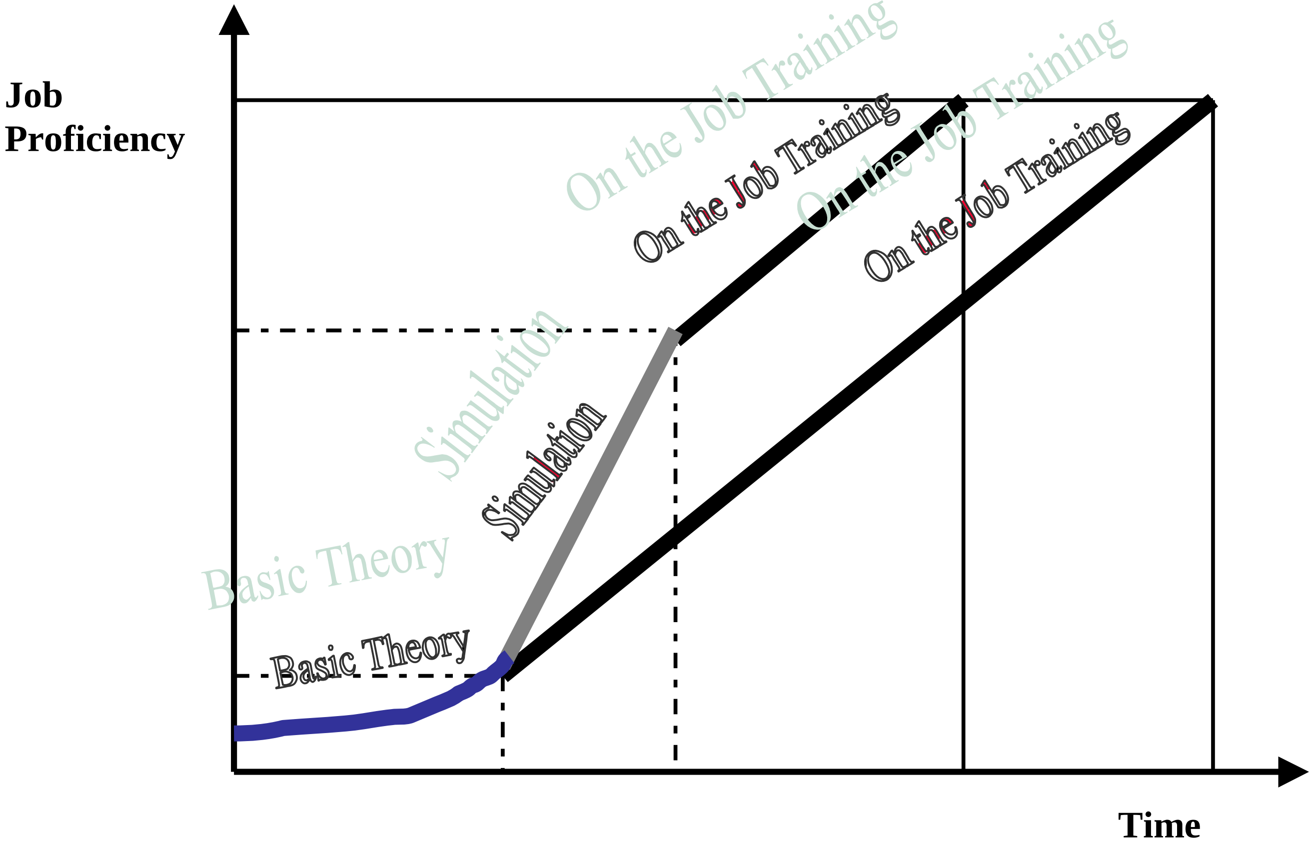

Fig.4.1: Increased training throughout early operational proficiency

Source: Hand-out Simulation system & Training Methodology
Professor P.Muirhead, September 1999.

4.2 USE OF SIMULATOR.

Because of recent trends in the marine industry towards small crew sizes, heightened public concern about marine safety and expectations for improvements, and changes in navigation and ship control technology, today's new ships are highly modernized and optimized with regard to balance between personnel and automation.

It is obvious the issue of minimal manning is centered on the economic factor where shipowners and shipping companies don't want to spend a lot of money to fight an enemy that no longer exists. Today, technology is there, it permits building of highly modernized and rationalized ships, which allows being completely operational with fewer crew. The acquisition cost of this ship may be very high, but the savings realized from crew reduction would justify the cost. However there is a point where the cost of the automation outweighs the benefits of reducing crew size. (Ship design and procurement. (Visiting Professor Cushing, April 2000). Figure.4.2.

Merely covering the economic part by providing more sophisticated equipment for new ship will not enough prevent accidents because there are several human factors that must be considered in conjunction with automation. Experience of modern technology in the automobile and aviation industry has shown that advancing levels of automation can produce at least two problems:

- First, at short-term loss of situational awareness: As machine replace humans are moved from the role of operator to that of supervisor, and are moved further away the actual process. And as result of decreased interaction with the system, the supervisor may be unable or slow to detect problems.
- Second, at long-term skill decline: with increasing automation, operators assume the role of technician and move away from hands on experience. The loss of hands-on experience can lead to loss of proficiency in basic control

functions as well as critical delays when the operator is required to override the automated system.

