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The use of maritime simulation for training

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THE USE OF MARITIME SIMULATION FOR TRAINING

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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 reflected my personal views and are not necessarily endorsed by the university.

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ABSTRACT

This thesis is a study of the growth in maritime simulation in general and its use as a training aid with specific reference to the need for shiphandling simulator programs in Iran.

The history of the development of radar and shiphandling simulators is examined and the development of maritime simulators in different countries is outlined.

The simulator training programs of three different institutes are looked at as representing different training systems in the world. A training program at the cadet level for the Nautical College of Chabahar is proposed which will cover the four years of the B.Sc program.

A series of courses at master, mate and pilot level have been established with the view that maximum advantage can be taken during the times that simulators are not in use for the cadets.

The present limitations imposed by the use of simulators are explored and the consequent restrictions on simulator training are discussed. An evaluation of shiphandling simulators and the factors effecting the validity of simulator training is commented upon.

Conclusions are drawn and recommendations made with the view to maximizing the benefits to be gained from the use of simulators for skill acquisition and enhanced experience in the maritime world.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1. THE NEED FOR IMPROVEMENT IN TRAINING:

The increased number of maritime casualties in past years caused a great loss of lives and properties. Enquiries into these casualties show most maritime accidents are caused by human error.

As the commission of the European communities (1993) stated:

> " Human error whether by crew, pilot or shore is a contributory cause ... for almost 60% of all major claims and for 80% of the incidents according to Protection and Indemnity (P&I) statistics."

The above mentioned facts show that there is a world wide problem of lack of appropriate education for seafarers.

Ships are becoming larger and faster, technology on board is rapidly becoming more modern. The incoming complex modern instrumentation needs newly trained cadets and active officers to become acquainted with these changes. The increasing need is for energy demands for the shipment of large amounts of oil, ore and liquified gases in large ships. The transport of new chemicals and material with a great potential to harm the environment has increased daily.

The waterways, canal and ports which at one time were considered suitable in depth and width for the safe use of vessels now cause the ships to enter a port and berth with a marginal dimension. The margin of error in navigating large vessels in restricted waters has been reduced. This requires the mariner to make decisions more accurately and more rapidly. The new trend in reduction of crews causes the responsibility of each crew member to increase not only with respect to their tasks under normal conditions but also with respect to their roles in critical situations.

The above mentioned facts show that conventional methods of training need to be supplemented. It seems that practically-oriented training is the best way to counteract this trend. It means that for safe handling of ships seafarers shall have a wide experience of actually handling such ships in different circumstances. In doing this there are some limitations because comprehensive training is costly and needs a long training time, and creating dangerous situations for the purpose of exercises is impractical.

One of the existing solutions is to use training ships. Training ships are a very good training device for hands-on practices, but lots of limitations are encountered.

The practice on training ships is to practice with just one type of ship. It is impractical, or very difficult, to exercise emergencies and hazardous situations. The environmental conditions are out of control and the required exercise areas are not available at all times. The best solution to this problem is the use of simulation technology.

1.2. WHAT IS THE SIMULATOR ?

The simulator is a device which duplicates real equipment or environment for a man to become familiar with its use or procedure through practical experience.

Froese (1989) describes a simulator as:

> " A controlled process within an environment containing fake elements in order to replace a real world process. "

Simulators use computers for this processing. The computers generate and control the simulation information and create the environment which in the case of a shiphandling simulator is the bridge. The essential part of a simulator is the mathematical model or models of the ship. The model is used by computers which accept commands from the bridge, the result representing the dynamic behaviour of the vessel according to environmental effects such as wind, current etc. The environmental effects are under the control of the instructor. Each mathematical model represents just one state of a ship. It is obvious that fidelity and validity of the system depend on the accuracy of mathematical modeling and computer calculations.

A simulator can be as simple as a part task simulator which simulates one or several instruments, for example a radar simulator. It can be a complete one as a whole task simulator which simulates everything in that environment, for example a full bridge simulator.

1.3. WHY A SIMULATOR ?

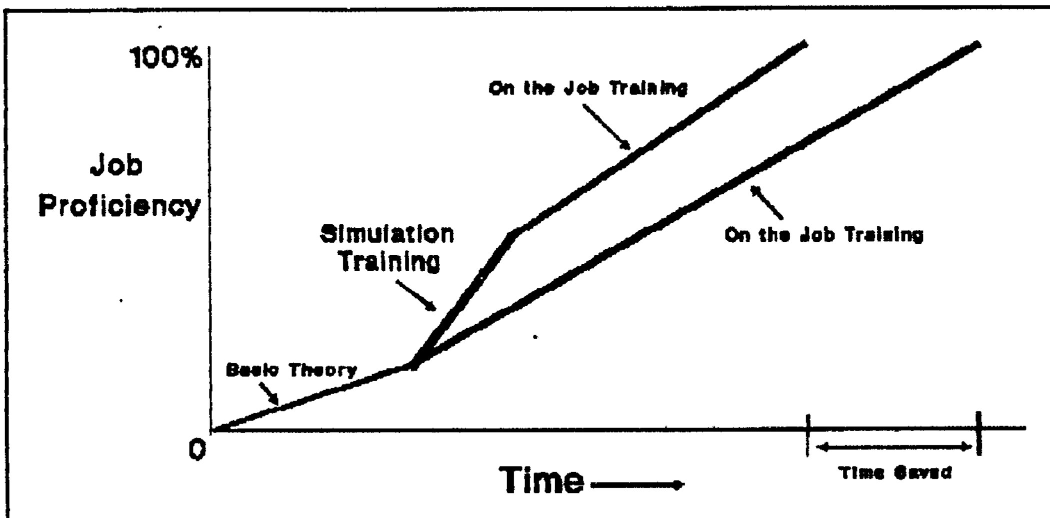
A brief look at the other industries such as nuclear power plants, aviation, chemical plants and space aviation shows the vast use of simulation as a training tool. Most of these industries start simulation earlier than in the maritime sector and most of them find it so useful that it has become a compulsory part of training.

Simulation is a dynamic part of the training program which can improve the effectiveness of training. Muirhead (1985) in his investigation pointed out that simulators are very powerful tools for improving training efficiency in many tasks provided that the training programs are carefully designed to meet the training objectives.

He added that there is no need for the simulator to be the exact copy of the real world, which would be a big investment, but it should contain the aspects of the tasks which are relevant to training purposes.

One of the main advantages of simulator training is time saving. The simulator causes the reduction of on-the-job-training by experience through the intensive simulation program. It means tasks which should be done on board ships in the lengthy course of time can be trained in a short period of time on simulators.

The graph in the following page from Atlas Electronic, one of the main simulator producers, supports this idea.



Source: Atlas Electronic (1993)

Simulators expose mariners to situations which are not possible, dangerous or costly to experience in real life and if they were to encounter such situations for the first time the results could be catastrophic. The availability of different exercise areas in any weather condition and different type of ships at any time in simulators, enable the trainee to gain experience of difficult conditions and emergency situations. The ability to repeat rapidly the difficult situations and the extensive use of debriefing by the instructor allows the trainee to review the tactic and finally reach the proficiency.

