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# Proposed training of cadets on the ship handling simulator of the Pakistan Marine Academy

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# PROPOSED TRAINING OF CADETS ON THE SHIP HANDLING SIMULATOR OF THE PAKISTAN MARINE ACADEMY

by

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

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

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To,

My PARENTS, WIFE and SON

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# ABSTRACT

PROPOSED TRAINING OF CADETS ON THE SHIP HANDLING SIMULATOR OF THE PAKISTAN MARINE ACADEMY.

The Ship Handling Simulator at the Pakistan Marine Academy has been operational since March, 1989. However to date it has only been used for the conduct of mandatory courses for Certificates of Competency examinations and revalidation. The pre-sea nautical cadets are not given any practical training on the SHS.

This dissertation presents a proposal for a training program for these cadets which is run as a separate module from the main routine. The aim of this is to evaluate requirements for future syllabus up-gradation which would incorporate use of SHS for training.

The pre-sea nautical cadets undergo two years training divided into four semesters. During this time they have done practical and exercises on Radar/ARPA simulator, as part of the radar navigation syllabus and studied all the required theory about navigation and seamanship. The proposed training program on the ship handling simulator allows them to use this knowledge in practice. The training will run for a duration of 10-12 weeks, during the last semester. This time constraint to the training period has been chosen in view of the pilot nature of this program and the present training structure at the PMA.

The SHS of the academy has three exercise areas, Karachi and Adjacent Coast, Hong Kong and Adjacent Islands, Pacific Ocean Area South-East of Japan. There are five different types of ships that can be handled, from VLCC to Ro-Ro.

This paper begins in the first part by a brief look at the Pakistan Marine Academy (PMA), and the maritime training of cadets. The next chapter studies the evolution of simulation and simulators in general and the development of ship handling simulators in particular to the present state of art. Also looked at, is the SHS training of cadets in the nautical schools of 3 countries representative of different maritime training systems. The matter is dealt with in a concise manner as the subject has a vast scope. Next the details of the simulator fitted at the PMA is presented. In the fourth chapter the proposed training program for PMA nautical cadets is set out in detail. In the final chapter the conclusions drawn from this proposal are given and some recommendations made.

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# CHAPTER 1

## INTRODUCTION

### 1.1 PAKISTAN MARINE ACADEMY.

The Mercantile Marine Academy was set up at Chittagong (former East Pakistan) in 1962. There it functioned until November 1971 when it was temporarily re-established in New Hajji Camp at Karachi and renamed Pakistan Marine Academy (PMA). The Academy was finally shifted to its newly constructed premises at Mauripur Road, Karachi in June 1978.

The purpose built campus has an area of 136 acres in the North West of Karachi Harbor. The Southern end of the academy grounds open to the Mauri Creek which connects with the Arabian Sea. It comprises an Administration cum Instructional Block, Cadets Residential Block, Workshop, Simulators Hall, Mosque, Bank, Jetty, Swimming Tank, Play grounds, Medical Center, Post office, Seaman's Training Center and Residential colony.

### 1.2 PRE SEA TRAINING.

Young boys of not more than 20 years of age, physically fit in accordance with the physical standards laid down by the Academy and holding Higher Secondary School Certificate (HSC:Pre-Engineering subjects) qualifications in at least 2nd division or its recognized equivalent are admitted on Regional/Provincial quota-cum-merit basis. Foreign students holding equivalent qualifications are also eligible for admission with the approval of the Government of Pakistan. The Academy has trained cadets from Republic of Iran, Malaysia, Sri Lanka, Ethiopia and Saudi Arabia.

The organization of the PMA cadets follows a regimental system patterned similar to that of the national Naval Academy. The cadets wear uniforms and are trained in military routines and discipline by officers and men seconded from the armed services to the PMA. The Commandant is appointed from the Pakistan Navy.

The duration of training at the Academy stretches over a period of two years divided into four terms allowing two months summer vacations during June/July and 15 days winter vacations during December/January every year. The daily schedule of the PMA is divided into three periods. The daily class schedule is from 0800 - 1400 hrs. daily except Friday which is a holiday. The morning and evening periods from 0530 - 0800 hrs. and 1400 - 2200 hrs. are allocated for homework/study and other training. During the above mentioned training period, academic and professional subjects are taught in and out of the classrooms in accordance with the syllabi approved by the Ministry of Communications, the Government of Pakistan and the University of Karachi. Apart from academic and professional training, general training is designed and conducted to develop leadership qualities, inculcate discipline, broaden perspective and develop overall personality. These objectives are achieved through extra-curricular activities such as physical and parade training, sports, talks and debates, pulling and sailing, lectures by prominent scholars/professionals and visits to ships/industrial organizations.

In 1986 P.M.A. was affiliated with the University of Karachi for award of B.Sc degree in Maritime studies to cadets who have successfully completed prescribed course of studies. This enables the cadets to continue their academic career if not absorbed by the Merchant Navy. Cadets securing distinctions in academic/professional subjects and general training are awarded medals and prizes. Efforts are afoot to start a four years course in Marine Engineering (B.E. Degree). The PMA is also recognized as a branch of the World Maritime University at Malmo; Sweden, for the conduct of IMO specialized short-courses and seminars.

Modern and scientific techniques are being adopted to train young seafarers to compete with the fast growing world of automation and computerization. Audio visual aids, video films, library stocked with nearly 10,000 text/reference books, well equipped laboratories and workshops, models of machinery and other gadgetry fitted on board vessels are available for imparting effective training. A language Laboratory with latest facilities helps our trainees, specially the foreign students in improving their command over the English language which is as important to assimilate and comprehend the academic and professional subjects. A most modern computer laboratory has recently been established both with a view to familiarize the cadets with computer technology and the learning of Nautical and Engineering subjects.

In 1986, the Government of Japan offered to provide Grant-aid for advanced Maritime Training Equipment to PMA. Phase I & Phase II of Up-gradation project of PMA have been completed on 19th March 1988 and 25th March 1989, respectively. During these phases the following equipment has been acquired:

NAUTICAL EQUIPMENT

Radar/ARPA Simulator (RAS)
Ship Handling Simulator (SHS)
Celestial Navigation Equipment
Models of Ships
Loading Calculator
Gyro & Magnetic Compasses
Cargo Handling Derricks

ENGINEERING EQUIPMENT

Engine Plant Simulator (EPS)
Workshop machines.
Testing and measuring equipment.
Cutaway models of pumps etc.
Fluid testing analyzers.
Models of Diesel generators.
Micro computer experiment device.

## 1.3 TRAINING STANDARDS.

The minimum knowledge of navigation and seaman-ship that a Master or Watch Keeping Officer must have are given in the IMO document, International Convention on Standards of Training, Certification and Watch-keeping for Seafarers, 1978.(STCW 78)
This knowledge is categorized for various grades by the Gross Registered Tonnage of the ship in which the seafarer will serve. The document details the requirements in appendix to regulation II/2 for certification of masters and chief mates of ships of 200 gross register tons (GRT) or more, and similarly in

appendix to regulation II/4 for certification of officers in charge of navigational watch on ships of 200 GRT or more.

However this document is out-of-date in various areas and most countries follow higher standards while fulfilling basic requirements. In the future it will be revised, keeping abreast of developments in maritime practice.

Moreover the International Maritime Organization (IMO) and the International Labor Organization (ILO) jointly prepared International Maritime Training Guide published as a Document for Guidance 1985 in which updated recommendations for training with reference to the IMO STCW 1978. Additional knowledge requirements are given herein keeping in mind the later developments.

## 1.4 NAUTICAL SYLLABUS.

The nautical syllabus for the cadets at the PMA, uses the minimum requirements given in the appendixes to regulations II/2 and II/4 of IMO document STCW 78, as the baseline. The syllabus for navigation and seamanship relevant to this project, is outlined in the Appendix . As Pakistan has ratified the above convention the present syllabus still incorporates some parts which are or will be obsolete in the future merchant ship. However the updating requirements contained in IMO/ILO International Maritime Training Guide are already incorporated into the present syllabus.

In Appendix is also given the detail of topics from various sub headings which are to be practiced in the exercises during the proposed SHS training. The relevant matter is marked in bold text.

## 1.5 PART OF TRAINING ON RADAR/ARPA SIMULATOR.

The section Radar Navigation is covered in all the four semesters. The practical training is given by using the Radar/ARPA simulator.

The first term consists of 16 lecture periods and includes basic theory and practical demonstration by instructors. The remaining three terms are taken up with theory and practical training on the Radar/ARPA simulator. The Radar/ARPA simulator has four own ships cubicles and 6 ship types can be simulated, from VLCC to small pilot craft. In addition 20 different targets can be displayed at one time and they are of 7 different types of ships. The four own ships can interact with each other or can be paired independently. The exercise area can be chosen from 7 different types from European waters, Singapore Straits and Japan.

The final term cadets will have no difficulty in transferring to SHS as the Radar/ARPA equipment is identical, and the practical training here covers certain tasks like vessel maneuvering, anti collision, radar assisted navigation etc.

# CHAPTER 2

## SIMULATION

### 2.1 ASPECTS OF SIMULATION.

The word simulation is derived from 'simulate'. The English Language Concise Oxford Dictionary defines simulate as 'imitate conditions of (situation etc.) with model: for convenience or training (in para phrase) made to resemble the real thing but not genuinely such '. Looking at the above definition the key words are imitate,conditions/situation,model,convenience/training. From these it is seen that to create an imaginary situation or condition using a model for training or research some device is needed and this is called a simulator. The Longmans English Dictionary defines simulator as 'a device that simulates various conditions or the mechanisms involved in operating a system, in order to train operators or for the purpose of research'. Looking at some aspects of simulators in various fields we have the following:

(i)Design and Research: Here a simulator solves problems for which no mathematical solutions exist. Example. Phase Lock Loop and other non-linear technical devices, Trial Maneuver on the ARPA, Towing Tank and Wind Tunnel.

(ii)Accident Investigation: Reconstruction of a catastrophic situation to analyze its causes. Examples are maritime accidents like Admiral Yakinow - Petr Vasev, Exxon Valdez, Herald of Free Enterprise. Nuclear disasters like Chernobyl and Three Mile Island. Chemical disasters like Bhopal.India.

(iii)Research and training:Assess or/and improve operator performance of a system in various situations.For example Flight simulator, Sat-com simulator, ARPA simulator, Ship handling simulator, Liquid cargo handling simulator, Engine room simulator, VTS simulator.

This project deals with the last mentioned class of simulators, in which there are three "areas" present. This is shown in figure 2.1

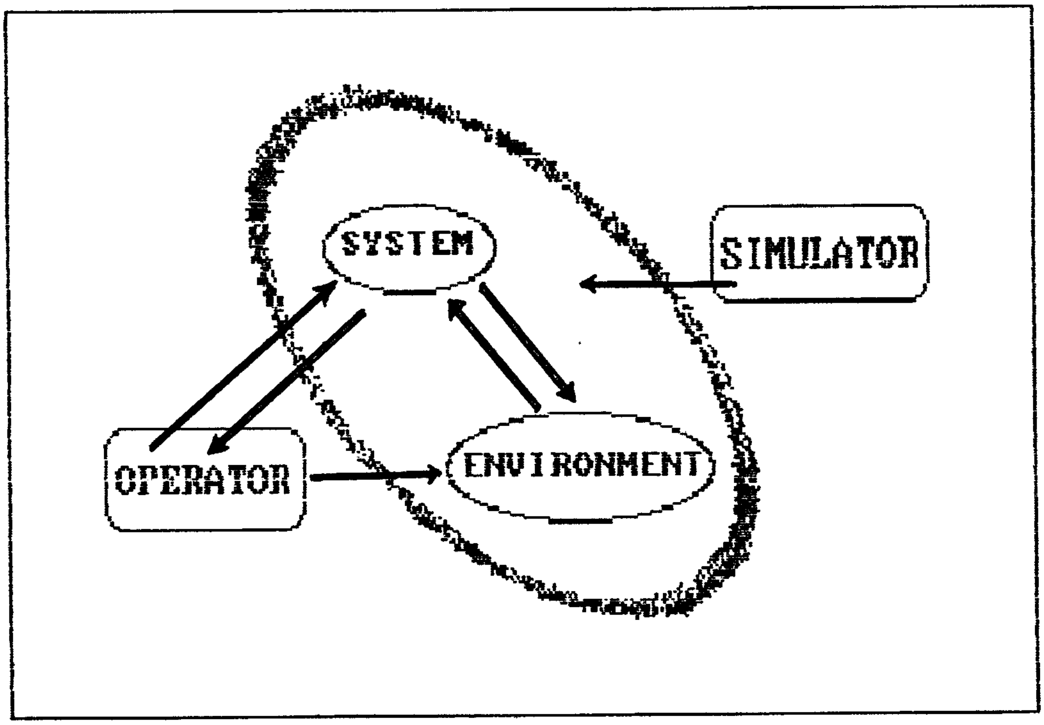



Figure 2.1

What is needed to achieve the goals of the simulation is a sufficient model of the system and the environment. The criteria for the realism of the models depends completely on its application.