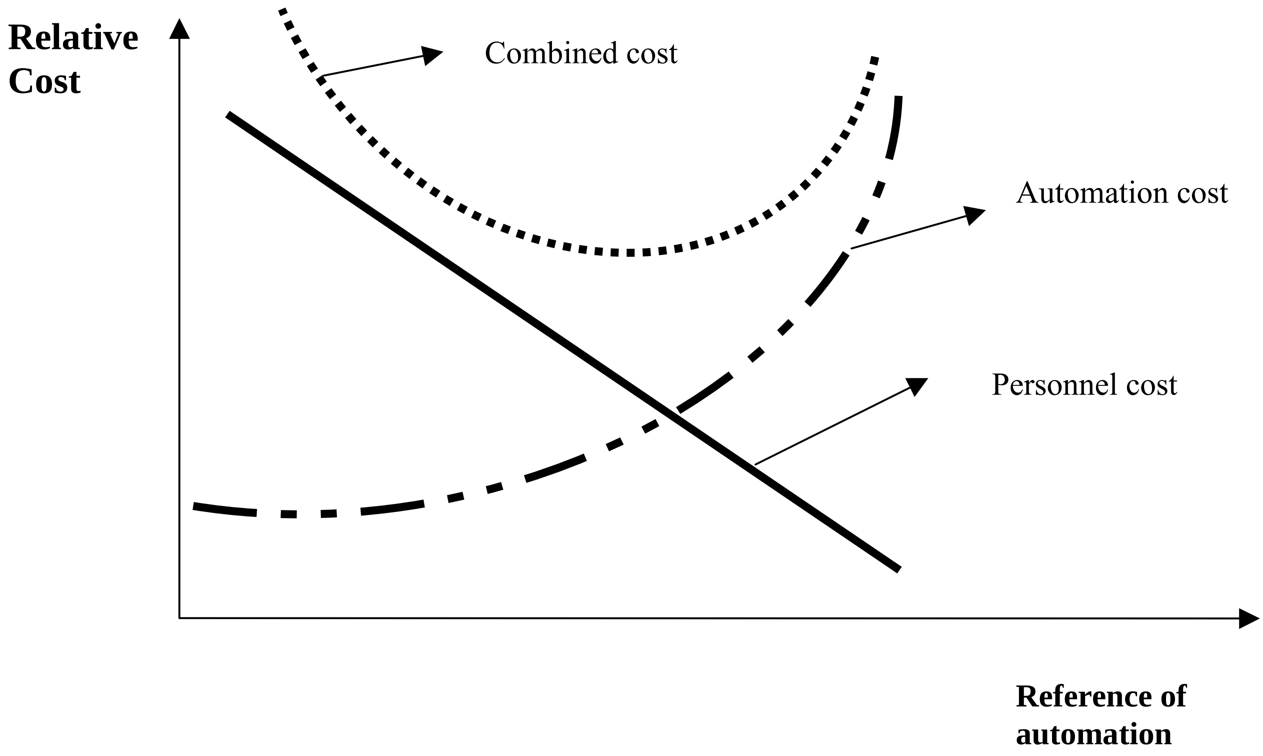

Fig 4.2: The relationships between the level of automation and acquisition cost, operating cost, and overall life cycle cost. (The shapes of curves are not as important as the concepts that are illustrated).

But as the technology changes, teaching methods need to change to improve education and training in order to help prevent maritime accidents and casualties.

To provide the minimum technical requirement of deck officers and marine engineers for assuring the ship safety and reliability of sectional duties on board ship, efficient and effective specialized knowledge is needed. As for the engineering side, the enhanced technique is essential for operation of the propulsion system: such as running up the engine from dead ship, monitoring methods of working machinery malfunction and fault.

With these changes and developments explained above, marine officers should now change the way they operate in order to keep abreast with the modern technology. One way to do this is by simulating the operational environment; from ship handling to emergency maneuver under distress conditions.

Many current Maritime Education and Training institution around the world particularly in Japan are established professional centers with modern professional development theory and practices. They have widely noted that the training using simulators for the above kinds of technique is very effective, efficient and safe (Pr. Hikima, METE 2000).

The use of simulators is becoming an accepted method of training. Over a period of more than 25 years it has proven to be a reliable tool, if properly used and understood, for training and post studies. However each institution has developed its own simulator-based training course and schedule, which is a not always fitted smoothly into comprehensive training program.

It must be borne in mind that training effectiveness will increase not only by equipment capabilities such as simulators, but also in how educational methodology is applied. As a result of limitations of the simulator itself and of simulation technology in general, even that part of reality reproduced by the simulator is not an exact copy.

Pr. Listewnik, Maritime University of Szczecin, Poland of the answers this question: “Fortunately, this is not always necessary, simulator most reproduce a certain part reality depending largely on the training and studies objectives.” And about degree of fidelity of simulator and how it influences results, he sad: “This can be achieved by combining theoretical knowledge with practical knowledge and experience, in particular with the scenarios to be simulated".