Simulators can be used for training the crew of specific kinds of ship even before the actual ship is built or put into operation. They can be used for port development and at the same time give the ships' crew or pilots of ships hands-on experience of entering a new port before it is completely built. A simulator is a valuable tool to study and guide human behavior under controlled conditions.

1.4. WHO CAN BE TRAINED ON A SIMULATOR ?

Maritime cadets during their studies in colleges can be trained by simulators. They can attend radar and ARPA training on a radar simulator and then undertake courses on shiphandling, rules of the road and team work on shiphandling simulators. They can use simulators in order to be competent before attending the exam.

Officers about to attain command can benefit from such a system. The pilots and masters can update themselves and become familiar with new equipment with the aid of a simulator. They can receive courses on emergency training, team work and procedural training.

Seafarers may be required to operate specialized vessels or ships with unusual manoeuvring characteristics. The personnel of off shore installations and V.T.S. operators are amongst those who can be trained on simulators.

CHAPTER 2

THE GROWTH AND DEVELOPMENT OF MARITIME SIMULATION

2. THE GROWTH AND DEVELOPMENT OF RADAR & MARINE SIMULATION

2.1 RADAR AND NAVIGATION SIMULATION

The history of radar simulation commenced in the early fifties when the use of simulators for navigation was mentioned for the first time.

Radar was introduced to merchant shipping after the Second World War. Regarding marine technology in that era, it was a very sophisticated tool which made it very difficult for officers to get used to it.

Radar was not only an aid to navigation (position fixing) but was also an aid to avoiding collision, mainly during low visibility. The main problem rose at this point because the movement of the target on the radar screen, or so-called PPI (Plan Position Indicator), was in relative motion.

Most of the officers plotted the ships or took the afterglow of ships' echoes on the radar display and by incorrect interpretation assumed it to be the true course and speed of the other vessel. This caused many collisions which afterwards were described as "Radar assisted collisions".

At that time some nautical colleges prepared and provided some courses for training of radar observers mainly in regard to plotting procedures and relative motion. As courses did not offer hands-on and practical training, officers had difficulty in transferring the knowledge to real world practice on ships.

Meanwhile some navigation schools were somehow conducting the simulation on paper. They put a large paper or chart on the table then the instructor operated small ship models as own ship and targets with predetermined course and speed. Range and bearing of other target ships in relation to the own ship were reported at regular intervals to the student by the instructor. Students at separate tables plotted target ships and decided to manoeuvre accordingly, the decision being passed to the instructor regarding change of course and/or speed and time of execution. The instructor amended the motion to the own ship accordingly. At the end, a review of the exercise was held.

In the late fifties, the electronic radar simulator was introduced to the market. It analyzed the information with the use of analogue techniques, and used a mechanical scanner shaft fitted with servo systems and relays. The flying spot technique with use of different transparencies was used for the production of the coastline.

The vector of movement of target ships i.e. course and speed was electrically analyzed to X and Y component and then compared to those corresponding to the own ship's movement. The result showed the new position of the echo on the PPI after integration of the resultant differences and the conversion to a bearing and range.

For target ship echoes a pulse generator sent a pulse, which was visible on the PPI, that corresponded to range and bearing of a given target ship during each rotation of the scan. The spinning of the scanner rotation shaft corresponded to all angular data required throughout the simulator.

The own ship in the display corresponded by origin to the PPI trace which was the same as the origin of the flying spot scan. Movement of own ship in the display was provided by a shifting voltage resulting from an analysis of own ship's velocity vector. The velocity and compass course data were primarily fed into the computer by the instructor. The characteristics of the type of vessel that was supposed to be simulated were fed into the computer system before the start of the exercise. Changes of speed and direction during the exercise, acceleration and deceleration were affected by speed inertia and, in the same manner, delays in course change after wheel-over were affected by helm inertia. The loss of speed during turning, and the effect of initial speed in the speed and rate of turn, were also included.

Regarding the movement of target ships, the position of target ship echoes was initially set by the controls provided for this purpose and then the course and speed data were fed into the computing system of the simulator. The computer was continuously comparing target data to data corresponding to the own ship's movements. The result was new positions of the target ships in relation to the own ship at each moment. The characteristics of the target ships were not included in the computing system, so response to the target ship's speed and helm demand was immediate.

The coastline in the simulation was created by an optical system using transparencies of radar photographs. To be similar to actual radar pictures, the flying spot scan was used that synchronized with the PPI trace.

Movements of the own ship was presented by movements of the origin of scan on the coastline transparency. This was achieved using the controls provided, but later by using a computer system.

To provide a realistic change in the aspects of coastlines, the shadow effect was used. By using strong echoes from high ground in the transparency patterns, shadow effects were generated. This caused features behind high ground not to be displayed until the shadow pattern was changed by movement of the own ship.

The means were provided to position target ships outside radar range. The effect of tidal stream was provided. By setting the tidal speed and direction in the computer the movement of origin of PPI scan in display, which corresponded to the own ship movements, was affected accordingly.

The effect of the sea clutter was shown by creating off-centre, circular areas in the vicinity of the own ship with crowded echoes. With a few degrees of repeated movement of the own ship's heading from its designated position, in the computing system, the yawing effects were displayed. Relative, stabilized and true motion were part of the simulation. The true motion display could either be true log or true manual.

Later developments allowed other features to be added to the simulator, such as showing the Racons, the simulation of auto pilot and moving platform. A noise generator provided an artificial background noise at the PPI to make it more realistic.

In some cases navigational equipment such as Decca, Loran, Omega and Radio Direction Finder were added to the simulators which made them navigation simulators.

In 1958 one of the first radar simulators was built at a naval navigation school in England. It consisted of five main sections containing control units, computer, pulse production, video shaping circuits and aerial rotation simulation.

The simulator had one target ship and a coastline of a special area but due to limitations the target ship and coastline could not be shown at the same time.

A year later a better radar simulator was installed in a nautical college in London. It was equipped with two radar display units; one as the main and the other as a slave display. Five target ships and a coastline were available.

The next step in development of the radar simulator was making use of transistors. It was a great advantage that the equipment was transistorized, resulting in better performances as well as eliminating the production of heat - as the heat was a source of tiredness and irritation for the students when valve equipment was used in simulators.

At the same time a simulator with two own ships was installed. It had four target ships. The interesting point was that one could see the view from both ships engaged in a dangerous situation. In addition it was possible to experience two own ships doing the same exercise sharing four target ships on their displays.

As far as training programs for radar simulators were concerned they were designed for the training of deck officers in collision avoidance, but it was found that they could be a useful tool for other forms of training. They proved to be good instruments for training pilots, vessel traffic operators, coast guard officers, tug masters and so on.

Later on radar simulator training became a part of the requirements of the International Convention on Standard of Training and Watchkeeping for Seafarers, 1978(STCW) and relevant IMO resolutions. Afterwards ARPA training by simulator was added to most simulator training curricula.

2.2 Development in radar simulation for different countries.

U.K.

One of the first colleges which started with radar simulator training was Liverpool Polytechnic in 1957. The reason for this was the request of the Steamship Owners' Association to familiarize the navigating officers with relative motion as seen on a radar screen. The simulator consisted of two own ships and four target ships plus a flying spot scanner for coastline generation. Later on an auto-pilot was added but no plotter was provided.