In a flight simulator the environmental model (outside view) is not very important nor is it difficult to simulate, the modelling of the aircraft accelerations and instrument readings are of major importance. In atomic plants, liquid cargo handling and communication simulators the environment also is not important.

In a ship handling simulator however the model of the system and the environment are equally important. This is the reason for the complexity of this type of simulator.

## 2.2 WHO USES SIMULATORS, WHY AND HOW.

Looking at the developments of the simulator in the historical sense, in context with the contents of the preceding paragraph, it is seen that the simulators antecedents are found within the earliest days of aviation. Edwin Albert Link is generally credited with planting the seed that grew into today's vast simulator industry.His first Pilot Maker was built in 1929, that is over 61 years ago from this day. Although the aviation industry has made further use of simulators than perhaps any other industry (with the possible exception of nuclear power and chemical plants), maritime simulators used for the training of merchant marine personnel and for research purposes have been available now for about 25 years. The simulator as a research and training tool is playing a more and more increasing role in our lives as the 21st century traverses its last decade. With the advancement of humans from an agrarian to a high tech society and associated developments in all sectors of industry following an exponential curve, the role for simulation is bound to become 'integrated' rather than 'if necessary'. This can be seen already in the nuclear industry, space exploration, aviation, military and many others. Looking at these names it can be seen that 'simulation' is very much a necessity for human behavior assessment and operator training in 'high risk' or 'no second chance' environments. Taking as example the historical landing of man on the moon. Just before Neil Armstrong, landed on the moon on July 20th, 1969, and uttered his now famous and well-prepared statement: 'That's one small step for a man, one giant leap for mankind', he also spoke less well- known words as he came in for landing: 'Everything is going A-O.K., it throttles down.... better than the simulator.' Before embarking on this spectacular space epic, Armstrong, had repeatedly practiced the maneuver in the most sophisticated simulator ever built. This is a very significant example of the use of simulators for operator training. In a nuclear power plant use is made of 'controlled and contained' nuclear processes to generate varying quantities of heat and subsequently electric energy. This is in contrast to the atomic bomb where an instantaneous maximum quantity of heat is generated without any 'control or containment'. Thus it is seen that a nuclear power plant if allowed to 'runaway' can easily become an atomic bomb. This can happen when the core temperature rises to a certain magnitude. Many factors and conditions can cause this and if these can be prevented from happening by certain actions, this dangerous situation is avoided. The operating personnel of the plant are practicing this and other emergency procedures using a simulator. Additionally, refresher and new operators training can be done here before going into

the real thing. This also applies to chemical plants. The above are just some examples from the broad spectrum of simulation users at present and this is widening fast.
In the maritime industry there are many different kinds of simulators in use. Some examples are Radar and ARPA, Navigational Equipment, Ship Maneuvering, Cargo Handling, Engine Plant, Off-shore Platform for Oil and Gas, Vessel Traffic System, Communications etc. In this project the application of a Ship Handling (Full Mission) Simulator for training purposes will be discussed.

## 2.3 DEVELOPMENTS IN SHIP HANDLING SIMULATORS FROM THE EARLY SYSTEMS TO THE PRESENT C.G.I TYPES.

2.3.1 Ship Handling Simulators evolved from the need to replicate as closely as possible the ship and its natural environment and the work that has to be done by the Bridge Team members.
Bridge work can be partitioned into three areas: navigation, maneuvering ship, engine and cargo control. However in the modern marine practice these are not separate tasks but interconnected by communication as shown below.

```
               1.NAVIGATION ---------------
              /                           ¦ Planning
COMMUNICATION -2.MANEUVERING              ¦ Execution
              \                           ¦ Monitoring
               3.SHIP,ENGINE,CARGO CONTROL ¦ Control
                 (this includes auxiliary ¦
                  engines,stability,      ¦
                  temperature,etc) --------
```

Distress communication is present in all three areas. This also is true for lookout, engine control and others such as cargo temperature, fire alarms watertight doors. Table I illustrates this.

Table I

| CLASSIFICATION OF BRIDGE WORK | | |
|---|---|---|
| NORMAL SITUATION | | |
| OCEAN | COASTAL | AROUND HARBOR |
| 1. POSITION FIX.<br>2. LOOKOUT.<br>3. CONNING SHIP.<br>4. ENGINE CONTROL. AUXILIARIES<br>5. NAVIGATION PLAN. CALCULATIONS OPTIMUM<br>6. CARGO. | 1. POSITION FIX.<br>2. LOOKOUT.<br>3. CONNING SHIP & MANEUVER.<br>4. ENGINE CONTROL. AUXILIARIES<br>5. NAVIGATION EQUIPMENT.<br>6. CARGO. | 1. LOOKOUT.<br>2. POSITION FIX & WATCH OF DRIFT.<br>3. CONNING SHIP & MANEUVER.<br>4. ENGINE CONTROL. AUXILIARIES<br>5. NAV. EQUIPMENT WATCH.<br>6. MOORING.<br>7. CARGO. |
| COMMUNICATIONS -->- | ------>---------- | ---------->-- |
| 1. RECEIVE WEATHER BROADCAST, TIME.<br>2. PUBLIC CORRESP. | 1. PUBLIC CORRESP.<br>2. TRAFFIC CONTROL.<br>3. INTERNAL. | 1. HARBOR CORRESPONDENCE<br>2. INTERNAL. |
| IN EMERGENCY: | | |
| | BRIDGE WORK | COMMUNICATIONS |
| | 1. COLLISION AVOIDANCE.<br>2. STRANDING AVOIDANCE.<br>3. INCIDENCE CONTROL CENTER. | 1. EMERGENCY COMMUNICATIONS.<br>2. INTERNAL. |

Therefore from table I we can see what kind of training are needed to practice these tasks.

(a) Keeping and altering course and track.

(b) Collision avoidance maneuvering.

(c) Emergency maneuvers and procedure.

(d) Conning of ship, monitoring of maneuvers in narrow channels;

(e) Berthing and deberthing maneuvers.

(f) Control and monitoring of main engine and auxiliaries.

(g) Communication procedures and performance.

(h) Adjustment, operation and use of navigational instruments;

(i) Action in case of equipment failure.

The necessary conditions for a perfect SHS can be seen from figure 2.2. Existing ship handling simulators always lack a number of these items. One of them is a perspective view which is only partially available.

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

These are:

(a) Reality:

Viewing scene from bridge.

Bridge layout equipment in bridge.

Sound, such as engine noise and signals.

Light conditions and vibration.

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

(c) Various viewing scenes:

Viewing condition in clear and foggy weather.

Night scene.

Presentation of various channels and harbors.

Encounter of various targets.

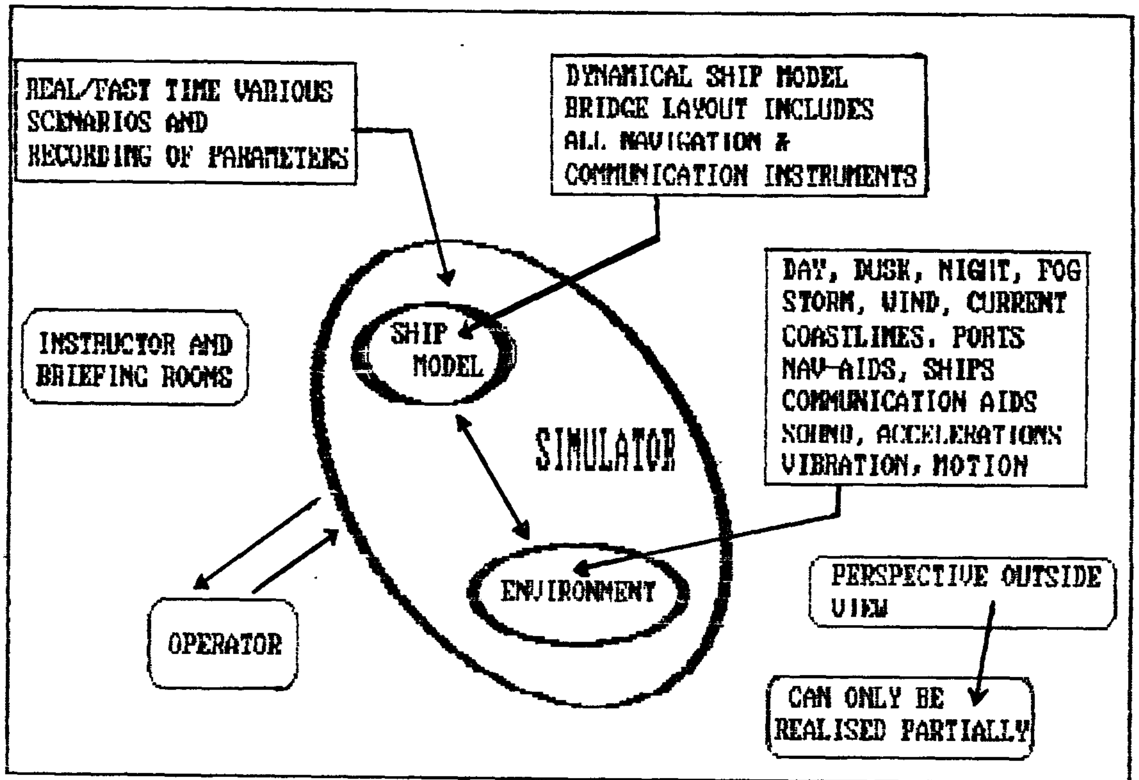


Figure 2.2

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

(e) Easy establishment of maneuverability of ship, tide and wind.

(f) Setting up sudden critical situations.

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

(h) Record of content and process of training.

2.3.2 Shiphandling simulation did not start with complicated electronic simulation, but originally started with what could be described as small scale models. It was ascertained during experiments at Grenoble, in France, that an accurately scaled down version of any specific vessel would in fact, render very satisfactory results for training in handling that particular vessel. In Western Europe there are only two establishments using this type of simulator for ship handling and research, namely Sogreah's Port Revel at Grenoble, France and one operated by The Southampton Institute of Higher Education, Warsash Campus. In both the establishments the models have been carefully engineered to replicate as exactly as possible all the dynamic characteristics of the vessels they represent, and all the ship handling exercises are carried out to a carefully calculated time scale. There are also reports that similar facilities exist in Eastern European countries which are mainly used in ship research.

There are however opinions contrary to the above, which consider the above method of simulation too unrealistic due to the size of vessels, the time scale and magnitude of the accelerations used. These are of the view that the degree to which this method of ship maneuvering contributes to ship handling capabilities is questionable, and has a negative effect on training.

2.3.3 Although the Japan Radio Company was the first, in 1967, to build a ship simulator, it was never put into full commission. The Dutch simulators at Delft and Wageningen were the first to be developed and used commercially beginning in 1968 and 1969 respectively. These used the shadowgraph point light source system. Three-dimensional models of the landmass, with horizon cut out and back-projected on to the screen with the aid of a light source. No other ships were possible within the usual scene but day, night and twilight exercises could be run.

The Japanese made use of the same technique for their simulators at the Tokyo University of Mercantile Marine (1976) and the Ship Handling simulator at Osaka University (1975). The restriction caused by the lack of other ships in the exercise area was overcome by superimposing a TV projection system over the basic shadowgraph. This could provide up to three other ships for exercise purposes.

The shadowgraph system allowed a full 360 degree visual scene. Its limitations were its inflexibility and an inability for Own ship to approach the landmass closer than one mile. However, its resolution was very good. The Dutch systems were used for both training and research, whilst the Japanese used theirs purely for research.

2.3.4 In the early 1970s, the Japanese were experimenting with a number of methods designed to produce a visual scene. A Ship Steering simulator was installed at Hiroshima University in 1971. The visual scene was produced by a color film and displayed by television sets over a 90 degree arc.