4.3 UNITED STATES MERCHANT MARINE ACADEMY.

The experience gained by the author of this dissertation on a field study to United States Merchant Marine Academy (USMMA) Kings Point, New York have revealed to some point simulator training is gaining popularity and its effectiveness in the transfer and absorption of the knowledge from the instructors to students involved is more efficient and faster.

A full mission engine control panel (an actual control panel transferred from the ship) gives an insight to students in understanding their responsibilities as marine engineer officers after graduation. A PC based simulation with students'station is used for basic training of systems and equipments on board. Students' interaction between themselves and the instructor has been possible and this is important for crisis management of engine room control.

Simulators are much cheaper than ships, cheaper to run and save time. When using simulator, a working ship does not need to be diverted from it normal route. Computers are able to put a student of the right area instantaneously. The programmes installed in these PC based simulators are exactly repeatable. The exercises can be rewound and run again from any chosen point to drive home a particular lesson. Furthermore, simulators above all, are safe. Students could be taken through exercises, which would be completely impossible in the real word. They can be allowed to overload the main engine or overpressure an auxiliary boiler with out any injury or damage, a situation, which could not be attempted on real ship.

Students in their second and third year, have an average of 4 credit hours in PC-base computer labs where, basic engine room system, operation of the main auxiliary engines and boilers, electrical system and including load sharing arrangement are taught.

The response of the students with this knowledge gained in the simulator one student explained, that is very effective from the first moment onboard the M/V-Kings Pointer (Motor-Vessel training ship). The added advantage for the PC based simulators is that students may practice on any item on their own even after lecture hours.

The full-mission simulator, being in its original form of a standard engine room control desk, is mainly for third and fourth year studies students to learn about real operation of engine room data collection (temperatures, pressures etc…), assessment of data and derivation of conclusion about the health of the engine. Trouble shooting exercises can be simulated and competency in engine operation at watchkeeping level assessed.

4.4 HOGESCHOOL VAN AMSTERDAM, NETHERLANDS.

The engine room simulator is a Configuration of Workstation Version supplied by Kongsberg Norcontrol. There are six student workstations from which either individual or group of students can work as an engine room team. The simulator room has in addition, a projector that can be used for initial learning. It has been linked with an instructor station where any program can be selected for elaboration.

The simulator have been installed with a PPT2000-MC80 (Propulsion Plant Trainer 2000) program which simulates graphics for engine room plant of VLCC (Very Large Crude Carrier) installed with MAN B&W 7K80MC main engine, two-stoke diesel engine driven generators, shaft generator, turbine driven generator and one emergency generator (diesel engine driven). The software of this model is based on real engine data that make the dynamic behaviour of the simulator closely similar to a standard arrangement on board a modern ship. Auxiliary equipment necessary to support effective/efficient plant operation, storage, settling and daily tanks, pumps and pumping systems including identifications of various colour coding for different fluids may be simulated. Coolers, purifiers, condensers, and exhaust gas boilers, refrigeration etc…are among the items that can be graphically displayed and simulated.

This simulator can provide training in action for all simulated devices and equipment under normal operations and abnormal emergencies. Students are also trained in locating and finding faults. It can provide a realistic demonstration of the various types of faults, malfunctions, deterioration and their effects on the total plant efficiency. An example of these mimics from the PPT 2000 simulator is presented on figure 4.3.

The simulator has a very convenient instruction function. All systems are under control of the instructor, who can give an initial condition and ships operation mode to the simulator, start it running and freeze the simulator at anytime. The simulator speed can be faster or slower than normal condition, either in whole system or part system. It also has the function of play-back of the operation process to give the trainee a chance of analysis and find out faults of operation. The instructor can set more than 200 faults.