Almost fifteen years later the simulator was replaced with a new one which had three own ships, four targets and a flying spot scanner plus two displays. In 1976 a radar recorder was added to the simulator, so that tapes made at sea could be replayed on to one of the displays. It was possible to record from the same display when it was in simulation mode.

A navigation simulation was installed in 1980. Based on a mini computer, it had three own ships which could simulate four different types of ships but no coastline was available. To operate navigational aid instruments, such as Decca navigator, Log indicator and DF, software was used. Later on Polytechnic staff developed software to display standard radar, ARPA features as well as static and dynamic trial manoeuvring facilities.

In the next step they developed software to display on a television screen the visual scene of the navigational light of target ships (a usual tool for teaching collision avoidance at sea) and a buoyed channel with its lights for port approach exercises.

Two years later another simulator was installed. The reason being that the previous simulator was mainly used for research and not for training. This simulator was a navigation simulator based on a minicomputer. It had three bridges setup as three own ships; each bridge was provided with a Radar ARPA, Decca Navigator, Loran, DF and Echo-Sounder. The internal and external communications were provided by means of VHF and RT. A radar recording and replay system was available for one of the own ships, for replay of recordings from the tape library made at sea, on real radars.

Boulevard Nautical College of Hull was equipped with a radar simulator in the early 1960s. The simulator had one own ship, two target ships and a flying spot scanner for producing coastline.

In 1974 a navigation simulator was installed. It had three own ships, 40 target ships and a digitally generated coastline. It was originally designed to train fishermen as well as deck officers so in addition to navigational aids such as Decca Navigator, Loran, DF and Echo-sounder it was equipped with fishing aids including Sonar, Fish Lupe and Net Sounder. The simulator was equipped with VHF for radio communication and a plotter to record tracks of own ship, target ships and fish shoals when fishing.

This navigation simulator worked with two computers so with the aid of software it was possible for it to be equipped with new equipment. As a result, an ARPA was added few years later. In regard to fishing, the significant updating was the installation of a colour display to simulate underwater pictures of net and fish as a top or side view.

In 1982 college staff, with their experience of simulators, designed and built a cheap fishing simulator. Later these simulators were sold to colleges in different countries.

The Nautical College in Plymouth installed a radar simulator with three own ships, four target ships, X/Y plotter and flying spot scanner in 1970. Another cubicle, which was a slave of one of the own ships, was added later.

In 1977 a digital navigation radar simulator was installed. It could run three own ships and six target ships and was equipped with a Decca navigator, medium frequency DF and Echo Sounder in addition to VHF and MF R/T for communication. Later updating included the installation of three ARPAs and disc storage.

Due to the new scheme of training undergraduate students, who entered the college for the maritime degree course, in the number of places available on the radar simulator was restricted, so the college ordered another simulator. The new four own ships simulator consisted of three main packages; a marine radar and navigation simulator, a visual scene simulator and a position system for hydrographic surveying. This simulator was able to satisfy the minimum standards of the department of trade specification for radar simulators and was able to obtain remission of sea service for officers from that department.

The simulator was equipped with ARPAs, radars, navigational equipment plus a separate hydrographic work station able to receive sensor outputs from a satellite survey navigator and survey echo-sounder. As well, this simulator had a bridge unit equipped with navigational equipment, ARPA and a visual scene.

The visual simulator with the use of TV projectors produced a C.G.I display on a screen with a horizontal field of view of 135 degrees. The visual simulator was a nocturnal one and was able to simulate up to 600 lights and 16 different ship types in different levels of visibility.

The College in Cardiff developed a radar simulator course in 1972. A radar simulator with one own ship and five target ships plus coastline generator was installed. Later on they replaced the simulator with one which had three own ships, four target ships and a coastline generator. The main courses carried on this simulator were pilot courses which formed the major part of the time table and also courses for vessel traffic system (V.T.S.) operators.

In 1981 the College bought a ship handling simulator. It had a visual system based on computer generated image using television picture generation for projection (TEPIGEN). This simulator was used for training but in addition the College used it for research in different fields such as emergency procedures on board ships, design and development of harbours and psychological aspects of human behaviour on ships' bridges due to stresses, fatigue and engine vibration and noise.

GERMANY

The Nautical College of Bremen installed its first radar simulator as early as 1959. It simulated one own ship and two target ships but no coastline was available. The nautical college used it as part of a non-mandatory training course and as a teaching aid. It was not until ten years later that a shipping company requested a mandatory course for their ships' officers to undergo a one week course on the simulator. The reason for this request was the increased number of collisions involving misuse of radar.

After some years, due to ageing and unavailability of spare parts, this simulator closed down and the College had to revert to old methods which were mentioned previously.

The main difference in the Bremen simulator compared with others, was the layout. There were no walls around the different cubicles and the students had free access to other cubicles, but instructors laid stress on the use of VHF/RT for communication between cubicles. The main idea was for the instructor to easily keep an eye on the students during the exercise.

FRANCE

Ecole National De La Marine Merchande in Le Havre installed their first radar simulator with one own ship and four target ships in 1963. Later on, in 1970, they replaced this simulator with a new one which had three own ships and two target ships. The next replacement was made in 1982 with a simulator equipped with ARPA as well as radar display unit. The new simulator had four own ships, 20 target ships, coast line features and traffic lanes plus a plotting table. Replay facilities on a television screen were also available.

In 1983 the same type of simulator was installed at the Maritime College, Marseilles, and after a few years another simulator was installed in St.Malo.

U.S.S.R.

In the U.S.S.R. it was customary for the shipping companies as well as maritime schools to have their own radar simulator. It was a shipping company in (former) Leningrad which began to use a radar simulator in 1969. At the same time another shipping company in Vladivostok installed a radar complex which included two radar simulators and a simulator fitted with nocturnal facilities.

They used their simulators for different training programs such as deep sea navigation and operation of hydrofoil vessels. They generally requested their own senior officers to attend the repeated courses, such as an 8-day intensive radar simulator course, at intervals of five years. Two-day refresher courses were also available.

In consideration of promotion for officers, the companies used a simulator to assess candidates in their knowledge of radar interpretation. In case of a collision they use the simulator for investigation and analysis of the casualty.

In 1982 there were 19 radar simulators operating in shipping companies and maritime schools all over the U.S.S.R. Some of them are gradually being equipped with nocturnal visual aids.

2.3 SHIP SIMULATION

The simulation technique did not originate in the maritime area. When maritime industries started to use simulators, it was already a well developed technique to some extent in other industries such as the aircraft industry. The first motivation for using simulation in the maritime field was not training,but for research into ship design.

Ship simulators (bridge/shiphandling) have been developed, built and used for almost thirty years in different institutes and colleges all over the world. The principle for all is almost the same. They have computerized mathematical simulation model programs describing the ship's characteristics, and consist of a bridge with controls and instruments partially or totally displayed around the wheelhouse. The central computer controls, the instrument and visual display system. Although the mathematical models in different simulators are not the same, all include ship dynamics and most of them calculate bank and shallow water effects.