Television cameras were also mounted over modelboards and the picture projected on to the bridge front. The model boards represented in scaled form a known port area. A small TV camera tracked over its surface driven by commands from the bridge. Other ships could be included, but only on predetermined tracks. The Institute for Perception at Soesterberg was the first, in 1976, to be equipped with such a device. The black and white visual scene extended over a 120 degree field of view.

An extensive modelboard library of twelve port approaches was developed by the Sperry Rand Corporation for Marine

Safety International and installed in their simulation facility at La Guardia airport during 1976. Used for training only, a three camera probe projected a black and white picture over a 140 degree field of view forward and include a 40 degree stern view via a monitor. Five own ship types could be used at this facility. The disadvantages of the model board presentation are the initial cost of the scaled physical model, the time necessary to change from one gaming area to another and update the navigational changes on the board, and the rigid tracks that have to followed by the other ships in the exercise.

2.3.5 The Japanese company IHI, and the German VFW-Fokker (later Messerschmitt-Bolkow-Blohm), have been the only companies to develop, manufacture and install a visual system which projects on to the screen color slides previously filmed from a scaled model. IHI, in cooperation with NYK line , installed a $2m simulator in Tokyo in 1975. Four color slide projectors were used for the land mass, and one color film projector for the one Other ship. A 100 degree field of view was provided.
VFW-Fokker installed their system at the Hochschule fur Nautik, . Bremen and a similar system was used to update the existing point light system at the Ship Maneuvering Simulator, Trondheim in 1986. A third system, ordered by the Maritime Institute of Graduate Studies, Maryland (MITAGS), was canceled due to technical problems with its design. The 35mm film is wound in a continuous loop and projected on to the screen from a position on top of the wheelhouse.

2.3.6 Two types of nocturnal display have been produced: the turret system which projects spots of light onto a circular screen from a position on top of the wheelhouse; and the point light source system which projects light spots onto a flat screen positioned in front of the bridge windows. The former type has been installed at MITAGS, the Royal Netherlands Naval College, Den Helder, and HFN, Bremen: the latter, flat screen type at the UK Nautical Colleges in Warsash, South Tyneside and Glasgow. In this system, the simulator is installed within two 'portacabins' connected end to end. The bridge window, on which the visual system is projected, is positioned at the connecting face of the two portacabins. Sixteen computer controlled projectors positioned at the far end of the portacabin throw spots of light 7 meters onto the screen. The spots of light can be combined to portray the navigation lights of a ship, or used singly as light buoys, lighthouses or lightvessels. A maximum of three Other ships can be observed at any one time within the 100 degree field of view. Star, horizon and fog projectors provide additional visual cues. A view of the ships bow is also projected onto the screen.
Situated behind the bridge window is a fully equipped bridge of modern layout, including two radars and other bridge equipment, which is coordinated with the visual scene. The watchkeeper controls the ship through the autopilot, wheel and telegraph controls. Communication with other ships and shore stations is provided by a VHF radio. Internal communication to various parts of the ship is via inter-phones. Behind the bridge is the Instructors control room, in which the exercise is monitored and hard data output to an X-Y plot sheet on the matrix plotter. In the Warsash simulator, a suite of

13 ships are available as Own ship, ranging from a 253,000 ton VLCC to a coastal patrol craft. When the simulators were introduced in 1977, they provided excellent training and research facilities at low cost when compared with later technology. The use of spot projectors has now been superseded throughout the maritime simulation industry by Computer Generated Imagery (CGI). Since 1983, CGI has been used to produce the visual scene on all new ship simulators.

2.3.7 The CGI concept is not new: aviation simulation manufacturers have been developing the system for many years. One of the first maritime visuals was produced by CGI when, in 1973, the Swedish State Maneuvering Simulator was developed in-house, providing a 35 degree field of view through seven black and white TV screens.
There are three basic steps in designing a CGI picture for an exercise. Initially, the planner decides which objects the Watchkeeper should be able to see and from which directions they can be observed (thus deciding the number of faces). The three dimensional co-ordinates are then input to the computer memory, together with the color, texture and shading of the object. Finally, a suite of multi-used objects such as buoys, lighthouses and fields are added. During an exercise, the computer is programmed to output to the projection or TV system the visual scene that can be observed within the field of view. The increase in computer power, backed by a considerable decrease in price for the same amount of memory, has ensured that the CGI presentation stays at the forefront of technology.
While the Swedes were experimenting their own CGI presentation system, the American Maritime Administration

(MARAD) was discussing the use of simulators with other maritime users, including the oil companies who had used the various European simulator facilities for the training of their Deck and Engine Watchkeepers. The talks led to a design specification for the most advanced shiphandling simulator at that time, applying and even pushing state- of-the-art technology.

Experienced U.S. mariners drew up the basic and most essential requirements. These were:

-Full color

-At least 6 different traffic ships in visual scene

-Day/Night operation

-At least 240 degrees azimuth

-Full size wheelhouse

-At least 24 degrees vertical field of view

-Radar - 24 ships.

MARAD started the Computer Aided Operations Research Facility (CAORF) to house and manage the shiphandling simulator. The simulator was built by the Sperry Corporation and managed by a number of companies including Ship Analytics Inc., Marine Safety International etc. It was later taken over by the last named company. It was claimed to be the most comprehensive, technically complex, and expensive full bridge, full mission simulator in existence at that time (1986). The cost was approximately 16 million U.S dollars. Used solely for research purposes, the visual scene was front projected by five Eidophor color projectors onto a cylindrical screen. CAORF has been at the forefront of simulator based maritime research since its earliest days, and has completed such projects as pilot training for various ports and an evaluation of the widening of the Panama Canal.

2.3.8 Krupp Atlas Electronic, Bremen improved the quality of the CGI picture, and their ship simulators were installed in West Germany (SUSAN), Australia and Taiwan. Another company, Norcontrol Simulation of Norway is also at the forefront in research into improving CGI visuals for maritime simulation. To date, the largest complex of ship simulators was designed by Tracor Hydronautics Inc., and run by Marine Safety International at the U.S. Navy base at Rhode Island. It comprises a CGI full mission bridge simulator, a bridge wing simulator and two visual scene shiphandling trainers. Considerable research in marine simulation is being done at this facility. Although simulation of all 'dimensions' in a marine environment is impossible to realize with the present state of technology, many problems have been looked at and practical solutions worked out.
For example the main criticism of some daylight CGI presentations is their cartoon-like quality. This is overcome to some extent by texturing and shading. The nocturnal scene needs a high resolution display otherwise the light projected onto the screen is too large and gives a poor presentation of range. Another serious problem is of image flickering and wobble. This has been reduced by using faster processors, larger memory and special video techniques; for example non-interlace scanning and higher picture refresh rate. Various ways to improve the realism of CGI presentation have been adopted by many companies including the above mentioned. An overview of a typical visual system is presented

below. This is the approach of one manufacturer. Others solve the problems in a similar manner.
The scenes produced with the visual system can represent any coastal area or port and most environmental conditions experienced at sea. The classifications would be as follows.

Day Scenes:
Full daylight scene simulation. This would take into account the effect of sun angle shading. A typical day scene may consist of the following visual objects:
Target ships includes such details as deckhouse, funnel, masts, containers, pies etc. depending on the type of ship selected.
The landmasses presented are a realistic presentation of the land masses in the actual area. Man-made features such as buildings, tanks, bridges, towers, piers etc. are displayed, great emphasis is put on inclusion of all objects representing important cues to navigation.
Aids to navigation include buoys, lighthouses, range structures with realistic details for positive identification.
The sky is shaded and the sea has sea texture which can be controlled by operator.

Twilight Scenes:
Twilight scenes can be simulated, and a smooth transition from day through dusk to night (and opposite) is possible. During this transition the daylight will slowly disappear making the scene darker, while navigation and other lights gradually become more visible.

Night Scenes:

During night scenes lights from other vessels, buoys and lighthouses can be seen. Flashing characteristics and light sectors are simulated. The system will also show a large number of urban lights including ones specially significant like building topmasts, radio towers etc. Motion of lights is smooth and relative. No perceivable wobble is seen as lights move across the screen.

A typical night scene may consist of the following visual objects:

Darkened sky and darkened sea. Sky and sea may be presented without horizon also.(both completely black)

Own ships bow image. The bow is presented according to light level.

Target ship lights. These lights conform with international rules and regulations and can be set for towing, at anchor, constrained by draught, grounded, not under command etc. Target ship silhouettes.

Urban lights . their intensity varies with distance, and they are invisible if beyond visible range.Colors used are those typical of urban lights.

Fog:

Fog density is variable and visibility varies with distance.The operator can introduce fog at any time, even at night by specifying the fog level.

Visual Scene Enhancements:

The realism of any visual system is to a large extent dependent on the systems ability to create realistic scenes. In the visual system this is accomplished by using advanced computer cosmetics.

Coloring:

A very large number of colors and light levels are to be available. In order to create realistic colors, shades and hues, one manufacturer has employed a visual perception artist to help chose the color palettes used in their visual scenes.

Lights and Surface Anti-aliasing:

Anti-aliasing is an advanced computer technique used to manipulate the light levels on the edges of the surfaces in the scene. This gives lights and surfaces moving across the screen a very smooth motion, and edges of surfaces will not have a staircase appearance.

Three Dimensional Perception:

Any visual system will present a three dimensional world on a two dimensional screen. In order to make this look real a number of effects are used. To create two dimensional scenes in a way that they are perceived to be three dimensional, we would need to know and define what these effects are.

Perspective drawing:

All piers, buildings, terrain, ships and other objects will have to be drawn with correct size, height and perspective angle with respect to viewing location.

Distance shading:

Colors tend to become less intense or darker with increasing range, so the color intensity is tuned down as a function of range.

Surface smooth shading:
To avoid noticeable lines between polygons smooth shading is used. Land masses, man made objects and target ships may either be completely or partially smooth shaded to provide greater scene realism.

Illumination:
All illumination will give a certain shadow effect. The side of an object facing the light source will appear brighter than the opposite side.

Other cues:
Waves are drawn at reduced size, according to their range. Known objects such as cars or lorries can be placed in the harbor area and aid in the judgement of object size and distance.

## 2.4 LOOKING AT THE FUTURE

The low revenues of these large simulators has meant that only a limited number exist worldwide. All full mission simulators have required some form of government finance which cannot be repaid through training cost income alone. The enormous cost of the one-off simulators cannot-be sustained for the Merchant service. The future for simulator-based training and research appears healthy, however the purchasing authority is now looking for a flexible system based on software packages that can be updated (such as an extension to the field of view) and improved at low cost.
In assessing a simulator the more important factor is not the hardware, but the flexibility of usage. As an example, for the first couple of years after a simulator

was installed at Warsash, U.K., that college was still offering only one course, albeit fully booked. Today, 25 different courses are offered which, together with the port development program and its use for research projects, ensures continuity of use but does mean the simulator is used for purposes far removed from its original intention. Another such example can be given for the simulation facility SUSAN installed at the Nautical School of the Hamburg Polytechnic. This very elaborate setup, in addition to training the schools cadets, is also offering courses to professionals in the maritime industry like Masters and Mates, Pilots, Vessel traffic System Operators, Ship Handling Simulator Instructors etc. The facility also has training contracts with large ship operators. Research projects commissioned by governmental and private organizations are also undertaken. The revenues thus generated help to balance the overall budget.

Similarly at the CAORF simulator in King's Point, New York and various others around the world, 'simulator time' is used to generate income for sustenance of the facility.

A number of companies, many small and innovative, have been looking at cheaper solutions, based on using commercially available hardware instead of one-off equipment. The CAPTAINS system, manufactured by Maritime Dynamics in the U.K., is a desktop CGI simulator using sophisticated and proven hydrodynamic mathematical models, with a field of view that can be extended when extra finance becomes available to the operator. Further improvements have allowed the use of a number of micro-computers such as the Acorn Archimedes and IBM PC's to be used to provide new levels of flexibility. This example was shown in 1989 at the Royal Navy Equipment Exhibition by BMT Cortec. This navigation simulator, called Rembrant- Real Time Bridge Aid to Navigation-incorporates very current technology to make it as small as possible so that deck officers can use it to practice their shiphandling even on board the ship itself. Another company, NorControl Imaging Systems Ltd., is currently developing multi-channel CGI systems for the modular maritime training simulator market. Their Norview-90 visual currently uses a transputer based system for generating the visual cues. A more highly specified system, the Nor- View 2000, is being developed for full mission ship simulators.