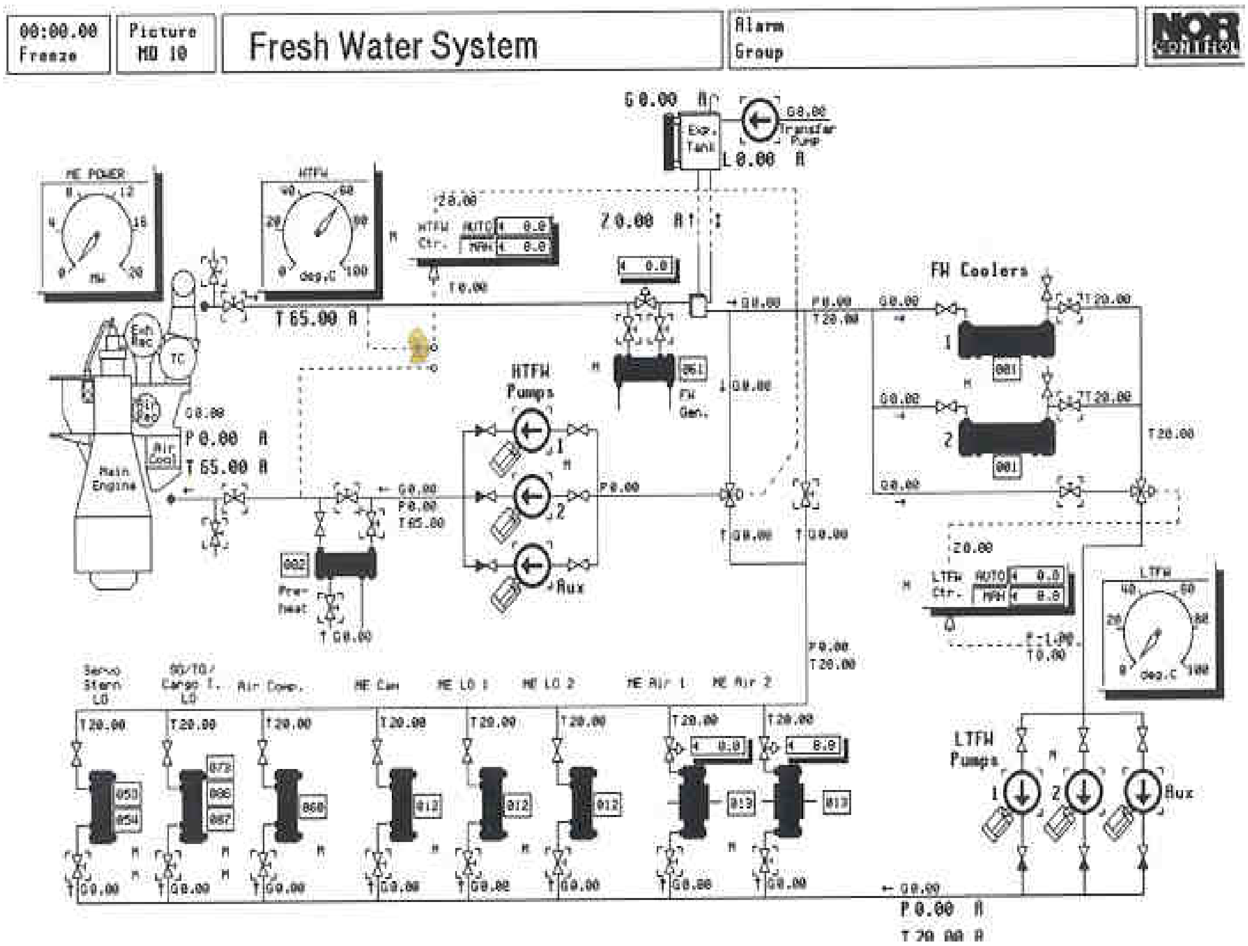

Fig. 4.3: Fresh water system

Source: Propulsion Plant Training (PPT2000) Manual, Kongsberg Norcontrol.

Key parameters can be trended at the instructor console to enable the instructor to monitor the state of the system.

The program is very effective for transferring the basic knowledge at an engineer watchkeeping level. Students may learn safety procedures in handling the engine room from cold state ship and post manoeuvres to emergency procedures of " bringing home the ship". The simulator program in general has all necessary facilities similar to that are installed in a modern shipboard engine room. Different operating parameters such as pressures, and temperatures can be observed and or set to indicate their effect on the plant operation. Control desks in the engine room and change over to bridge control together with audio-visual alarm gives students the impression of a real engine room.

In Hogeschool Amsterdam the engine simulator program is scheduled for students at the rate of 2 hours per week during the first and second year studies. Student can learn the basics of all engine room systems already mentioned above. Also, when students come back from sea services for their last year of studies they are doing more elaborate exercises such emergency procedures and trouble shooting on the simulator according to the requirement of STCW convention.

4.5 MARITIME UNIVERSITY OF SZCZECIN, POLAND

The courses are conducted on a level of four years professional studies and the graduate obtains a BSc degree in marine engineering. The engine room simulators installed in laboratory give a better picture of the practical training possibilities. The simulators are supplied by Kongsberg Norcontrol, which comprise:

- An operational version equipped with several consoles:
  . PTT2000-MC90 (MAN B&W) simulates a VLCC
- Workstation Configuration, it a configured Propulsion Plant Trainer include one instructor workstation for training and evaluation, and five student workstations:

. PPT2000- MC90 (MAN B&W)

. PPT2000-M11 (Krupp Mak)

In Szczcin Maritime University, students use the simulator only when they have completed their sea- going practice in ship engine department:

- Stages one at fourth year studies, students have 12 weeks simulator training at the rate of 3 hours/day/week. Simulators offer to students the possibility of conducting basic training in the domain of engine room operation. This allows to students to familiarize with plant and process dynamics to test start up procedures in order to learn the process of control and optimise the system of economic performance. This training experience on the simulator is required of students just before they train on real plant.
- Stage two is designed for Chief engineer courses, it a preparatory courses for certificates. They have 35 hours of simulator devoted for diagnostic issues.