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

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

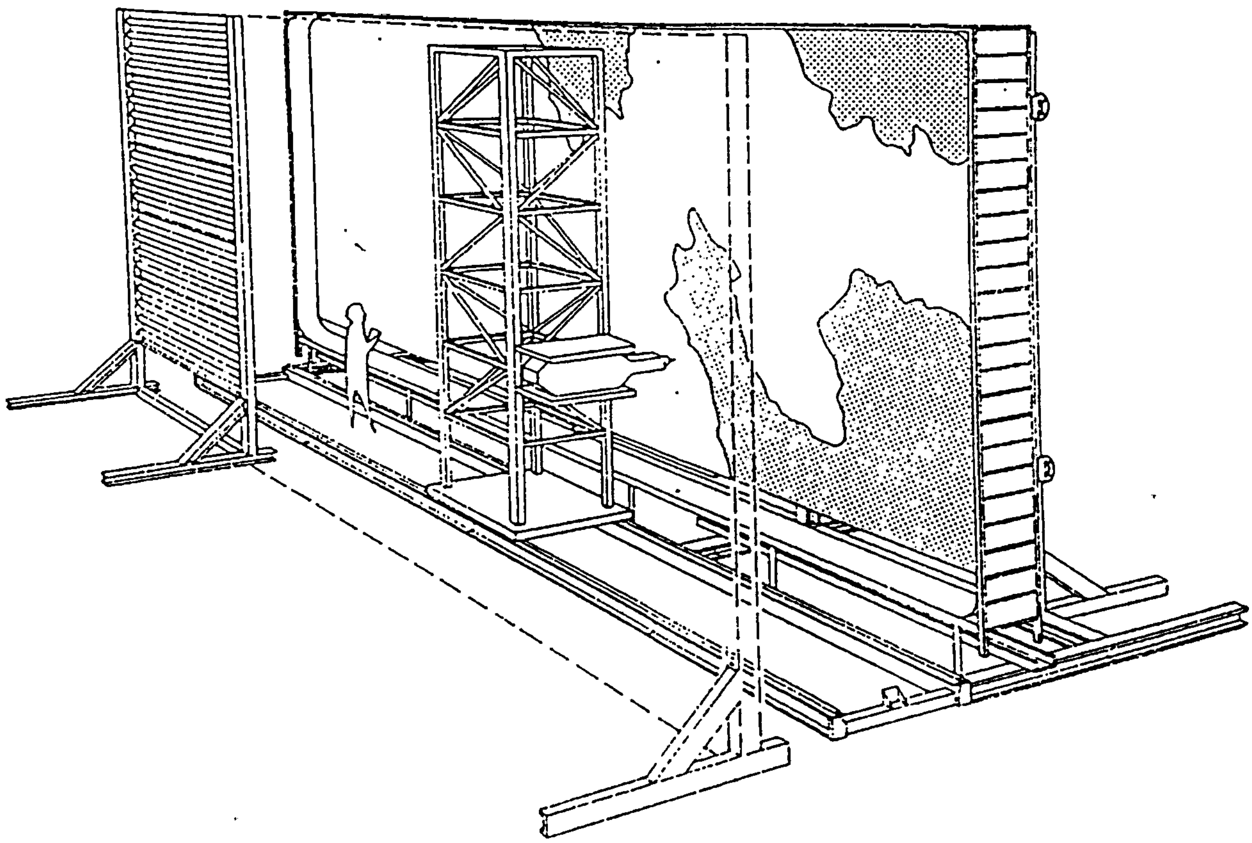
A description of the main projection systems follows:

1-Model board system
2-The shadowgraph
3-Slide protection system
4-Nocturnal display
5-Computer Generated Image (C.G.I) visual display

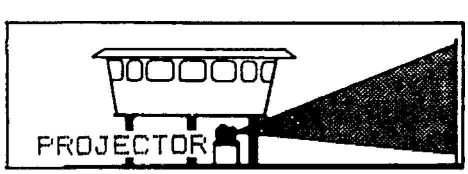
2.3.1 MODELBOARD SYSTEM

This system was one of the pioneering systems in marine simulation. In this method the exercise area was constructed physically on a small scale (see figure 2.1.). A small TV camera represents the own ship in the exercise area, and is controlled, in scale, by orders from equipment and installation in the wheelhouse. The pictures from the camera or cameras are projected on to a screen outside and around the wheelhouse. Target ships are represented by small model ships set to a fixed course and speed.

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



Typical 15x30 foot model board of MarineSafety shiphandling simulator system. Visual imagery projected on panoramic screen before bridge is provided by gantry-mounted three-camera, wide angle optical probe of geographical "gaming area" under simulation. With a 2,000-to-one scale, model board covers 50 square mile area.



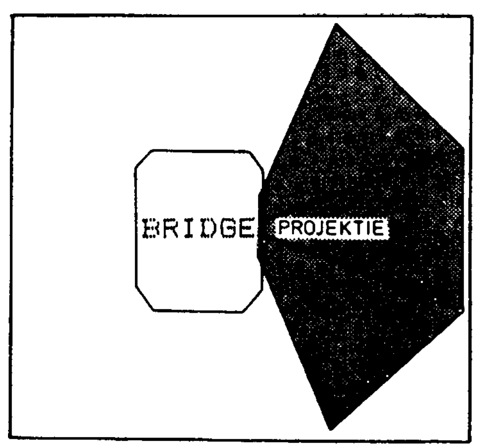


Fig. 2.1. Model board projection system

Several institutes have installed this kind of simulator. In 1976 TNO-DELFT in Netherlands installed single modelboard/pointlight source simulator originally for research purposes. It was able to display 120 degrees field of view. It could manage own ships up to 545,000 d.w.t of different classes. Delft was able to operate the own ship with wind, current and shallow water effect. The exercise areas consisted of open sea, coastal situation, harbour situation, single buoy mooring system and the inland sea.

A special area was developed to allow for night visibility conditions. One disadvantage was that it could display only black and white vision.

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

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

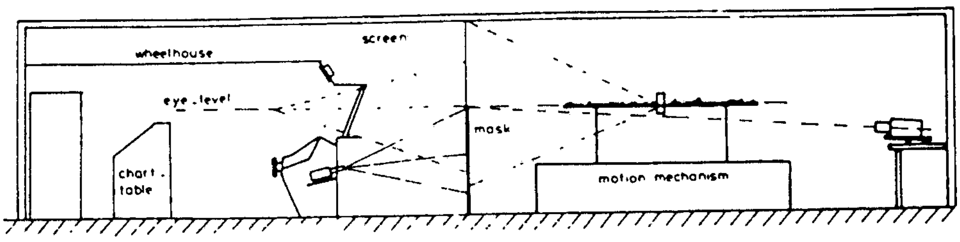
The other new features were vibration and sound of engines, use of up to 12 pull/push tugs and three anchors at the same time. More exercise areas and more traffic ships were included.