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

## 2.5 POSSIBLE APPLICATIONS OF SHS AND THE ADVANTAGES

**Applications:**

The training and research requirements of the following categories of personnel can be fulfilled.

(a) Students with limited practical seagoing experience who require basic and advanced training.

(b) Certified masters, ship officers and pilots who require refresher courses or orientation training with new ship types and unfamiliar port approaches.
(c) Harbor Authorities who need to investigate new routings, buoyage systems and harbor and waterways development programs.
(d) Maritime Administrations which need to investigate marine casualties and safety aspects.
(e) Other organizations engaged in research work which is related to the handling of ships. Some examples are bridge layout, nautical acceptability of harbor design, human response to navigational situation, assessment of vessel traffic systems ... etc.

Advantages and disadvantages: The major advantages of training on SHS are as follows.
(a) Sophisticated simulators are expensive but still far much cheaper than exploiting a ship, as there is no cost for fuel, less man power, less investment and no depreciation of capital or wear and tear of vessel.
(b) Training is not weather dependent.
(c) It is possible to train for extreme situations. Dangerous exercises can be practiced, particularly emergency situations which would be otherwise inadmissible in the real world, eg. hazard training without any danger. Situations with a high workload can easily be provided for.
(d) Exercises can be frozen on the screen and mistakes discussed immediately.
(e) Exercises can be repeated in similar or different environments to derive a particular lesson. The repeatability process allows performance of different teams under identical inputs to be compared. This opens

up the possibility of the assessment of candidates and bridge teams on the simulators.

(f) Pre-selection of conflict situations.

(g) Considerable time can be saved in training schedules.

(h) Personnel can familiarize themselves with different ports and harbors and the handling of different types of vessels.

(i) Developing future ship handling techniques, procedure and rules.

(j) Support in maritime court cases.

(k) Possible investigation of marine accidents and navigational problems to find out the causes and best avoidance methods at minimal cost.

There are some disadvantages of simulators like high investment of capital and running costs, training of specialist operators cum instructors for these and the quick obsolescence of models due to newer technological developments in the industry. There are some training disadvantages too, however these can be compensated for by other supplemental training.

## 2.6 AN EVALUATION OF THE SHS TRAINING OF CADETS IN SELECTED COUNTRIES

U.S.A: The US Merchant Marine Academy at King's Point, New York utilizes the training facilities at CAORF for simulator training of the graduating cadets. The program is called Bridge Watch Standing Simulation Training For Cadets. The program is implemented in the final year of training.

The main features are as follows:-

1. Cadets are divided into bridge watch-keeping teams of 3 members, one each as officer on watch, navigator and

helmsman. Role of the master and pilot are played by instructors.

2. The course runs over a period of 10 weeks. Each watch team has 2 hours simulators time plus one hours classroom time per week. The total number of hours for each team in the course are as follows.

Exercises 10 hours
Debriefing 10 hours
Classroom 10 hours.

3. The course is planned as a series of practical voyages designed to reinforce theoretical knowledge of ship maneuvering characteristics, voyage planning and execution and 2 weeks are devoted exclusively to Collision Regulation scenarios.

4. The course participants are assessed and students have to pass the tests.

**GERMANY:** In the German system of maritime training the various states follow their own program of training on the SHS. The course at Bremen Polytechnic for Master (F.G) syllabus has SHS training in the final sixth semester of the 3 years course. The total simulator time is 36 hours on the Visual and 20 hours on the Nocturnal simulator. The main topics of the visual SHS training are:-

1. Maneuvering characteristics of ships under different conditions.

2.Practical maneuvering of different ships in exercises for search and rescue and man-over-board procedures.

3. Exercises in various confined waterways to practice anti-collision and navigation.

The Maritime School of the Hamburg Polytechnic is using the facilities of SUSAN, a sophisticated full mission simulator, for training its cadets. The total training period for the cadets is 8 semesters. The training program overview is given below.

Communications: 12 hours.

Technical/ Instrumentation: Total 6 hours for one group of 6 cadets. (under real-time conditions).

Manoeuvreing: Total 15 hours with different ships.

Bridge Training: 27 hours. 9 weeks x 3 hours per group (3 cadets). Time is divided 80% Watch Officer duties (assistant) and 20% Master's duties.

**AUSTRALIA:** At the Australian Maritime College in Tasmania the 4 year course of Nautical Diploma for cadets has a SHS based part of training as follows.

Year 1 = Nil

Year 2, Semester 1.

Subject : Navigation. Unit : Coastal navigation

Topics : Radar/ARPA, Electronic navigation aids, Bridge team work, Collision avoidance and watch-keeping procedures.

Total hours on SHS = 40 hours each group.

Note. the students are in groups of 4 each.

Year 3, Semester 1.

Subjects:

Demo ship handling exercises by instructors.= 6 hours.

Ship handling exercises by students.

Topics:

Man-overboard situation; Williamson Turn.

Turn a single screw vessel short round in a confined channel.

Navigate through a channel, swing and bring vessel to a single anchor in a crowded anchorage.

Total time for above exercises is 3 hours.

Total hours for each student on simulator = 6 hours.

Year 4. Full semesters.

Subject: Command Navigation.

Units:

Collision situation and Master.

Traffic control.

Shipboard control.

Total hours on the SHS = 35 hours each group.(3 students)

# CHAPTER 3

## SHIP HANDLING SIMULATOR AT THE PAKISTAN MARINE ACADEMY

### 1.GENERAL DESCRIPTION.

The Ship Handling Simulator is a full mission type manufactured in Japan by The Japan Radio Company. It is using CGI for the display of the visual scene. The command center for exercises by the trainees is configured like a regular ships bridge, complete with all the required equipment. Operation of the navigational instruments and other equipment is carried out in the same way as on a normal ship. There are a few minor constraints that a user may experience but these do not affect the value of the training exercises. When concentrating in an exacting maneuver even these become unnoticeable. The visual scene is visible 60 degrees on either side of the center line. In the rear of the wheelhouse there are 3 observer stations complete with their own chart tables and radars equipped with true motion units. These are slave units getting their input from the master radar. Whistle signal of other ships and wind noise is also simulated. There is no dynamic motion stimulation. The instructor station with control console and computer equipment is situated in the room behind the wheel house and there is an anti reflecting observation window for the instructor to get a full view of the wheel house and visual screen. During an exercise the operating instructor has real time interaction with the bridge team. Next to the instructor room there is a de-briefing room with all equipment, like overhead projector, video monitor and white board. Figure 3.1 shows the plan of the simulator.(SHS)

2.DETAILS OF THE SET UP WITH TECHNICAL EXPLANATION AND CONSTRAINTS.

The Ship Maneuvering Simulator, consists of 4 (four) groups:
Training equipment in bridge compartment (UNIT 1)
Equipment for instructor's control (UNIT 2)
Equipment for simulator control (UNIT 3)
Visual display system (UNIT 4)

TRAINING EQUIPMENT IN BRIDGE COMPARTMENT
The following equipment are provided in the bridge for trainee's control.

(1) Control Console

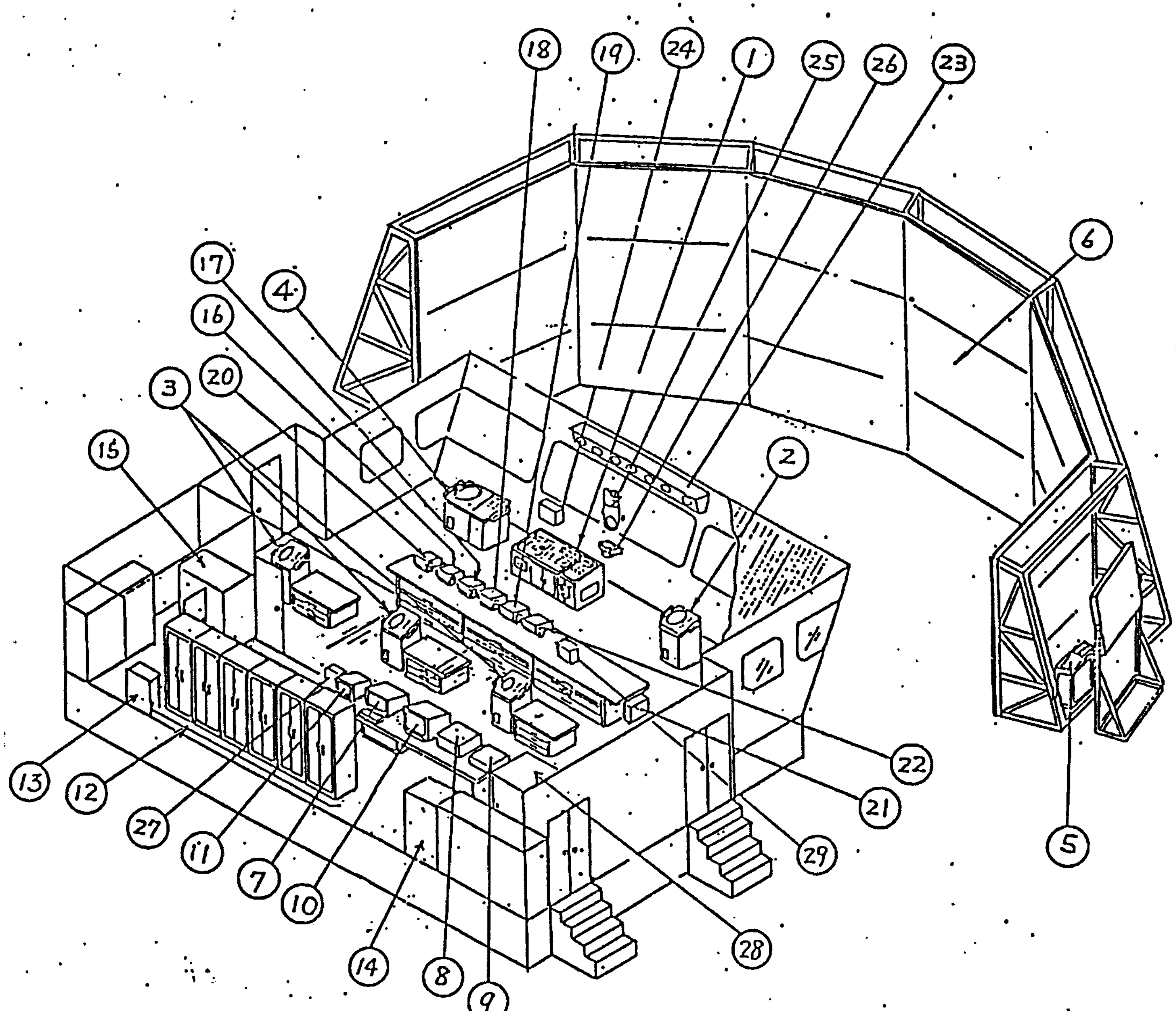
The control console is provided to control the engine and helm of the simulated ship. The control console can be divided to two (2) parts, those are Steering Stand and Engine Control Console.

(a) Steering Stand

The Steering Stand is installed in the center forward of the bridge compartment. There is no gyro installed and directional signals to repeaters are simulated.

(b) Engine Control Console

The Engine Control Console is provided on the left side of the steering stand to control ship's engine. It includes intercommunication equipment, and a public addresser.




1 : Control console
2 : Radar dispray
3 : Slave radar display
4 : Radar display with ARPA
5 : Video projector
6 : Screen
7 : Instructor's console
8 : X-Y plotter
9 : Printer
10 : Monitor for radar display
11 : Monitor for visual display
12 : Control cabinet
13 : Distribution panel
14 : Automatic voltage regurator
15 : Packaged air conditioner
16 : Omega navigator
17 : Decca navigator
18 : Satellite navigator
19 : Loran C navigator
20 : Direction finder
21 : Echo sounder
22 : Doppler sonar
23 : Overhead instrument panel
24 : VHF communication
25 : Stand-by compass
26 : Repeater compass for maneuvering
27 : Communication control panel
28 : CVCF
29 : Course Recorder

FIG.3.1 LAYOUT OF SHIP MANEUVERIG SIMULATOR

(2) Overhead Instrument Panel

Overhead Instrument Panel is fitted on the bridge front bulkhead panel. Following instruments are fitted on the panel. Each instruments has an illuminating light and size of them is about 200 mm diam. Each illuminating light is controlled by dimmer switch from engine control console.

(a) Clock

Type :digital type.(simulated time).

Display range :hours and minutes (from 00.00 to 11.59).