4.6 ECOLE NATIONALE DE LA MARINE MARCHANDE DE NANTES (ENMM), FRANCE.

The unique feature of French maritime education is the polyvalence. At ENMM Nantes the courses are conducted in five years studies and graduates obtain a:

- Diploma polyvalent (deck and machine), and after sea time they receive a certificate of Master " Officier Superiéure de la Marine Marchande" on ships without limit of power and tonnage.
- Or, diploma monovalent (deck or machine) and can receive after period of sea time, certificate of deck officer or chef engineer on ships powered by main propulsion machinery less than 3000kw propulsion power.

The engine room simulator installed at ENMM Nantes is a full mission graphic ERS supplied by Norcontrol. The model is a single engine propulsion plant of B&W (6 cylinders, 17500kw, 90 rpm) two-stoke, slow speed, large bore engine with uniflow or loop scavenging. Figure 4.4.

- During second year students have one-week simulator on training in watchkeeping engine room operation.
- One week troubleshooting simulator in the third year.
- One week in the last year, students learn the process of control optimisation and the system of economic performance. The simulator is used at the rate of 6 hour/day.

According to instructor Mr, Allemandou Philippe chief department energy propulsion ENMM Nantes, the simulator has a great impact in preparing cadets for their future onboard ship. It provides them an approach method of engineering watch and also allows them to familiarise with the equipment, and to conduct the alarm, and incident procedures.

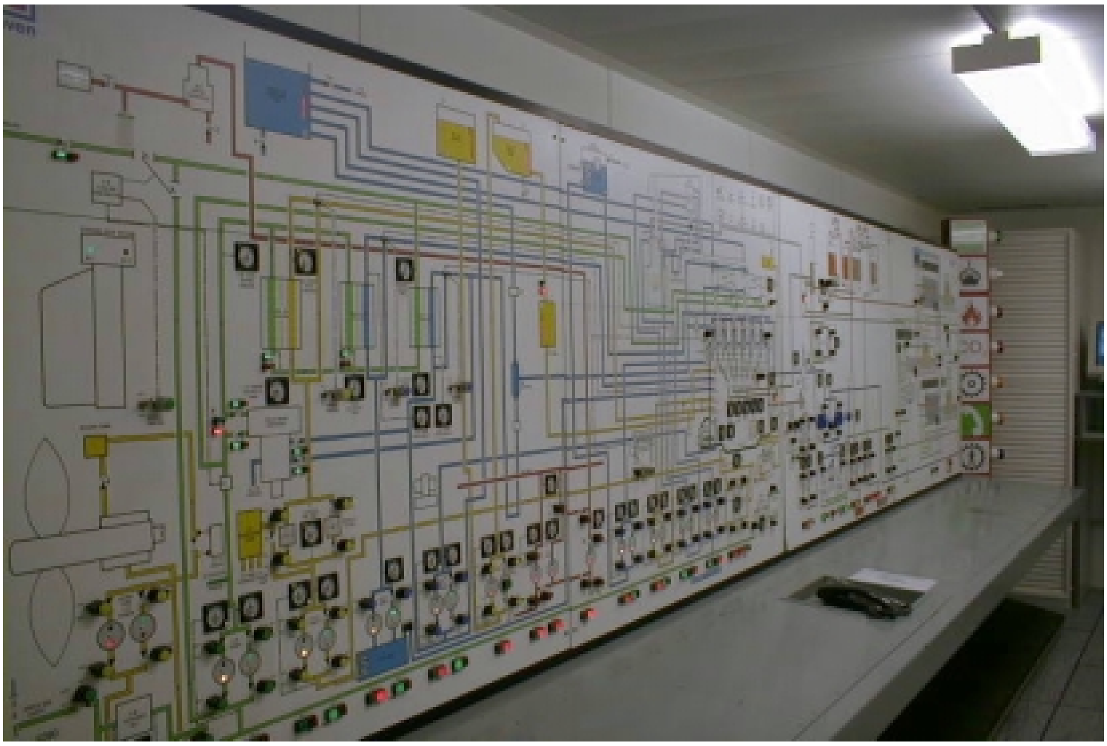

Figure 4.4: Full mission graphic ERS (ENMM Nantes).

Source: Field study photo report Pr. Hikima

4.7 WARSASH MARITIME CENTRE SOUTHAMPTON, UK.

The engine room simulator installed at Warsash Maritime Centre is a full mission ERS supplied by Transas Marine (figure 4.5). It offers an environment of full functional ship's engine room, comprising a control console which is provided for monitoring operations that are simulated in the engine room operating room.
The graphics established in this operating room enable the simulation of a real life engine room. Control of fuel tank levels, pressure and temperature gauges for example are provided alongside operating switches.
The machinery space simulator is utilised for both cadets and officers up grading, and for assessment. Cadet marine engineers are taken through a four years BSc-course with the last year mainly for practical on board ships, workshops, and in the engine room simulator for one week. There is also an opportunity to use the simulator in this way in preparation for junior engineers certificate of competency, generally a class four certificate. With the aid of simulator and practical training cadets may graduate as junior officers holding a class for certificate of competency.
In addition, the machinery space engine room simulator is used for up-grading courses for engineer officers and used also as examination tool for higher certificate of competency.
Different courses such as Engine Room Systems Management course, which is generally a one week intensive program is aimed at training engineering officers in handling the machinery space in all operating conditions. Risk issues, efficient use as the resources, risk assessment and risk management along with environmental issues is taught at this level.
The simulator is utilised in a more cost-effective manner because of the fact that such courses may be arranged as tailor-made or in course training to suit the customers.