2.3.2 THE SHADOWGRAPH

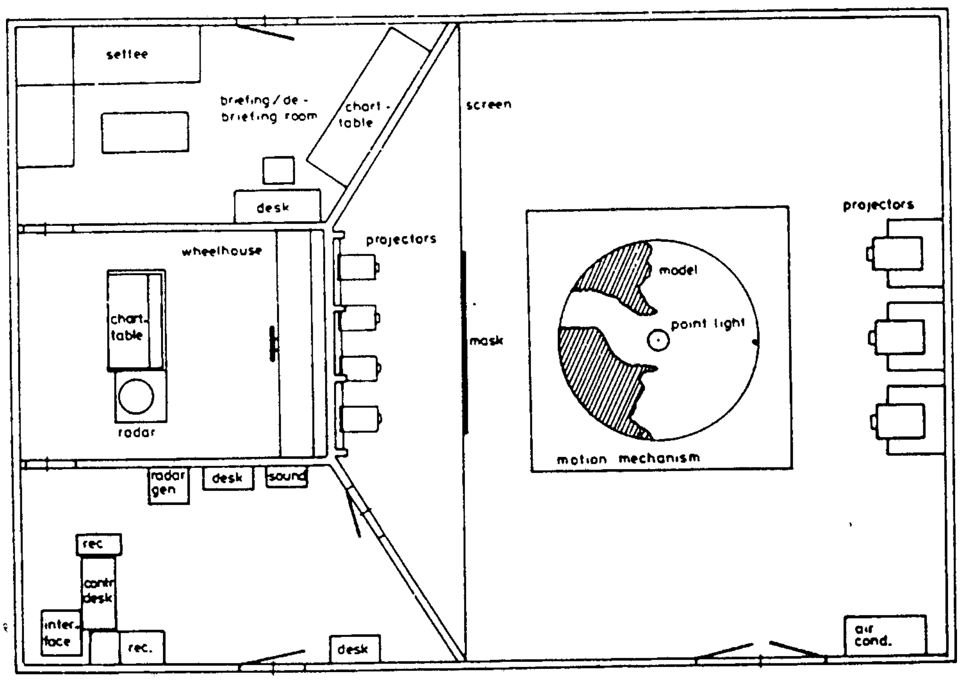
In this method the visual environmental condition is displayed by using a point light source projection system, the shadow of cut out models of horizon and land mass object are placed in front of the light source and projected onto a circular screen (see figure 2.2.). The generated visual display is in colour and the background, navigational marks, moving water surface and clouds are visible. The constant view of the own ship forward of the bridge is produced on the screen by additional slide projectors. By using a point light source system it is possible to produce day-light, poor visibility and nocturnal conditions.

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

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



CROSS-SECTION



TOP VIEW

Fig. 2.2. Shadowgraph projection system

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

2.3.3 SLIDE PROJECTION SYSTEM

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

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

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

2.3.4 THE NOCTURNAL DISPLAY

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

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

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

The same company produced a further upgrade of this type of simulation in 1981 with a computerized system controlling light points from 60 spot projectors to create a field of view of 360 degrees in a spherical screen. The bridge was fully equipped with all instruments and electronic navigational aids. An additional technique used a motion platform which permitted the bridge to roll up to 20 degrees either way, and to heave up to 45 centimetres in a full range of environmental effects up to sea state ten.

Two years later the Norcontrol company, in conjunction with Seagul company, provided a cheap and efficient nocturnal visual system using 24 spot light projectors. This was a very useful system to upgrade the present radar simulator to a visual simulator.

2.2.5 THE COMPUTER GENERATED IMAGE (C.G.I) VISUAL DISPLAY

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

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

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

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

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

CHAPTER 3

TRAINING BY SIMULATOR SOME APROACHES

3. TRAINING BY SIMULATORS- SOME APPROACHES

The shiphandling simulator is used to train mariners with different backgrounds and experience from cadet to pilot. They expose the trainees to a wide range of experience in seamanship, shiphandling, emergencies and navigation. They are designed to give practical experience of tasks, which are done at sea, in a safe and effective way. Different approaches are taken by colleges and institutes, which are provided with simulators, through their training programs.

This chapter deals with the training programs on simulators of some developed countries. These samples are from colleges which are pioneers and well advanced in simulator training. It will give a brief indication of how other countries are running their simulators and show that while the training objectives for certain levels are not much different the approaches taken are, at least to a certain extent.

SCHOOL OF MARITIME STUDIES, HAMBURG

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

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

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

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

The total simulator training for each student is about 81 hours consisting of 45 hours of radar training and blind pilotage and 42 hours of shiphandling exercises. Each student receives about 12 hours of command time in watchkeeping and shiphandling.

The simulator training program covers passage planning, bridge watchkeeping, collision avoidance, approaching and communication in general, one man bridge watch, berthing and unberthing, taking a pilot, emergency anchoring, search and rescue and tug handling in particular. The exercises are done in day and night conditions, bad visibility and different wind forces and weather conditions.

The sessions consist of three hours of exercises. The first four sessions are done with six students present on the bridge. The rest of the exercises are done by three students except the one man bridge watch, which is obviously done by one student.

The exercises are spread over 9 to 11 successive weeks, each week with one or two sessions. The radar simulator training is done in parallel with the shiphandling simulator training in the same weeks.

Students are provided with material for briefing a few days before the exercise. Each session consists of a series of exercises and debriefing by the instructor after each exercise. The student maintains the roles of helmsman, navigation assistant and officer of the watch in turn.

The exercise areas are Deutsche Bucht, rivers Elbe and Wesser, and port of Zeebrugge, but the main exercise area is an artificial area called Simland. Simland is designed to have most of the necessary features required for different kinds of exercises. It consists of an island with buoyed channel, traffic separation scheme, anchorage area, VTS system and port area. The own-ships are generally a container vessel and a middle sized tanker.

The course aims to train the promotion of correct decision making by the officers. The main objectives of the courses are to enable the students to carry out all watch officers' routine tasks and to make use of the theoretical subjects they have learned in practical shiphandling and taking proper action.

The school runs another course for those ship engineers who wish to achieve an additional nautical qualification for promotion to ship operation officer. The course consists of two semesters.

A shorter simulator training program is designed for this course. The program contains 9 sessions. In the first three sessions the students participate in groups of six trainees and for the rest of the sessions three students form a bridge team.

The course covers watch procedures, passage planning, internal and external communication, emergency manoeuvres, collision avoidance and shiphandling.

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

The shiphandling simulator courses of Hamburg maritime school run at a "shiphandling and simulation facility" called SUSAN. SUSAN, which is the German abbreviation of Schiffsfuhrungs Und Simulations ANlagen, is one of the most advanced and sophisticated simulation facilities available in the world.

The large horizontal field of view, sophisticated monitoring system and motion platform in one side and highly competent and expert staff on the other side make this facility one of the best.

This facility, in addition to the above mentioned courses, is used for other training programs and research. The training programs consist of master/chiefmates, pilots, VTS operators, shiphandling simulator instructors and special courses as demanded by the clients. The courses are designed for two levels of trainees, the experienced and non or low experienced. The masters and chief mates courses have a duration of three to five days, depending on the own-ship size and manoeuvrability. The container vessels as own-ship cause the course to be a three day course because the container vessel is relatively fast and so the number of simulator runs per hour are more. In contrast the tankers and large bulk carriers are slow and need lengthy exercises.

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

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

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

BREMEN POLYTECHNIC

The Department of Navigational Studies (Fachbereich Nautik, FbN) educates and trains foreign-going masters (AG-certificate), but also offers courses for lower nautical certificates (limited tonnage: AM, coastal range: AK). The College has started new training programs for training dual qualification officers (AG certificate plus chief engineer certificate). The master AG course takes about three years or six semesters of college studies which include three semesters of fundamental studies, two and a half semesters of marine engineering studies and two and a half semesters of nautical studies. The simulator training is done for both groups in the two final semesters.