(b) Propeller RPM indicator

Type :analog type

Display Range :from astern 220 R.P.M. to ahead 220 R.P.M.

(c) Turning rate indicator

Type :analog type

Display range :port 30°/min.
starboard 30°/min.

(d) Rudder angle indicator

Type :analog type

Display range :port 40° to starboard 40°.

(e) Speed indicator

Type :analog type

Display range :from astern 6 knots to ahead 30 knots

(f) Wind direction indicator

Type :analog type

Display range :port 180° to starboard 180°.

(g) Wind speed indicator

Type :analog type

Display range :from 0 m/s to 60 m/s.

(3) The VHF unit is provided to simulate radio communication between ship (bridge compartment) and land/other-ship (instructor station).

(4) The Navigation Light Indicator Panel is installed on the left wall of the bridge compartment.

(5) Radar Displays

There are five (5) radar displays in this simulator. The main radar display is allocated at right of control console, and ARPA display to the left. Three (3) Slave Radar Displays are installed in the aft side of bridge compartment.

(6) The following equipment is installed on the main chart table Radio Direction Finder, Omega navigator, Decca Navigator, Satellite Navigator, Loran C Navigator, Doppler Log, Course Recorder, and Echo Sounder.

(7) Repeater Compass

The Repeater Compass is installed on the forward center of the bridge compartment for visual bearings.

(8) Magnetic Compass

The magnetic compass is a reflector type fitted through the wheel house ceiling.

(9) Other equipment in the bridge

The following units are also provided in the bridge compartment.

Speaker unit for instructor public address.

Sound speakers

EQUIPMENT FOR INSTRUCTOR'S CONTROL.

A 14" color CRT display is provided as an instructor monitor which is used with control keyboard to set up the exercise.

The X-Y Plotter is provided to record positions of own ship and each target.
The Printer, installed in the instructor station, is used as a peripheral of the computer system.
A 14" color CRT display is provided as a monitor of visual scenes which are projected on the screen channels.
A radar monitor CRT is provided and used to monitor the radar situation. This CRT is also used as a subsidiary control with the keyboard for simulated radar condition control.
Communication equipment such as Talk Back, Intercom set, VHF set, and direct speaker are controlled by a separate console. This console also monitors the operation of Navigation Light Panel.
Visual Projector Remote Controller. There are six (6) remote controllers to make adjustment to each visual projector.
Sound Generator and Noise Unit. This unit can generate sounds. Example, wind noise.
Jack Box. The jack box has two jacks to connect headphone and microphone, for communication between the bridge and instructor station. The jack box also has the visual monitor select switch to choose one of six projectors for monitoring.
The following components are also installed in the instructor station. Connector Box to supply AC 100V electrical power for each component/unit. Radar Power Unit to supply AC/DC power for 3 slave radar displays.

EQUIPMENT FOR SIMULATOR CONTROL

The Ship Maneuvering Simulator is basically controlled by simulator control equipment which are installed at the rear of the instructor station.

AVR (Automatic Voltage Regulator). CVCF (Constant Voltage & Constant Frequency unit). These two (2) units are provided to supply stable AC power for each part of the simulator.

Control Cabinets. There are six (6) cabinets in the rear of the instructor station to control the simulator.

Control Cabinet 1. This cabinet is providing main power of the simulator control after AVR and CVCF. The navigation host computer is also installed in the cabinet.

Control Cabinet 2. This cabinet is assigned for navigation equipment control.

Control Cabinet 3. This is used for the multi-computer system.

Control Cabinet 4. This cabinet is provided for the radar system control. The instructor host computer is also installed in this cabinet.

Control Cabinet 5. In this cabinet, visual control system is installed. Two audio amplifiers for sound system are also installed in this cabinet.

Control Cabinet 6. This cabinet is used for the Video Data Processor which generates the video signal for the visual projectors. This cabinet also has Gyro Signal Distributor and Synchro Converter for synchronous system.

VISUAL DISPLAY SYSTEM

The visual display system consists of a six channel projection system and 120 degrees wide view. There are six projectors to display the visual scene which is back projected to the screen. The screen system is constructed with steel frames to which is fixed the coated vinyl screen and the reflection mirror at the rear reflects the image to this, which is visible from the wheel house.

OTHER SPECIFICATIONS

Name and location of exercise areas.

(a) Hong Kong

| | | |
|---|---|---|
| Dimensions | : | 30 NM x 30 NM |
| Map Center | : | 22° 08'N/114° 14'E (Fixed) |
| Magnetic Var. | : | 1° 36' W (Fixed) |

(b) Karachi Port

| | | |
|---|---|---|
| Dimensions | : | 30 NM x 30 NM |
| Map Center | : | 24° 39'N/66° 55'E (Fixed) |
| Magnetic Var. | : | 0° 05'E (Fixed) |

(c) General ( No Map )

| | | |
|---|---|---|
| Dimensions | : | 30 NM x 30 NM |
| Map Center | : | 35° 00'N / 145° 00'E (changeable) |
| Magnetic Var. | : | 05° 15'W (Fixed) |

Own ship models

It is possible to select five (5) types of ships for training. Table 3.1 shows the own ships characteristics and Table 3.2 shows dynamic characteristics.

Target ship characteristics

| | |
|---|---|
| (1) Initial position | :Initial positions are set in steps of 1" (lat.& long) |
| (2) Speed | :0-50 Kt in steps of 0.1 Kt |
| (3) Course | :0-359 in steps of 1 Deg. |
| (4) Fade-out range | :0-60 NM (for radar) |
| (5) Max. number of ships | :20 (for radar) |
| (6) Max.number of targets | : 8 (for visual) including fixed targets |

(7) Target ship's type for visual and radar

Table 3.1 - Own ship characteristics

| ITEM | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| SHIP TYPE | | BULK CARRIER | CONTAINER SHIP | GENERAL CARGO VESSEL | VLCC | Ro/Ro SHIP |
| GROSS TONNAGE | | abt. 38,500 t | abt. 35,000 t | abt. 11,200 t | abt. 132,000 t | abt. 3,000 t |
| DEAD WEIGHT | | abt. 66,000 t | abt. 33,600 t | abt. 18,000 t | abt. 240,000 t | abt. 3,300 t |
| SHIP LENGTH(Lpp) | | 220 m | 189 m | 140 m | 305 m | 105 m |
| BREADTH | | 36.4 m | 32.2 m | 22.9 m | 55.0 m | 18.0 m |
| DRAFT | | 11.3 m | 11.5 m | 9.6 m | 19.4 m | 6.0 m |
| EYE POINT ABOVE S.L. | | 21.7 m | 27.3 m | 15.8 m | 24.9 m | 15.3 m |
| TRIM | | 0 | 0 | 0 | 0 | 0 |
| ENGINE TYPE | | DIESEL | DIESEL | DIESEL | DIESEL | DIESEL |
| ENGINE M.C.R. | | 10,200 PS | 18.900 PS | 9,400 PS | 24,240 PS | 7,880 PS |
| ENGINE TELEGRAPH POSITION vs R.P.M & SPEED | DEAD SLW | 30 RPM / 5.3 kt | 26 RPM / 6.4 kt | 45 RPM / 5.3 kt | 25 RPM / 5.2 kt | 63 RPM / 6.6 kt |
| | SLOW | 40 RPM / 7.2 kt | 32 RPM / 7.9 kt | 60 RPM / 7.0 kt | 30 RPM / 6.2 kt | 85 RPM / 8.9 kt |
| | HALF | 55 RPM / 9.8 kt | 40 RPM / 9.8 kt | 80 RPM / 9.2 kt | 35 RPM / 7.2 kt | 107 RPM / 11.0 kt |
| | FULL | 65 RPM /11.5 kt | 48 RPM / 11.7 kt | 100 RPM / 11.4 kt | 50 RPM / 10.2 kt | 129 RPM / 13.0 kt |
| | NAV.FULL | 80 RPM /13.8 kt | 83 RPM / 19.4 kt | 140 RPM / 15.7 kt | 70 RPM / 14.2 kt | 185 RPM / 17.7 kt |
| RUDDER TYPE | | SEMI-BALANCED | SEMI-BALANCED | BALANCED | SEMI-BALANCED | HANGING |
| RUDDER AREA | | 49.2 $m^2$ | 35.2 $m^2$ | 19.2 $m^2$ | 111.4 $m^2$ | 10.2 $m^2$ |
| PROPELLER TYPE | | SOLID : 5 BLADES | SOLID : 5 BLADES | SOLID : 4 BLADES | SOLID : 5 BLADES | SOLID : 4 BLADES |
| PROPELLER DIA./PITCH | | 6.6 m / 5.7 m | 7.2 m / 7.7 m | 5.1 m / 3.6 m | 8.7 m / 6.9 m | 3.9 m / 3.3 m |

Table 3.2 Own ship characteristics ( Dynamic characteristics)

| ITEM | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| SHIP TYPE | | BULK CARRIER | CONTAINER SHIP | GENERAL CARGO | VLCC | Ro/Ro SHIP |
| TURNING CIRCLE CHARACTERISTIC STARBOARD SIDE | TACTICAL DIAMETER | 740 m | 770 m | 580 m | 860 m | 550 m |
| | ADVANCE | 680 m | 640 m | 530 m | 900 m | 520 m |
| | TRANSFER | 290 m | 320 m | 260 m | 360 m | 250 m |
| TURNING CIRCLE CHARACTERISTIC PORT SIDE | TACTICAL DIAMETER | 730 m | 740 m | 570 m | 830 m | 530 m |
| | ADVANCE | 700 m | 650 m | 550 m | 910 m | 470 m |
| | TRANSFER | 280 m | 320 m | 250 m | 370 m | 230 m |
| INERTIA TEST | HEAD REACH | 4400 m ( 3kt) | 5000 m ( 3kt) | 2800 m ( 5kt) | 9400 m ( 5kt) | 2500 m ( 5kt) |
| | ELAPSED TIME | 29' ( 3kt) | 28' ( 3kt) | 10' ( 5kt) | 36' ( 5kt) | 12' ( 5kt) |
| CRASH ASTERN | HEAD REACH | 2100 m | 3400 m | 1900 m | 4200 m | 1300 m |
| | ELAPSED TIME | 10' | 10' | 7' | 18' | 4' |

(a) Car ferry

| | | |
|---|---|---|
| .Tonnage | : | abt. 2,000 GT |
| .Ship length (Lpp) | : | 115.0 m |
| .Ship width | : | 20.0 m |
| .Draft | : | 4.5 m |

(b) Passenger ship

| | | |
|---|---|---|
| .Tonnage | : | abt. 37,000 GT |
| .Ship length (Lpp) | : | 210.0 m |
| .Ship width | : | 26.0 m |
| .Draft | : | 7.0 m |

(c) Survey vessel

| | | |
|---|---|---|
| .Tonnage | : | abt. 3,000 GT |
| .Ship length (Lpp) | : | 115.0 m |
| .Ship width | : | 20.0 m |
| .Draft | : | 5.0 m |

(d) Cable ship

| | | |
|---|---|---|
| .Tonnage | : | abt. 2,000 GT |
| .Ship length (Lpp) | : | 70.0 m |
| .Ship width | : | 10.0 m |
| .Draft | : | 4.5 m |

(e) Patrol boat

| | | |
|---|---|---|
| .Tonnage | : | abt. 190 GT |
| .Ship length (Lpp) | : | 44.0 m |
| .Ship width | : | 8.0 m |
| .Draft | : | 1.5 m |

(f) Cargo ship

| | | |
|---|---|---|
| .Tonnage | : | abt. 20,000 GT |
| .Ship Length (Lpp) | : | 260.0 m |
| .Ship width | : | 40.0 m |
| .Draft | : | 8.6 m |

(g) Car Carrier

| | | |
|---|---|---|
| .Tonnage | : | abt. 15,000 GT |
| .Ship Length (Lpp) | : | 210.0 m |

| | | |
|---|---|---|
| .Ship width | : | 50.0 m |
| .Draft | : | 9.2 m |

(h) Oil Tanker

| | | |
|---|---|---|
| .Tonnage | : | abt. 60,000 GT |
| .Ship Length (Lpp) | : | 320.0 m |
| .Ship width | : | 50.0 m |
| .Draft | : | 16.7 m |

Environmental parameters

| | |
|---|---|
| (1) Calendar (simulated) | 1st. January 1988 to 31st. December 1999 |
| (2) Tide | 0° -359° /0-9 knots (Set by instructor) |
| (3) Sea Clutter | Variable (3-4 NM) (radar display only) |
| (4) Wind | 0° -359° /0-99.9 m/s (set by instructor) |
| (5) Depth | 0-400 m (data based on the Admiralty chart 1988) |