Figure 4.5: Full mission ERS (Warsash Marine centre Southampton).
Source: Field study photos report Pr. Hikima.

CHAPTER 5
SIMULATOR TRAINING NEEDS ANALYSIS.

5.1 TECHNICAL REQUIREMENT NEEDS.

511 FOR COURSE COVERAGE.

Maritime education and training in Algeria characterized itself by being too traditional for too long a period of time, often due to its heavy bureaucratic system which cannot be changed quickly. But with a new staff, the board of the Institute recognized the need for updating the curriculum. This has resulted in more effective communication between deck and engineering department and the application of multipurpose ship's officer curriculum. The realization of the multipurpose officer curriculum is only possible through the availability of adequate facilities and new teaching methods to cover all course requirements. Institut Supérieur Maritime (ISM) has number of modern facilities such as anti-collision ARPA simulator, satellite communication simulator navigational GPS, and a recent real diesel engine plant laboratory. In order to achieve the objective of improving professional competence and to keep pace with the changing technology and the job requirements of the new work environment, ISM has to review again the process of how to provide the training of sea-going personnel. It is clear that there is nothing that can replace a real sea experience for seafarers. The trend of automation is increasingly apparent on board new ships. This situation has imposed high demands not only on professional skills and has also required enhanced situational awareness and timely and accurate communication between players in the work place. Thus, to meet these requirements and to optimize training, it is necessary to balance effective training between operational systems and simulation technology. Table 5.1 shows the quality outcomes of the main three methods used in maritime training. In developed countries, education and training by means of simulation is considered the most effective didactic tool for training. The average of 50% of their lecture theory of the curriculum is devoted to hands on practical experience in simulator laboratories. Japan is considering adopting simulators as substitute for the onboard training of crew. (MER, Marine Engineering Review, May 1993). Among its topics for discussion, the IMO STW sub-committee, which is undertaking further revision of the STCW convention, is looking at the expanded use of simulators as part of the training process for providing knowledge and skills to the future merchant fleet officers.

Table 5.1: Comparison of quality outcomes of various training methods.

Quality outcomes	Sea training vessel	Diesel engine Room plant	Engine room simulator
Hands on experience	XXX	XX	X
Effective training & maximum flexibility	X	XX	XXX
Safe and cost less training	X	XX	XXXX

X: Good, XX: Very good, XXX: Excellent

Since the reluctance of certain Algerian maritime companies to provide for the onboard training of the crew, which may due to economic problems, has resulted in situation where cadets have been unable to gain sufficient on board experience. And the traditional existing facilities at ISM such as workshops and diesel engine plant laboratory are not enough for covering efficiently the engineering programs. To provide trainees with relevant applied skills necessary to fulfill the role as officer in charge of an engineering watch, the author proposes to insert simulation into the existing course:

- To stop a gap in training.
- To enhance the teaching programs.
- To give the opportunity to student for using modern technology.
- To implement the use of simulation to integrate and enhance skills of future sea-going staffs.
- In order to take over, conduct and hand over the watch in accordance with recognized standards and practices.

<u>Type of courses:</u>

There are three types of simulator courses proposed:

1- A basic operational training using a modern interactive teaching aid for both disciplines which is integral of the engineering part. This course will be inserted in the third-year program. The objective is to develop safe operational watch-keeping routine. The main subjects of this teaching program will be as follow:

- Introduction: "simulator basics, operating instructions, engine parameters inspection".
- Engine start, stop and load change: "the engine when stopped, the engine parameters when running, the engine parameters under different speed and load, the actual and the reference parameter values".
- Different operation conditions simulation (minimum and maximum value of the range): "the ambiance air pressure and temperature, the cooling water pressure and temperature, the lubricating oil pressure and temperature"…

- Single simulation (minimum and maximum value of the range): "air filter-increase in air path resistance, air blower-decrease in air flow efficiency, gas turbine- increase in gas path resistance, air cooler-decrease in air resistance, gas leak trough piston rings or

- Both valves and fuel effective quantity decrease, injection advance angle change, decrease in cooling efficiency, friction coefficient increase, engine speed, engine load”.

2- Second course will be designed especially for engineers during the last six months of advanced training courses. This course will increase trainees awareness about economical and optimized operational such reaction and response when faced with serious problems, crew operation when abnormal situations develop, tracing and handling of errors/malfunctions within the system, and bringing the engine room back to normal operation. The content of this course is as follow:

- Multiple simulation: “air filter fault with all other simulations, air blower fault with all other simulations, gas turbine fault with all other simulations, gas leak through the piston rings with all other simulations, the fuel effective quantity decrease with all other simulations, decrease of cooling efficiency with all other simulations, friction coefficient increase with all other simulations, engine speed with all other simulations, and engine load with all other simulations”.
- Live Run exercises: “general maintenance strategy discussion based on the examples”.
- Live Run test: “first test, second test, result discussion”.