The FbN is equipped with three manouvring simulators, a radar simulator, a shiphandling simulator and a navigation light simulator (nocturnal). The college is equipped with a liquid cargo handling simulator as well. The shiphandling simulator was the first one in the world to be designed, developed and built solely for a nautical training establishment.

The shiphandling simulator visual system was originally a slide projection system which was then updated to CGI type with 90 degrees horizontal view. It operates three own-ships, a general cargo, a container vessel and a VLCC tanker.

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

The total number of 44 hours of simulator training in eight sessions is provided in the 5th and 6th semesters for the Master AG certificate. The initial simulator training has to be done after or parallel to the theoretical lectures.

In the 5th semester exercises for students cover the following areas:

-Familiarization with the simulator including demonstration simulator run.
-Filling up the manoeuvring tables of own ship via performing trial manoeuvre.
-Execution of turning circle with various speed, drawing turning circle diagrams.
-Constant various turn technique (CRT), calculation of ROT/speed values.
-Man-over-board manoeuvring technique.
-Search and rescue, excution of different pattern (squares/sectors).

-Turning ship on the spot from stand still condition within a limit.
-Manoeuvring in bad weather, track keeping.

The exercises are done by a general dry cargo ship as own-ship because it is easier to handle for the less experienced students. The exercises in the final semester are almost of the same nature but with VLCC tanker and loaded container vessels as own-ships. In the 6th semester exercises cover the additional areas such as:

-Understanding of power/weight ratio and plotting the changing course and speed tables/diagrams.
-Sailing in narrow fairways.
-Emergency situation, rudder and engine malfunction.
-Passage planning, execution and monitoring.

The simulator training in Bremen engages students in data collection and documentation such as drawing manoeuvring curves and diagrams. This gives the students a better understanding of manoeuvring characteristics of other ships from the tables even before they actually manoeuvre the ship.

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

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

MERCHANT MARINE ACADEMY (MMA), KINGS POINT

The MMA has conducted shiphandling simulator training for cadets (midshipmans) since 1979. At the inital stage the course was designed as a part task training course, covering three major tasks, Shiphandling, Rule of the Road and Voyage Planning. The course program was revised in 1984 to a whole task training program. The course is designed to intensify the potential third mate's decision making skills as for voyage planning, collision avoidance situations and correct bridge procedures and at the same time help the college to meet the IMO requirements for training and watchkeeping standards. The bridge watchstanding course is a three credit course thought to deck and dual ship's officer cadets. The course has a duration of 10 weeks, each week 3 hours of simulation and one hour of classroom work.

Students are divided into groups of three or four to make up the bridge watch teams. The cadets fill the roles of officer of the watch, navigator, radar observer and helmsman in a team, roles changing in turn for new exercises. Two teams attend one simulator session at the same time. One team will observe and monitor the exercise while the other is executiong the exercise on the bridge. After each exercise two watches change over. After each hour on the simulator, the watch team is debriefed for an hour. The chance to observe all procedings on the bridge and compare data from instruments provides a major feedback to the students observing the exercise and allows the trainee to understand more about ships' manoeuvring characteristics and human behaviour.

Finally each team receives, out of three simulator hours, one hour of watchkeeping and exercise, one hour of observation and one hour of debriefing which includes 15 to 20 minutes of individual watch responsibility at the end of each week. As prebriefing, prior to each simulator session, each team prepares for at least one hour for the next exercises. The entire group meets at the end of the week in a one hour classroom session to debrief and prepare for the next week's scenario.

The simulator training course objectives are to enable the students to:

-Understand the manoeuvring capability of own-ship as it relates to rudder and engine ability and limitations and the effect of the environment on shiphandling.

-Assess the traffic conditions and prevent close quarter situations through application of rule of the road, proper communication and efficient lookout.

-Maintain a safe navigational watch at all times especially in coastal and confined waters as it pertains to: preparation, execution and monitoring passage planning, correct response to malfunctions, following masters orders and communication.

The students are evaluated and graded by the instructor at the end of the course. The grades consist of these parts; one third of the grade is watch team grade, another third is individual watch grade and the last third is watch officer potential evaluation. Attitudes during the watch and punctuality in taking over the watch plus the observation of the instructor and his opinion on the ability of each individual is crucial in determining the grades.

The course structure is modelled as follows:

0.5 hour	familiarization
45 min	preparation and commencing a voyage
1 hour	arrival and pilot boarding
2 hours	rules of the road and steering failure
1 hour	landfall and anchorage
1 hour	transitting straits and watch transfer
1 hour	coastal and traffic separation lane navigation
1 hour	arrival port and channel transit in daylight
1 hour	departure from port, using VTS and channel transit at night

CHAPTER 4

DEVELOPMENT OF TRAINING PROGRAMS FOR THE ISLAMIC REPUBLIC OF IRAN

4. DEVELOPMENT OF TRAINING PROGRAMS FOR THE I.R.IRAN

In meeting the requirements of advanced maritime training, the Nautical College of Chabahar (IRAN) bought a set of simulators from Norcontrol in 1992 (see chapter 4.1). The ship simulator was originally bought for training the cadets of the Nautical College itself but due to the high capital investment for this machine and the high running costs involved it is wise to use this valuable system for other purposes as well in order to return some of this investment. The course programs also should be designed to get maximum advantage from this training aid in order to be more cost effective.

The simulator facility in Chabahar can be used for the following:

I. CADET TRAINING
For the training of deck cadets studing at the Nautical College of Chabahar who will be trained to the B.Sc level and at the same time 3rd class watchkeeping proficiency.

II. OFFICER TRAINING
For officers upgrading to a higher rank or attending refresher courses.

III. PILOT TRAINING
For training new pilots, assistant pilot upgrading to pilot and pilots requiring training in a new subject.

IV. SPECIAL COURSES
Special courses designed at the request of clients, for

example operating a new kind of vessel with special manoeuvring characteristics.

This chapter will discuss items I to III. Item IV will not be discussed here because the objectives for this kind of training are dependent upon client needs so the training programs are not predictable.

The training program recommended in this chapter is designed to provide a high quality training and to be cost effective. Each course has a duration of 30-36 hours of simulator exercises and lectures. The number of students participating in each exercise is restricted to permit actual role-playing. Each student will have a chance to get about 8 hours of individual responsibility for control of own ship.

At the beginning of each course there are two to three hours of familiarization with the simulator facility for the students. During these hours, as there is no direct interaction between students and the simulator, a larger number of students should attend in order to save time and cost.

The individual course programs will be discussed later in this chapter but, before that, the simulator facility in the college will be described.

4.1. THE SIMULATION FACILITIES

The simulator set in the Nautical College of Chabahar consists of a shiphandling simulator (NSS-90), a radar simulator (QR-303) and an engine room simulator (DPS).

The shiphandling simulator is a bridge simulator which has a horizontal field of view of 200° with the required set of bridge equipment. The radar simulator has four own ships and the engine room simulator is a diesel engine (operational version) simulator.