Recording and playback functions

| | |
|---|---|
| (1) Data sampling interval | 1 second (Events data) 1 minute (ship data) |
| (2) Max. recording time | 240 minutes |

(3) Recording items

a) Events data

Input data from bridge (e.g.switch operation) except communication equipment

Input data from instructor's console except communication equipment

b) Common data of the simulator

Present training time

Own ship data

Target ship data
Environmental conditions

Radar System

| | |
|---|---|
| (1) Range of map | App. 30 NM |
| (2) Resolution | 55 m at 30 NM range |
| (3) Simulated phenomena | Sea clutter<br>Precipitation<br>Receiver noise<br>Ramark (1 station)<br>Racon (1 station)<br>Shadow sector<br>(3 directions) |

Navigation System

(1) Loran C navigator system

| | |
|---|---|
| (a) Chain No. | :GRI Preselected by instructor. All chains. |
| (b) Signal & noise level | :Set by instructor (10 step variable) |

(2) Decca navigator system

| | |
|---|---|
| (a) Chain No. | :Preselected by instructor (1 --- 40 ) |
| (b) Signal level | :Set by instructor (10 step variable) |
| (c) Noise level | :Set by instructor (10 step variable) |

(3) Omega navigator system

(a) Station :Auto-tuning

(b) Noise level :Set by instructor (10 step variable)

(c) Pre-heating time:Within 30 minutes

(4) Radio direction finder system

(a) Beacon stations :4 (set by instructor)

(b) Noise level :Set by instructor (10 step variable)

(c) Fading :Set by instructor ("on" or "off")

(5) Satellite navigator system

(a) Signal acquisition and tracking :Automatic

(b) Clock :Internal quartz clock (stand alone)

(c) Display :Position, Date and time Satellite alert

(This is simulated according to software program installed in the simulator for this purpose.)

Visual System

(1) General

(a) Max.number of targets are 8 (the total of other ships, buoys and islands appear at one time.)

(b) Max.size of each target W:1800mm, H:1350mm on the screen (target size is frozen when W or H reaches this value)

(c) Projection angle is Horizontal field of view:120° Vertical field of view:15° (Sky: 5° , Sea : 10°)

(d) Target colors are Max. 8 colors in combination of Red, Green, Blue.(RGB)

(e) Background colors are a Max. 256 colors in combination of R.G.B

(f) Visibility variations are stepped 0.1 NM,3 NM,6 NM and clear.

(g) Image update rate is more than 1 Hz (for target ship movement). More than 0.2 Hz (for own ship movement).

(h) Simulation of ship movement is Yawing.

(i) Projector's light is more than 300 Lumens output (at white level).

(j) Resolution: Horizontal:640 (in TV lines). Vertical :480 (in TV lines)

(k) Scan rate is 60 Hz. 480 lines TV scan (interlaced).

(2) Display of images.

(a) Each Own ship's bow image is shown.

(b) Target ships. 8 type of ships are available by selection from the instructor's console.

(c) Background. Sky: clear weather. (e.g. no clouds) sea: plane surface (e.g. no waves).

(d) Buoys, light beacons and light houses are pre programmed by instructor. Total number of buoys, light beacons and light houses are 32 per one training area.

(e) Islands are pre-programmed by instructor. Total number of islands are 8 per one training area.

(f) Visual Exercise Areas.

Karachi: The visual images for Karachi are prepared for entering fairway to Karachi/Lower Harbor (at the point of mooring buoy before Bunker Island).

Hong Kong: The visual images for Hong Kong are prepared for three fairways to Hong Kong Harbor (West Lamma channel, East Lamma channel and Tathong channel).

Sound System

(1) Own ship: Engine sound and whistle sound (3 types determined by the ship's length).
Target ship: Whistle sound only. (3 types determined by the ship's length).
(2) Whistle sound frequency vs ship's length :
200m or more. Appx. 135 Hz (70---200Hz)
75m but less than 200m. Appx. 240 Hz (130---350Hz).
Less than 75m. Appx. 475 Hz (250---700Hz).

## 3.EXPLANATION OF SHS BRIDGE AND EQUIPMENT DETAILS.

The bridge design is of fixed type having the operation console in front, separated from wheelhouse windows and the navigation console and chart table behind. There are no side windows as the visual system is not expandable for side views. The layout is of conventional vessel type and is modified to the extent that three extra chart tables with slave radars are fitted at the rear of the wheelhouse. The equipment is normal off the shelf, operating exactly as it would in a normal ship board environment. Modifications for simulator use are internal and transparent to the trainee. A few constraints which require a different operating procedure are explained and demonstrated in briefings. The equipment is as below.

(1) The Overhead Instrument Panel is located on the top of center forward wall in the bridge compartment and the following instruments are installed in the panel.
Digital Clock.(simulation time), Propeller RPM indicator, Rudder angle indicator, Turning rate indicator, Speed indicator, Wind speed and direction indicators. Analog Clock.(Battery operated independent time).

(2) The Control Console consists of a steering stand and an engine control console.

(a) Steering stand (with Autopilot) Steering stand is of stylized type of Yokogawa Navitec / PT11 which has following equipments. It is able to control each three mode (auto steering mode, hand steering mode and non follow up steering mode).

(1) Auto Steering Panel. This has the following performances.

Steering stand repeater compass
Indicator lights
Dimmer (for steering stand)
Universal indicator
Rudder angle limit indicators
Master caution indicator
Bar graph indicator (rate of turn & rudder angle)
Steering mode switch & indicator
Course set switch & setting course indicator
Lamp test switch

(2) Hand steering panel. This has the following performances.

Helm wheel handle
Helm wheel handle angle indicator
Pilot switch
System switch
Non follow up lever

(b) Engine control console is designed to control three different conditions, one for remote control from wheel house (unmanned engine room condition), one for engine control room operation (instructor's manual operation), the other for engine room control (instructor's manual operation). These three conditions are selected by a switch of engine monitor panel. Following equipment are fitted on the engine control console.

(1) Engine telegraph. It has following equipment.

Order pointer

Answer pointer

Handle (with fine adjuster at navigation full)

Buzzer (be used both as telegraph buzzer and alarm buzzer)

(2) Propeller RPM indicator is calibrated 0-220 RPM ahead and astern.

(3) Starting air pressure indicator indicates engine starting air pressure (from 0 to 50 $kgf/cm^2$).

(4) Engine monitor panel has following switches and lights.

Engine failure indicators

Sub telegraph switch & indicators

Control position switch & indicators

Sea condition switch & indicators

Sequence prog. switch & indicators

Emergency stop switch

Buzzer stop switch (for alarm buzzer)

Lamp & buzzer test switch

(5) Air horn switch panel has following switches and lights.

Source lamp

Source switch

Auto fog signal switch

Blow switch

(6) Intercom unit is used to communicate from the wheel house to engine control room, radio room, steering room, captain's room, chief engineer's room, chief officer's room and engineer's room ( all positions are simulated at instructor's station).

(7) Alarm buzzer is used both as alarm buzzer and telegraph buzzer. It will be stopped by buzzer stop switch.

(8) Dimmer switches

Lever (Engine telegraph) lamp dimmer switch
Indicator lamp dimmer switch
Lamp dimmer switch
Magnet compass dimmer switch
Other instrument's (overhead instruments) dimmer switch

(9) Public addresser is able to announce by public address speaker from wheel house to compass deck, engine control room, cabin and passenger deck (simulated at instructor's station). And also talk back system is able to talk from forecastle deck, poop deck, each wings, general office and radio room (simulated at instructor's station) to wheel house.

(3) Radar Display and Slave Radar Displays.

| | |
|---|---|
| (a) CRT size | :16 inches diameter |
| (b) Range scale/rings | :0.25-120NM/0.05-20NM |
| (c) Variable range marker readout | :0 to 120NM,4-digit |
| (d) Electronic cursor | :Three EBL's-CRT center (PPI sweep center, originating and movable,independent EBL's). |
| (e) Scan rotation rate | :APP.18 RPM |
| (f) P.R.F. | :APP.750 PPS |
| (g) Presentation mode | :Headup, Northup,true motion. |

(4) Radar Display with ARPA.

The radar display with ARPA has following characteristics.

(a) Acquisition:

| | |
|---|---|
| Acquisition mode | :Full auto and/or manual. |
| Excluded area | :Manually set in auto acquisition mode. |

(b) Tracking:

| | |
|---|---|
| Max.number of tracked target | :20 targets. |
| Past position indication | :True/relative position indication (interlocked with vector mode),5-point indication interval 0.5,1,2, minute and STD (Standard) STD (Interlocked with range scale). |

| Range scale: | Interval |
|---|---|
| 1.5, 3NM | : 0.5 minute |
| 6, 12NM | : 1 minute |
| 24NM | : 2 minutes |

(c) Display:

| | |
|---|---|
| Display unit | :Integrated with radar indicator, or separate. |
| Cathode-ray tube | :High-brightness,16-inch cathode-ray tube (CRT), superimpose of ARPA data on radar raw video. |

Range scale:

Radar mode :0.25/0.5/0.75/1.5/3/6/12/48/120 NM

ARPA mode :1.5/3/6/12/24 NM

Display mode :TM / RM

Bearing indication:North up/Course up/Head up.

Vector mode:True/relative-speed/vector presentation,0 to 30 min. variable

Undesired target cancellation:Each target or all targets.

Bearing & distance measurement:VRM and EBL incorporated (2 lines).

Time required for vector presentation:Less than 1 minute.

Vector stabilization time:Less than 3 minutes.

(d) Alarm:

Variable Guard ring:Manual setting by VRM.

Range:0.5 NM to 5/3 of used range, up to 24 NM.

Alarm presentation:Mark on CRT display and visual/audible alarm.

Dangerous target Criterion of situation evaluation:Min. CPA; 0 to 9.9 NM. Min.TCPA; 0 to 99 min.

(f) Numerical display:

The following data is indicated simultaneously and sequentially

Target data:Bearing, distance, true course, true speed, CPA, TCPA.

Own data:Course and speed.

(g) Trial maneuver:

Manual setting:(manual/auto return).

Trial speed:0 to 28 knots, and present speed.

Trial course:Up to 50 degrees (5 step) turn to right and left from present course.

(h) Presentation accuracy:

Conforms to IMO Standards.

Performance test:System monitor, sensor monitor.

Diagnostic function provided.

System failure alarm:Visual/audible alarm.

(j) Speed input:Manual/auto (Dopplerlog).

(k) Navigation line:Manual settings, as desired a pair or 3 segment lines.

(5) The Omega navigator simulates the type JRC/JLA-104 which has the following performance.

(a) Position display:Latitude & Longitude with 0.1 min. resolution.

(b) Initial input data:Year/month/day/time and ship's estimated position.

(c) Station selection:Automatic / manual.

(6) The Decca Navigator simulates the type ShipmateRS-4000 which has following performance.

(a) Position display:Latitude and Longitude with 0.01 min. resolution.

(b) Initial input data:Ship's D.R. position.

(c) Chain Selection:Automatic/manual.

(d) Lane correction:Automatic / manual.

(7) The Satellite navigator simulates the type of JRC/JLE-3850 which has following performance.

(a) Signal acquisition and tracking:Automatic.

(b) Data display:2 sets of 8-digit indicator.

(c) Display item:Latitude and Longitude

Date and time

Course and speed of last fix

Satellite alert

Elapsed time of dead reckoning

Current set and drift

Average course and speed

(d) Initial input data:Year/month/day/time,ship's DR position

(8) The Loran C navigator simulates the type JRC/JNA-761 which has following performance.

(a) Position display :Latitude and Longitude with 0.01 min. resolution.

(b) Time difference: Two 6-digit read-out

(c) Initial input data: Chain GRI.

(9) The radio direction finder simulates the type JRC/JLD-10 which has following performance.

(a) Receiving frequency:200 - 580 Khz, 1.6 Mhz - 2.8 Mhz.

(b) Measurement of radio direction:Automatic / manual

(10) The Echo sounder simulates the type of JRC/JFE-570S which has following performance.

(a) Type: Recording type.

(b) Sounding depth: App. 0 - 450 m.

(11) The Doppler sonar simulates the type JRC/JLN-420 which has the following performance.

(a) Measuring depth : 3 - 400 m.