3- Third it a short course in marine continuing professional development. The aim of this course will be designed to enhance the knowledge and skills of junior engineer (or refresh more experienced chief engineer) in order to improve and to encourage a systematic approach to the management of engine room system and operations through practice.

5.1.2 FOR ASSESSMENT OF COMPETENCE.

Besides being a training tool, the simulator can be useful used in many assessments of competence for certification of seafarers. ERS can be applied favorably for assessing competence of engineer officers. However the simulator training for engineers is not a mandatory requirement under STCW 95 convention, but the purpose of using this facility is made to improve the reliability of the assessment by providing a mechanism to raise the standards of competence and professionalism of seafarers. And as it is stipulated in STCW 95, the requirement for certification of engineer officers at the operational and management levels should demonstrate the ability to undertake the duties and responsibilities by examination and assessment.

Type of tasks:

The main tasks of engineer officers, which can be assessed and trained by engine room simulator, are:

a- At the operational level.

- Operations of generators and all control systems.
- Operations and maneuverings of main engine and auxiliary machinery and all associated systems.
- Routine procedures for preparing the engine room system.
- Routine checking and preparing of engine plant system in port such as cold standby.
- Operations of all pumping and its control systems
- Maintaining a safe engineering watch.
- Maintaining the seaworthiness of the ship.

b- At the management level.

- Planning the operations.
- Overall actions and procedures for engine room processes, management
- Locating and finding of system conditions such as single fault.
- Routine remedial actions and procedures.

- Emergency operations and procedures
- Fine-tuning of process in main and auxiliary system.
- Optimization of the whole plant and setting factor affecting ship's economics and safety.

5.1.3 FOR RESEARCH.

The objective of introducing simulation in training programs is a means to complement the existing facilities at ISM and improve the hands-on training. Such advanced technology will help to orient the Institute in its preparation to keep up-to date with developments in the training standards around the world as proposed in the STCW´95 Convention. But, the opportunity may also open doors to do some advanced career education in diesel engine principle, where students can conduct some scientific research work on:

- Optimization of fuel consumption.
- Studying the efficiency of diesel engine.
- Studying the cause of machinery failure.
- Studying the case of emergency procedures.
- Controlling exhaust gas emissions.

5.1.4 SIMULATOR APPROACH.

- Simulators should not be complex or expensive. They should be simple to use both for instructors and students. Simulation could be used to ensure familiarity with the various systems and process involved in operating an engine room. All situations, which effect on engine room operations, should be easily simulated. The degree of difficulty and complexity of training can be adjusted to match the knowledge and skill level of trainees who have little experience at sea, or the level of a qualified senior engineer with years of sea time.

- Simulation should be used to intensify course and to reduce the time for training. It should be also flexible in arranging for tailor made courses and bring the balance between the benefit of time and quality of simulation exercises.

- The structure of simulation course should be flexible in order to manage the unpredictable responses of the various trainees and skill within the basic course script.

- The repeatability of simulation training must be possible to have consistency in training programs. This will allow better monitoring of results and analysis of any trends.

- The overall impact of students' actions on the engine room can be observed right away, which allows them to see the cause-and-effect of their performance.

- Simulators should provide an appropriate method for measuring, evaluating, and assessing individual mariner performance in order to test their levels of competency and proficiency.

- The simulation should form an important part in the total training concept and should allow to students to study at their own speed and convenience. It should also lead them through simulation training together with real sea training to meet the high standards of knowledge designed both by ISM code and STCW95 requirement.

5.2 TECHNICAL AND FINANCIAL CAPABILITY TO PURCHASE THE SIMULATOR.

There is no room for doubt, the full-mission engine simulator with its high fidelity models is the most useful facility for ISM to enhance its programs and enhance the skills of trainees. But this is not an alternative today, first because of its high price, and second when the opportunity was presented in 1992 to choose between full-mission engine simulator and real diesel engine plant, the decision was made to opt for a real diesel engine plant. The aim of this paper is to advocate an adequate engine room simulator, which can complement perfectly the real diesel engine plant installed at ISM Bouismail.

With regard to above analysis, the experience gained during the field trips through Maritime Education and Training institution in the world, and the different demonstrations from the manufacturers; the author has widely convinced that there are three types of engine room simulators mentioned below which could provide an appropriate training platform, relevant to training objectives, and be easy to use and to maintain. However, for technical operation of ships and training watch keeping at ISM Bouismail these simulators could be the most excellent tools.

- The Kongsberg Norcontrol Engine Room Simulator used at Hogeschool Van Amsterdam: Type PTT 2000 MC 80. It simulates a Very Large Crude Carrier (VLCC), with diesel engine: MAN B&W 7K80 MC. The software of this model is based on real engine data that make the dynamic behavior of Simulator close to real engine response.