4.1.1. THE RADAR SIMULATOR

The radar simulator's floor contains five rooms, four rooms for own ships (OS1, 2, 3 & 4) and one room as an instructor's station. This simulator can well be used for blind pilotage and part task training.

4.1.1.1 OWN SHIPS

Each own ship comprises a ship's bridge without a visual scene and is equipped with a manoeuvring console, VHF, radar set, overhead panel and electronic navigational aids. Own ship 1 is provided with a raster scan colour ARPA display (DB-2000 A-19") in addition to other equipment. All four own ships can be presented in the same exercise area at the same time and have interaction with each other (see figure 4.1).

A. MANOEUVRING CONSOLE

The manoeuvring console includes different controls and indicators which are necessary for controlling the own ship by cadets during manoeuvring in exercises. The console is fitted with a steering system, engine telegraph, bow thruster control, fog signal control and RPM indicator.

The steering system enables the students to steer in four modes; external mode, auto pilot mode and manual rudder mode with the aids of joystick and emergency mode which is controlled by two push-buttons. The digital readouts on the panel are true course, set course and rudder command, and an analogue rate of turn indicator.

Engine throttle controls the main engine and analogue instruments indicate RPM and starting air pressure at the same time. In the case of air pressure dropping below a certain limit there will be no response from the engine.

The bow thruster operates by push-buttons to port and starboard with selective thrust.

B. COMMUNICATION

A VHF set for communication purposes has been installed in each cubicle.

C. RADAR/ARPA

The radar sets are of a DB-6 type which permits simulation in radar relative and true motion, plus ARPA mode. The radar has X and S band selection with programmable parameters such as antenna height, scan rate, azimuth beam width and pulse length. The instructor is able to add sea and rain clutter and even other radar's interference. These radars have 64 NM nominal range with resolution of 6.25 meters.

D. OVERHEAD PANEL

The overhead instrument panel includes analog rudder angle and rate of turn indicator, digital ship's speed, wind's speed and direction indicator. A digital clock shows simulated time of day in hours, minutes and seconds.

E. NAV AIDS

Electronic navigational aids available on all own ships are OMEGA, RDF, DECCA and GPS. Own ships 1 and 2 have LORAN C and own ships 3 and 4 have TRANSIT SATELLITE in addition to the above mentioned navigational aids. All the navigational aids have two working modes, a simplified mode which does not need any initiation, and normal mode which operates identical to a real receiver.

4.1.1.2 INSTRUCTOR'S STATION

This room contains the instruments needed for controlling and monitoring simulated exercises by the instructor. From this room the instructor prepares exercises and creates scenarios, with the aid of a computer. Through the Situation Display the instructor is able to see the environment, check the situation of each own ship and target ship and interact whenever he feels it is necessary.

The debriefing after each exercise is done with the aid of a data recording facility in the instructor's computer plus plotter and printer drawings and print outs. The replay of the full exercise can be done in real time or fast time. A VHF set is provided for communication to cubicles as a target ship or pilot station.

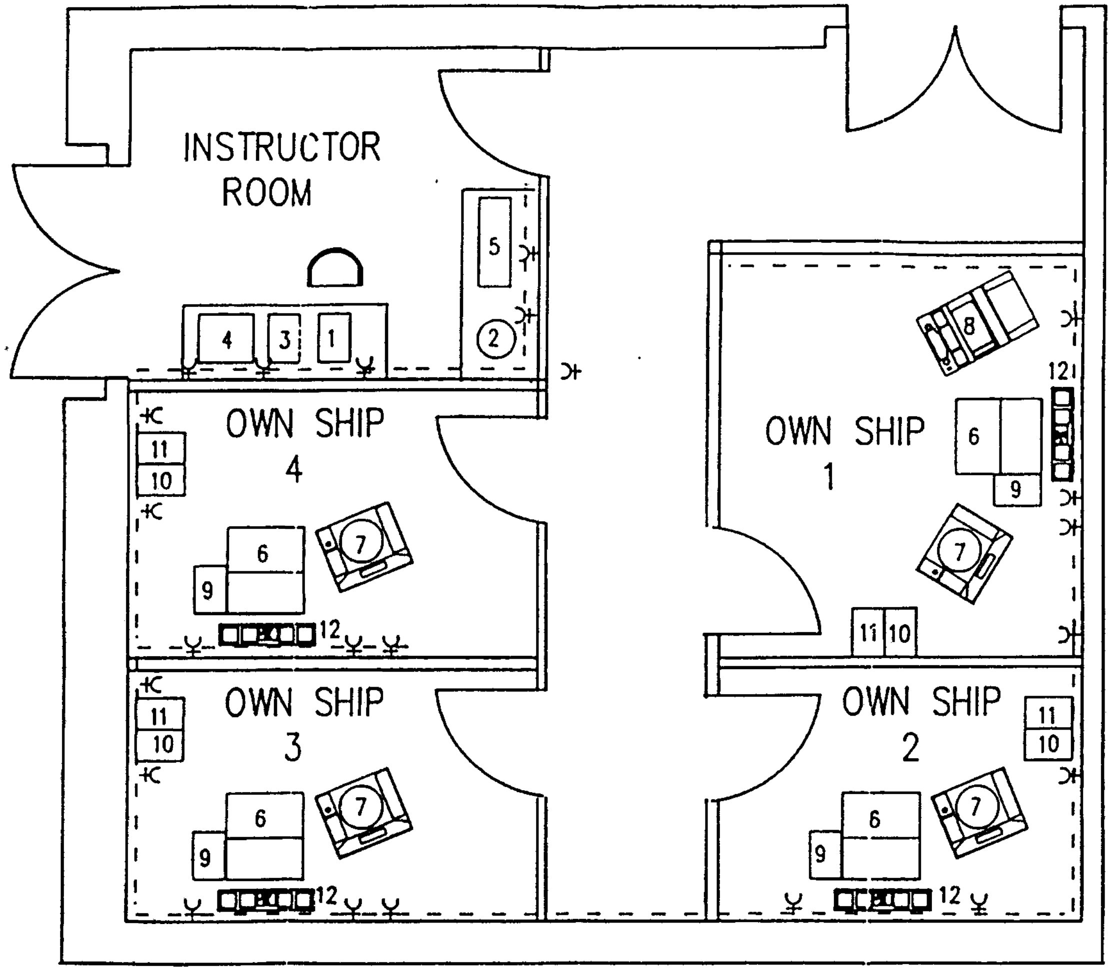


Figure 4.1

1. PC-INSTR.
2. SITUATION DISPLAY
3. VHF
4. PRINTER
5. PLOTTER
6. MANOEUVRE CONSOLE
7. DB-7
8. DB-2000
9. VHF
10. LORAN-C
11. STYL. NAV. REC.
12. OVERHEAD PANEL

ISSUE	CO-ORDS	CHANGES	DATE/SIGN.

QR-303
RADAR SIMULATOR, IRAN
ROOM LAYOUT

NORCONTROL SIMULATION

SCALE 1:50	RPL. FOR
DRAWN A.J.	RPL. BY
TRACED 910319 TLH	DWG. NO HS331078 P
CHECKED	
APPRD. 1	REF.
APPRD. 2	PAGE

4.1.2. SHIPHANDLING SIMULATOR

The shiphandling simulator consists of a simulated bridge, instructor's station and debriefing room. The bridge is designed as a regular ship's bridge complete with all the necessary equipment. The bridge has a 200° horizontal field of view with a 30° vertical field of view.