(b) Measuring speed : Forward & Aft 29.99 kts.
Athwartships 9.99 kts.

(c) Speed resolution: 0.02 kt

(12) The VHF communication unit simulates the type JRC/JHV-229 with control panel and hand-set. It has following performance.

(a) Number of channel:12 channels

(b) Communication system:Press-to-talk type, simplex or duplex system

(c) Preset channels:06,08,09,11,12,13,14,15,16,17,19,22.

(13) Intercom unit:

(a) Interphone with a handset for direct communication to engine room (simulated at instructor station).

(b) Public addresser will simulate the type JRC/NVA-1800, and it's control panel(stylized type of JRC/NCE-8901A) is fitted with microphone for communication to bow and stern (simulated at instructor station.

(14) Magnetic Compass is a modified magnetic compass with deckhead periscope viewer. The indication of compass includes magnetic variation.

(15) Repeater Compass for Maneuvering.Bracket type repeater with illumination light and azimuth circle. Bearing of screen objects can be taken from here.

(16) Course Recorder is Ship-board 2 channel recorder, which records own ship's heading and rudder angle.

# CHAPTER 4

## SHS TRAINING PROGRAM OF PAKISTAN MARINE ACADEMY

### 4.1 INTRODUCTION.

The training on the SHS will be spread over a period of 10-12 weeks of the last semester for the graduating pre-sea nautical cadets. They will be divided into groups of 3 or 4 cadets, dependent on the strength of the class. Each group will be taken as a Bridge Watch-keeping Team, and will comprise of Watch Officer, Navigator, Radar Observer and Helmsman. The team members will change positions in rotation. The instructors will assume roles of Master and Pilot as required.

In view of the present PMA system of training nautical cadets and the valuative nature of this program, it is designed as a series of practical voyages, utilizing all the resources available at the simulator. This method is considered most suitable now, as these trainees, will come back to school after thirty months of sea-time at which time they will again be under going mandatory training of a more comprehensive nature utilizing both the Radar/ARPA and the SHS. This is the training that is one of the pre-requisites for being allowed to sit for a certificate of competency as a watch keeping officer.

The proposed, 'voyage concept' method of simulator training has been used at maritime schools in England (Southampton Marine Polytechnic) and USA (US Merchant Marine Academy), for more than 6-7 years, and analysis of results has shown it is more effective for cadet level than 'single task' training method, as it more closely replicates the natural on board work environment. The latter is more suitable for higher level or specializing. The nautical cadets training system in USA and UK is different to Pakistan's. There the cadets have been at sea during their training period, and have had some on the job experience. The nautical cadets at the PMA have no seagoing experience but during the period prior to the time of the proposed program, they have already had class-room training in bridge watch keeping and other ship operation tasks concerned with navigating the ship. They start from the basic level, where they are taught the fundamentals of tasks required to be done by a watch keeping officer. For this training use is made of computers for lights and shapes, colregs etc. Also during Radar/ARPA training practical chartwork and anti-collision is practiced. Basic seamanship including steering and compass work are also taught practically, using these facilities fitted at the Seaman Training Center.

Further more this method of training by creating practical voyage scenarios on the SHS is suitable for the present day PMA cadets because as soon as they graduate, they are assigned to vessels, wherein they are assisting the deck officers in their daily work in port and while at sea. The SHS training aims to impart to this cadet, a conditioning of the mind, by replicating as closely as possible the real life conditions on active vessels. The objective here is not to produce an independent watch-keeper but an informed and trained assistant. From an informal study of the present graduates (without SHS training) who go on board it was found that majority took time to adjust. This has a negative effect on the ships efficiency, as present day officers do not have the time or motivation to teach. It is merely an irregular and haphazard contribution.

The time scheduling of the training program is in the afternoon from 1600-1800 hrs Monday, Tuesday, Wednesday Thursday and Saturday. Sunday afternoon all groups will meet from 1600-1800, where the training sessions will be discussed and planned for coming week.

The post noon period has been proposed so that the normal classroom instructions from 0800 - 1400 hours are not disturbed. This keeps the training course separate for an independent evaluation. The results achieved will assist in integration of SHS training into the syllabus which needs improvement to conform with modern maritime practice.

## 4.2 PROPOSED PROGRAM.

The cadets are divided into groups A, B, C, D, E, F, G, H, J, K. The weekly schedule is as follows.

| GROUP | DAY OF WEEK |
|---|---|
| A and B. | Monday. |
| C and D. | Tuesday. |
| E and F. | Wednesday. |
| G and H. | Thursday. |
| J and K. | Saturday. |

The working method of the proposed program on any of the week days shown above is as follows.

First Group:

Preparation = 1500-1600 hrs.

Exercise = 1600-1700 hrs.

Debriefing = 1700-1800 hrs.

Second Group:

Preparation = 1600-1700 hrs.

Exercise = 1700-1800 hrs.

Debriefing = 1800-1900 hrs.

Therefore it is seen that each cadet group has 3 hours of time at the simulation facility per week, comprising of 2 hours pre and post exercise de-briefing and 1 hour of exercise. As in any trial program, these should not be taken as conclusive figures.

The list below shows the simulator use for each week, and the voyages that have been designed as dictated by area databases available.

| WEEK NO. | TIME HOURS | EXERCISE |
|---|---|---|
| 1 | 1 | Familiarization with bridge and vessels. Demonstration exercise. |
| 2 | 1 | Ship is in Karachi Harbor at mooring buoys. Prepare to depart for Dubai. Master on bridge. Pilot boards.Cast off from moorings and proceed out. Disembark pilot at break-water. Full away. Master leaves bridge. Daylight condition. Light wind and current. Steam toward Dubai via Cape Monze. |
| 3 | 1 | At sea. Colregs exercises. Day and night. Normal environmental conditions. (normal visibility, light wind and current) |

| | | |
|---|---|---|
| 4 | 1 | At sea. Colregs exercises. Day and night. Variable environmental conditions. (variable visibility, wind and current). |
| 5 | 1 | At sea. Colregs exercises. Day and night. As in (3) & (4), with emergency conditions. Steering, Gyro, etc. breakdown. |
| 6 | 1 | Proceeding towards Dubai via Cape Monze. Orders by Master to turn vessel around to Karachi anchorage. Dusk conditions. Normal environment. Prepare to anchor. |
| 7 | 1 | At Karachi anchorage. Master on bridge. Dusk conditions. SW'ly monsoon. Weigh anchor, full away. Master departs from bridge. Proceed towards Hong Kong. Transfer watch. |
| 8 | 1 | In China sea off Hong Kong Is. Take over watch. Prepare to approach Green Island pilot station via West Llama channel. Call Master. Pick up pilot. Proceed to mooring inside harbor. Daylight. SW'ly monsoon. Currents. |
| 9 | 1 | Vessel in Hong Kong.Prepare for departure to Karachi. Pilot boards. Master on bridge. Cast off from mooring. Proceed outside via Tathong Channel. Pilot disembarks. Full away. Master leaves bridge. Hong Kong Eastern approaches, |

| | | |
|---|---|---|
| | | watch-keeping in traffic scheme. Dusk conditions. SW'ly monsoon. Currents. |
| 10 | 1 | Watch-keeping on fully loaded VLCC. Simulated area. Day and night. Strong currents. Follow a buoyed channel. Straight. Angled. Double angled. |

## 4.3 BENEFITS OF SHS TRAINING.

The above training program complements the other theoretical and practical knowledge, received by nautical cadets in navigation and watch-keeping. After going through this course, the objectives attained can be summarized by partition into three different areas as shown below.

VESSEL MANEUVERING.

With regards to maneuvering capabilities of various types and sizes of merchant vessels, familiarization with the following.

a) Amounts of rudder required for various maneuvers.
b) Rudder orders.
c) Rudder response time.
d) Rate of turn.
e) Engine speed and vessel maneuverability.
f) Engine Orders.
g) Engine response time and limitations.
h) Speed change and its time requirements.
i) Effect of current and wind.

ANTI COLLISION

The importance of monitoring and assessing traffic situations and to identify collision risks as it pertains to the following.

a) Application of collision regulations in all conditions.

b) Proper use of VHF to communicate.

c) The need to maintain an efficient lookout and take visual bearings.

d) Clear and concise information to Master using relative bearings and distance.

e) Timely alterations of course.

f) Special circumstances and ambiguous Rules of the Road situations.

g) How to maneuver the vessel in a difficult situation.

NAVIGATION

Keeping a safe navigation watch in coastal waters and while approaching a pilot station as it pertains to:

a) Importance of reading and following Standing and Night orders.

b) Monitoring all bridge equipment and to respond to the information or to a malfunction.

c) Handing over and taking over a sea watch.

d) Communications internal and external.

e) Preparation of ships arrival and departure.

f) Proper log book entries.

g) Preparation of passage plan and monitoring progress of vessel in accordance with the plan.

h) Identifying situations when it is necessary to call the master.

i) Role of watch officer with Master and/or pilot on the bridge. Bridge teamwork. (interactions with conning officer).

j) Approaching an anchorage.

k) Utilizing all means available for navigational fixes.

In a first look at the proposed program it would seem that a period of about 10 hours per team is rather short to achieve the above mentioned objectives. But as has been referred to before this is a preliminary proposal aimed at an assessment of the PMA needs in the overall upgrading of training. Also there are time constraints due to other commitments. If an examination of the individual exercises is done it is seen that they do contain specific ship operation tasks like maneuvering for anti-stranding (track keeping) and collision avoidance, performing constant radius turn (specialist maneuver anti-stranding), influence of wind and current on ship handling etc. Moreover many of these tasks are a carry over from the practical done by cadets on the Radar/ARPA simulator. An exact specification in time of these, in the above period is difficult, however after analysis of the exercises the above tasks can be related with it, and approximate percentage of total time stated.

| | | | |
|---|---|---|---|
| Maneuvering: | | | |
| | Collision avoidance. | Weeks 3 - 5. | 100% |
| | | Weeks 2, 6 - 9. | 20% |
| | Track keeping. | Weeks 2, 6 - 9. | 50% |
| | | Week 10. | 60% |
| Turns: | | | |
| | Constant radius. | Weeks 2, 6 - 9. | 10% |
| | | Week 10. | 20% |

Wind / current:

| | | |
|---|---|---|
| Influence on | Weeks 2, 6 - 9. | 20% |
| ship-handling. | Week 10. | 20% |

However for appraisal of this training the grading of the cadet groups will be made on the form shown on next page. The marks shown in these are only for use of simulator instructor and will be utilized as an aid to research for a improved training syllabus.

# VALUATION FORM

DATE: TEAM:

WATCH OFFICER: NAVIGATOR:

RADAR OBSERVER: HELMSMAN:

SCENARIO SETUP:

**APPRAISAL & PLANNING:Total 30 Points(2 points per item)**

01.All relevant publications studied.

02.Passage plan.

03.Tracks & courses on chart.

04.Dangers and margins of safety marked

05.Tidal times and heights calculated.

06.Sufficient UKC/heights ascertained.

07.Currents marked and effects considered.

08.ETA's and distances planned.

09.VHF channels noted and R.P's marked

10.Frequency & method of fixing planned

11.Relevant port regulations considered

12.Weather expectations and forecasts

13.Ship's maneuvering capabilities considered

14.Contingency plans made

15.Effective anchoring plan made

APPRAISAL AND PLANNING SCORE

**EXECUTION:Total 40 points.(2 points per item)**

01.Compliance of Master's/Standing orders
02.Proper preparation for arrival
03.Proper internal communications
04.Proper VHF procedures
05.Master/Engine Room kept informed
06.ETA's maintained
07.Proper helm orders given
08.Frequency and method of position fixing.
09.Margins of safety maintained
10.Optimum use of all navigation aids
11.Correct collision avoidance taken
12.Safe speed maintained at all times
13.Efficient visual lookout maintained
14.Anchoring properly prepared and executed
15.Optimum use of bridge personnel
16.Bell book properly maintained
17.Log book properly maintained.
18.VHF log properly maintained
19.Emergencies effectively dealt with
20.Ship satisfactorily maneuvered

EXECUTION SCORE

MONITORING:Total 20 points.(2 points per item)

01.Track (charted fixes and P.I)
02.Depths
03.Traffic
04.VHF
05.Helm
06.Instruments
07.Visibility/weather
08.ETA's
09.Passing of information
10.Watch Officer

MONITORING SCORE

ORGANIZATION & TEAMWORK:Total 10 points (5 per item)

01.Watch officer composure
02.Teamwork

ORGANIZATION & TEAMWORK SCORE

SUMMARY

Appraisal & Planning (30) .............
Execution (40) ......................
Monitoring (20) .....................
Organization & Teamwork (10) ..........
TOTAL POINTS (Out of 100)

COMMENTS:...............................................
.......................................................
.......................................................
.......................................................