- The Networked PC Version of Marine Soft Machinery Space Simulator. According to the demonstration Dr. Harro G. Kucharzewski gave during his time at WMU this simulator is very convenient, flexible, efficient, and economical and can work in a multimedia environment providing easy to understand images, sound and text.

- The Transas Engine Room Simulator type ERS 2000. It a PC-based networked which can include many interactive workstations. The simulator can be used for both individual and team training.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS.

6.1 CONCLUSIONS.

The polyvalence program in marine officer training is the obvious choose, and no doubt it will enable maritime companies to meet their needs, allow them to be more flexible in utilization of crews, and integrated officers will become efficient, employable and enjoy greatly job satisfaction. Based on the field trips study of the MET program, in developed countries such as USA, Norway, Netherlands, France and UK, it is clear that they give the STCW convention full and complete effect. And also they pay more attention in using modern teaching methods emphasizing on new equipment and facilities, which allow their students to meet the demand of the trade locally and internationally.

Unfortunately, with insufficient facilities at ISM Bouismail, the reduction of sea-time period becomes difficult to manage with the companies. Thus, due to the lack of availability of training berth on board, training will become less effective. To solve the problems of the training process and to improve practical skills of trainees when working and interacting new technology system require a high training quality. It is really important today that ISM takes with great consideration this purpose goal of introducing simulation to enhance its program.

Introducing such simulation into the curriculum will help ISM to overcome its problems and without a doubt, it will be the best compromise training solution to enhance the modern merchant ships´ training, in order to assure the high standard of competence of the marine officers. The graduates will be highly qualified skilled. This is in line with government's policy to encourage ISM activities to have quality standard in place and to train marine officers at high skill levels in order to serve tomorrows-shipping companies efficiently.

6.2 RECOMMENDATIONS.

The International Maritime Organization (IMO) is currently making extensive revisions to its Standards for Training, Certification and Watchkeeping guidelines, including specifications and uniform standards for attaining competence in maritime education and training. The criteria with detailing the standards of knowledge understanding and proficiency to be achieved in each element of competence by candidates for certification. However, part A, section A-I/12 of the STCW95 code contains mandatory requirements concerning performance standards for simulators and section B-I/12 contains guidance regarding the use of simulator.
ISM Bouismail implements and complies with revised STCW conventions. But for the development and qualification of professional mariner officers' knowledge and skills at international level, it is urgent for ISM to use marine engine simulation in conjunction with other training methodologies during routine training.

The greatest benefit of simulation for training is realized with a more structured system of new courses, the continuous improvement of the existing courses, and a need for specially trained instructors who have the skills and knowledge requirements to conduct training in a specific simulator. Therefore, it is important to set up a committee to manage this project of engine room simulator to be able to:

- First, to design new curriculum in order to integrate ERS programs into the marine engineering syllabus as an effective mechanism for assessing the candidate's knowledge and instructor's ability to apply that knowledge, to prioritize tasks, and to perform several tasks simultaneously. The main points are:

- Identifying clearly training objectives.
- Developing standard course syllabi.
- Establishing instructor qualification.
- Codifying procedures for teaching all functions routinely required aboard ship.
- Creating student evaluation and assessment methodologies.
- Structuring industry wide research and program effectiveness measures.

▪ Second, as the ISM staff has little experience in operating engine room simulators, selecting an appropriate ERS. And in order to meet the objectives assigned, to specify the training needs, and to provide the adequate funding; consultation of outside experts such as professional marine engineering, international marine educators, and representing manufacturers will be needed for advising the committee.

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APPENDIX 1

MARINE SOFT MACHINERY SPACE SIMULATOR VERSIONS OF CONFIGURATION AND PRICE LIST.

Figure A.1.1: Single-PC System

Figure A.1.2. PC- Net version with instructor workstation

Figure A.1.3: Console version with instructor workstation.

Figure A.1.4: Combined PC-Net-Version with console.

Figure A.1.5: Machinery Space simulator Price List 1999

APPENDIX 2

QUESTINNAIRE FORM

WORLD MARITIME UNIVERSITY (WMU)
MALMÖ, SWEDEN

To Whom It May Concern:

I am a student at the World Maritime University Malmö Sweden, doing Maritime Education and Training (MET) postgraduate degree.

In partial fulfillment for the award of Master of Science degree, I am writing a dissertation titled ***" Investigation into the feasibility of introducing a marine simulator into our MET in Algeria".*** Therefore, one of my chapters is on the users of engine simulators, as a result I am seeking the opinion of the various professionals using this type of teaching tool.

The purpose of this short letter is to request for your opinion regarding the engine simulator by answering the attached questionnaire.

I will highly appreciate your assistance on the matter.

Thank you,

Djelloul Bouras

WMU

My address
Djelloul BOURAS
Henrik Smith Hostel
Malmö Sweden
E-mail: s00004@wmu.se

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Questionnaires.

1. What is the type of engine simulator do you have in your Institution?
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2. How is it used in your program?
(Education, training, assessments… hours allotted/year…)

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3. How did the simulator improve your training program?

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4. What is the qualification of the simulator's instructors?

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5. How is the simulator maintained?

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