# CHAPTER 5

## CONCLUSIONS AND RECOMMENDATIONS

### 5.1 CONCLUSIONS

(a) The proposed training program will support the cadets in adjusting to the shipboard regime in a short time, compared with someone who has not had the opportunity to translate a theoretical topic into its practical equivalent by actually doing it.

(b) Shipping business presently, and more so in the future does not allow the on the job training methods of the bygone years. Serving officers will welcome an asset rather than be burdened, to additionally train a graduate on elementary items.

(c) Since the program runs parallel with the current training schedule, the academic studies will be strongly supported. Also the mandatory courses for officer licensing and re-validation will not be disturbed as they run from 0900-1400 hours.

(d) An evaluating period is made available thus, to provide for an eventual updating of the PMA nautical syllabus incorporating the use of the simulator in cadet training.

(e) When the eventual use of the SHS is integrated with the PMA syllabus, theoretical lectures can be reduced to certain extent.

(f) Practical training of new procedures/methods such as GMDSS, SAR etc. can be given, after necessary update.

(g) The fuller use of this valuable asset, installed at great expense, will go a long way into the future, strengthening the foundation of these potential officers for handling highly technical and costly ships joining our expanding national fleet. Also our nautical officers, will be at par with maritime education and training with other countries.

## 5.2 RECOMMENDATIONS:

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

(a) The proposed program may be started from 1992 for the graduating class of that year.

(b) The post noon non-academic activities for final semester cadets should be rescheduled.

(c) Initially, for a trial period the cadets are not examined until the full integration of the SHS training into the mainstream program.

(d) The syllabus should be revised and must incorporate SHS training, and Maritime Communications training. It will be possible to achieve this by streamlining the existing syllabus.

(e) The SHS simulator should be equipped with GMDSS equipment and Electronic Navigation chart. For this purpose the manufacturers in Japan can be approached to assess the possibility and costs.

(f) Provision of necessary staff for scheduled time periods of proposed training should be made. The requirement for this would be 1 simulator instructor/operator plus 1 nautical instructor.

(g) This would require additional expenses. The costing is worked out below in Pakistani Rupees. (Rs.)
Simulator electrical load = 22 KVA (max)
Air Conditioning electrical load = 40 KVA (max)

Electric charges rate = Rs. 2 per KVA/hour.
Simulator running time per day:
= 1 hour preparation + 2 hours exercise.= 3 hours.
Total running for 12 weeks (taking maximum):
= 12 x 5 days x 3 hours = 180 hours.
Electric costs for simulator:
= 22 x 2 x 180 = Rs.7920.
Air conditioner running per day:
= 0.5 + 3 = 3.5 hours.
Total running for 12 weeks (taking maximum):
= 12 x 5 x 3.5 = 210 hours.
Electric costs for air conditioning:
= 40 x 2 x 210 = Rs.16800.
Instruction allowance for 2 instructors.
From 1400 - 1900 = 5 hours/day for 5 days of week.

From 1600 - 1800 = 2 hours on Sundays.

Total number of hours = (5 x 5 x 12) + 24

= 324 hours.

At Rs.100/hr. Total allowance:

= 324 x 2 x 100 = Rs.64800.

Total costs for this course will be:

=Rs.7920 + 16800 + 64800 = Rs.89520.

At the current exchange rate of about $1 = Rs.24 this works out to $3730. per course. Although the above costing does not take into account the use of SHS consumable items and running maintenance costs but assuming a higher side figure of $200 per course, this works out to $3930. Therefore rounded off to $4000 per course, for a 5 year period of keeping the same costs in mind the total expense comes to only $20,000. This is just a small fraction of the money involved in the shipping industry.

Therefore, better training of our potential officers, saves costs incurred by Pakistan, in loss of costly ships with valuable cargoes, or causing immense pollution which beside irreparable damages to the environment, can be a very expensive experience as was shown in the case of the Amoco Cadiz and the Exxon Valdez.

# APPENDIX

The revised syllabus effective from January, 1987 for nautical cadets is divided into 4 areas as shown below.

1. NAVIGATION.
2. MARINE OPERATIONS.
3. MARINE TRANSPORTATION.
4. MARINE METEOROLOGY.

Each of the above areas are divided into sections, the breakup is as follows.

| NAVIGATION: | PERIODS. |
|---|---|
| (a) Principles of Navigation. | 192 |
| (b) Ocean and Offshore Navigation. | 160 |
| (c) Coastal Navigation. | 128 |
| (d) Radar Navigation. | 96 |
| (e) Electronic Navigation systems. | 64 |
| MARINE OPERATIONS: | |
| (a) Seamanship (Theory). | 192 |
| (b) Seamanship (Practical) | 64 |
| (c) Watch-keeping. | 64 |
| (d) Marine Communications. | 64 |
| (e) Engineering Knowledge. | 32 |
| MARINE TRANSPORTATION: | |
| (a) Ship Stability. | 96 |
| (b) Ship Construction. | 96 |
| (c) Cargo Handling and Stowage. | 128 |
| MARINE METEOROLOGY. | 64 |

The topics studied by cadets in the various sections are listed below. Those topics which will be practiced during the training exercises on the SHS are marked in bold text. This practice is supplemental in some cases to that done during class work, for example chartwork. However given the limitations of the present configuration of the SHS and the pilot nature of this proposal, a certain number of them may only be exercised partially or not at all.

Principles of Navigation.

Topics:

Description of Earth. Sailing. General Astronomy. Celestial Sphere. Time. Position Line Theory. Satellite Orbits.

Ocean And Off Shore Navigation:

Topics:

Calculating Courses and Distances. Nautical Almanac. Altitude Corrections. Astro Position Line. Compass Errors - Azimuth.

Coastal Navigation:

Topics:

Information from Charts and Nautical Publications. Position Fixing. Course Corrections. Laying of Courses. Wind and Current Effects. Tides. Exercises.

Radar Navigation:

Topics:

Radar Basics. Setting up and Maintaining Displays. Unwanted and Spurious Responses. Range and Bearing. Radar Plotting. Application of collision regulations as pertains to radar. Automatic Radar Plotting Aids.(ARPA) Practical and Exercises. (note: this section is practiced in the dedicated Radar/ARPA simulator, however the knowledge gained carries over to the SHS exercises).

Electronic Navigation systems:

Topics:

Electromagnetic Waves. Thermionic Valves. Magnetic Compass. Gyro-Compass. Echo Sounder. Echoes. Radio Direction Finder. Polar Diagram. Polar Diagram. Cardioid Diagram. Bellini-Tosi Aerial System. Radio Beacons, Bearings. Hyperbola. Ambiguity. Lattice Pattern. Loran C. Decca Navigator. Omega System. Setting up Omega. Propagation Anomalies. Differential, Omega. The Transit Satellite System. Tracking, Stations. The Navstar Satellite System, Sources of Error. Integrated Navigation Systems.

Seamanship (Theory):

Topics:

Basic Personal Conduct. General Terms Applied. Helms-Man Ship. Watch Organization & Musters. Ropes & Wires. Lifting Gears. Survival at Sea. Types of Survival Crafts. (boats). Inflatable Life Raft. Life buoy & Life Jackets in buoyant apparatus. Abandoning ship and after actions. General Safety and Accident Prevention. Ropes and Wires. Anchor, Windlasses & Stowage of Cable. Cargo Handling Equipment. Mooring Operations. Ship Manoeuvering and Handling. Search and Rescue. Officer-on-Watch duties at sea & harbor. Basic Training in Fire-Fighting. Emergency Procedures. Basic Oil Tanker Safety. Prevention of Pollution of the Marine Environment.

Seamanship (Practical):

Topics:

Bends and Hitches. Boat Pulling. Rope Work. Boat Sailing. Power Boat.

Watch - Keeping:

Topics:

Implementation of 1972 Regulations for Preventing Collision at Sea. Helm and Engine Orders. IALA System of Buoyage. Duties of Watch-keeping Officers.

Marine Communications:

Topics:

Basic definitions. Explanation of morse code, letter and figure spelling. Description of flags. Types of Signal letters. Methods of Signalling. Distress Signals. Coding and De-coding. Flag Signalling. How to Signal numbers and Signal letter Signals with complements. Radio Telephony, VHF procedure, etc. Morse Signalling. Sound Signalling. Practical.

Engineering Knowledge:

Topics:

Deck Machinery. Marine Boilers. Turbines. Pumps and Auxiliaries. Refrigeration. Steering Gears. Main Shafting, Propeller, Fuel Consumptions.

Ship Stability:

Topics:

Hydrostatic Principle. Form Coefficients. Tonnes Per Cm Immersion. Effect of density on draught. Loading & Discharging and Shifting of Weights. Transverse stability (small angles). Transverse Stability (Large angles).

Inclining Experiment. Free Surface Effects. Longitudinal Stability. Load Lines. Stability Information Carried on Ships.

Ship Construction:

Topics:

General Description of Ships. Stresses in Ship's Structures. Framing Systems. Double Bottom Tanks. Structure at Upper Deck. Stern Structure. Bulkheads. Corrosion.

Cargo Handling And Stowage:

Topics:

Basic Definition. Preparation of Holds. Cargo Handling Equipment. Cargo Stowage Organization. Ventilation and Sweat. Safety at Work. Carriage of dry cargoes. Carriage of Bulk cargoes. Carriage of Grain cargoes. Carriage of Coal cargoes. Carriage of Dangerous cargoes. Carriage of Special cargoes. Carriage of Unitized cargoes. Carriage of Refrigerated cargoes. Oil cargoes - Safety.

Marine Meteorology:

Topics:

General Introduction to "Meteorology" as a Science. The mercurial barometer-theoretical and practical aspects. The aneroid barometer-theoretical and practical aspects. The Barograph-Principles, theoretical and Practical aspects. Thermometry-Different type of thermometers, and temperature scales in use. Hygrometers and Psychrometer. Sea-Surface temperature, as distinct from surface air-temperature. Earth's Atmosphere, physical characteristics and divisions. Heat-Exchange between the Earth and its Atmosphere; the "Lapse Rate". Water-Vapor in Atmosphere, Humidity and its parameters. Atmospheric Pressure, and its related aspects. The processes of "Condensation" and "Precipitation". Formation of Fog, and Cloud; types of Cloud. Correlation between "Wind" and "Pressure", the forces involved. Mean Synoptic Surface Pressure and wind distribution Belts. The principal cloud types according to "Mode of Formation". Basic Concepts Relating to "Low-pressure" and "High pressure" systems. Elementary concepts regarding "Air Masses" and allied aspects. Elementary Concepts about "Fronts" and related aspects. Elementary Concepts regarding "High-latitude Frontal Depression". "Occlusion" - mechanism, types. Elementary theoretical and practical concepts about TRS. The Beaufort Wind Scale; weather notations used at Sea. Introduction to MET - reporting. The principal Ocean Currents - general basic ideas. "Floating Ice" - general basic ideas.

# BIBLIOGRAPHY


Australian Maritime College. (1991). Department of Navigation. Course information for cadets training.

Bremen Polytechnic. (1991). Department of Navigation. Course information for cadets training.

Carpenter M.H. A Guide to Merchant Ship Simulators. Sea Technology, June 1991.

Froese. J. Prof. (1991). Hamburg Polytechnic.(SUSAN) Visiting Professor. (WMU). Information and lecture notes.

Iijima Yukito. (1983). Marine Simulators. Seminar on Seafarers' Training and Certification, Tokyo/Kobe, Japan.

Japan Radio Company, Tokyo, Japan. (1988-89). Technical Manuals of Ship Simulator.

Krupp Atlas Electronic Co. Bremen. Germany. Information brochures.(1991).

Mulders J. Prof. (1990-91). World Maritime University. Various information notes.

Norcontrol Simulation. (1991). Product Information and Technical Manuals.

Pakistan Marine Academy. Information Brochures. Prospectus. Departmental Papers.

Proceedings of The 6th. International Radar and Navigation Simulator Lecturers Conference, St. Malo, France. June 1990.

Safety at Sea. May 1990. Simulators for training and research.

Saleh Salah. (1989). Ship Handling Simulation Training Systems. Journal of the Arab Maritime Transport Academy.