Immediately behind the bridge there is a large room with a debriefing section and instructor's station. The operating instructor has all the facilities at his station to control the environment; traffic vessels, exercise areas and tugs. During the exercises the instructor has real time interaction with the bridge and is able to create malfunctions in the bridge's equipment. He has plotting and recording facilities.

The debriefing section is equipped with a large screen projector and overhead projector. The full exercise can be replayed at real time or fast time for debriefing analysis (see figure 4.2).

4.1.2.A. OWN SHIP'S BRIDGE EQUIPMENT

The own ship's bridge is equipped with manoeuvring console, RADAR/ARPA, navigational aids instrument and overhead panel and visual scene.

A. MANOEUVRING CONSOLE

The manoeuvring console has two main parts, a computer section and a control part. The computer section consists of a digital coastline generator and micro processors with electronic interfaces plus a noise

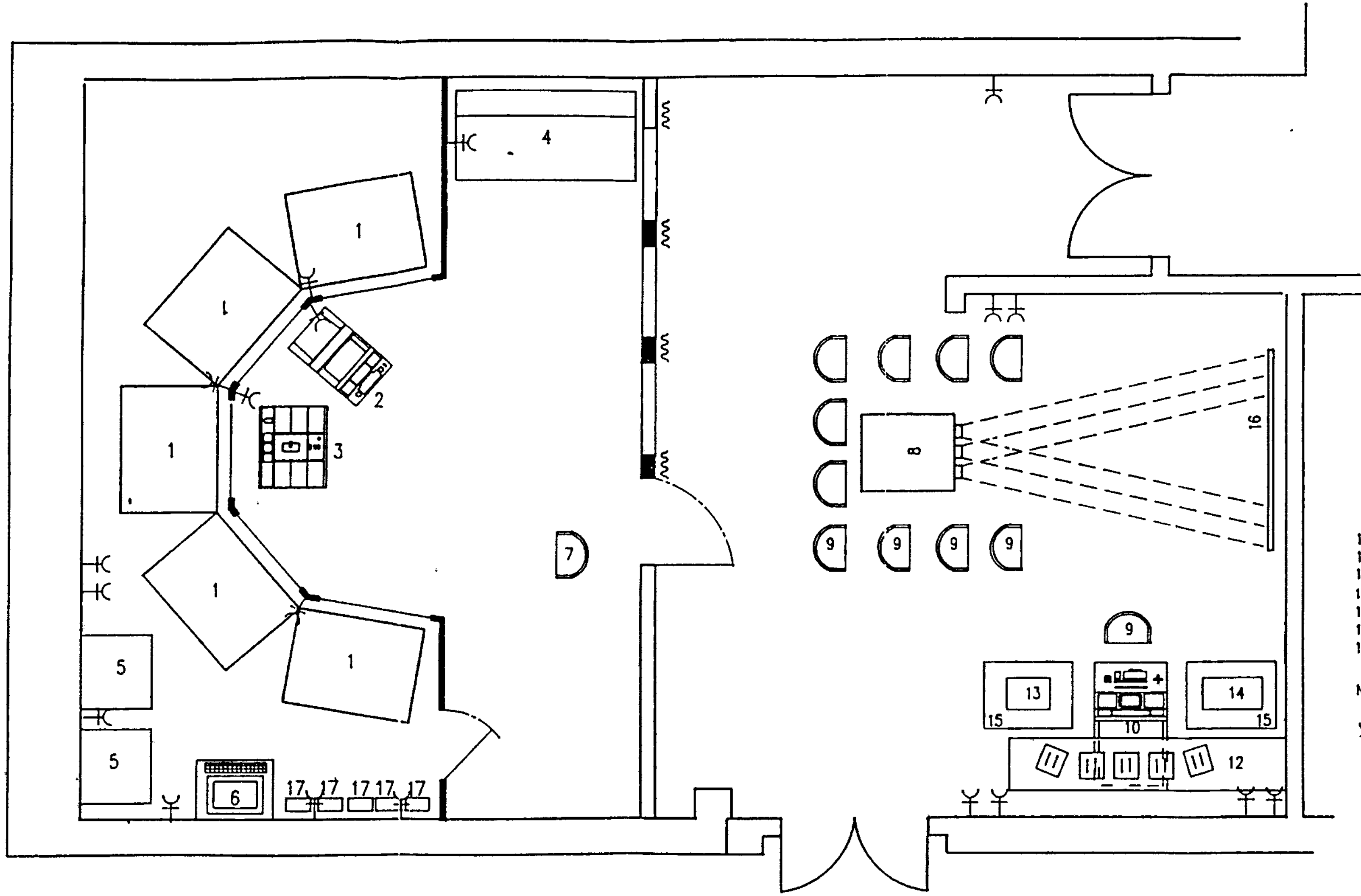


Figure 4.2

LEGEND:

1. PROJECTOR BOX
2. DB-2000
3. MANOEUVRE CONSOLE
4. CHART TABLE W/NAV. INSTRUMENTS
5. IMAGE PROCESSOR
6. COMPUTER FOR VISUAL SYSTEM
7. CAPTAINS CHAIRS N.D.
8. LARGE SCREEN PROJECTOR
9. CHAIR N.D.
10. INSTRUCTOR STATION NSS-90
11. MONITOR
12. SHELF
13. PRINTER
14. PLOTTER
15. TABLE N.D.
16. SCREEN N.D.

NOTE: N.D.=NOT DELIVERED

(outlet symbol) = 220V DOUBLE OUTLET W/GROUND

ISSUE	CO-ORDS	CHANGES	DATE/SIGN.

NSS-90 CHABAHAR ROOM LAYOUT	SCALE	RPL. FOR
	DRAWN BLi 910416	RPL. BY
	TRACED 910417 TLH	DWG. NO HS331159P2
NORCONTROL SIMULATION	CHECKED	
	APPRD. 1	REF.
	APPRD. 2	PAGE

generator. This part computes the whole simulation and radar images except visuals.

The control part contains controls and indicators including the steering system. The controls are engine throttle and engine emergency control, steering gear control, bow thruster control, fog signal control and anchor control. The panels are log and doppler log panel, engine instrument panel and light panel. The indicators show propeller RPM and starting air pressure. The steering is controlled the same as own ships, by joystick.

B. RADAR/ARPA

The RADAR/ARPA is a DB-2000 model which is identical to the one in own ship 1 (see figure 4.1)

C. NAV AIDS

A standard shell is used for navigational aids instruments which includes Decca navigator, echo sounder, Radio Direction Finder (D.F.), Loran C, Omega, transit satellite navigator, and GPS which are identical to those of the radar simulator described previously.

D. OVERHEAD PANEL

The overhead panel contains rudder angle, rate of turn, wind speed and direction, and speed log indicator plus ship's course repeater and a clock.

4.1.2.B. VISUAL SYSTEM

The visual system consists of an image processing computer and projectors. The projection is done by "projector boxes" (see figure 4.3.) which can produce

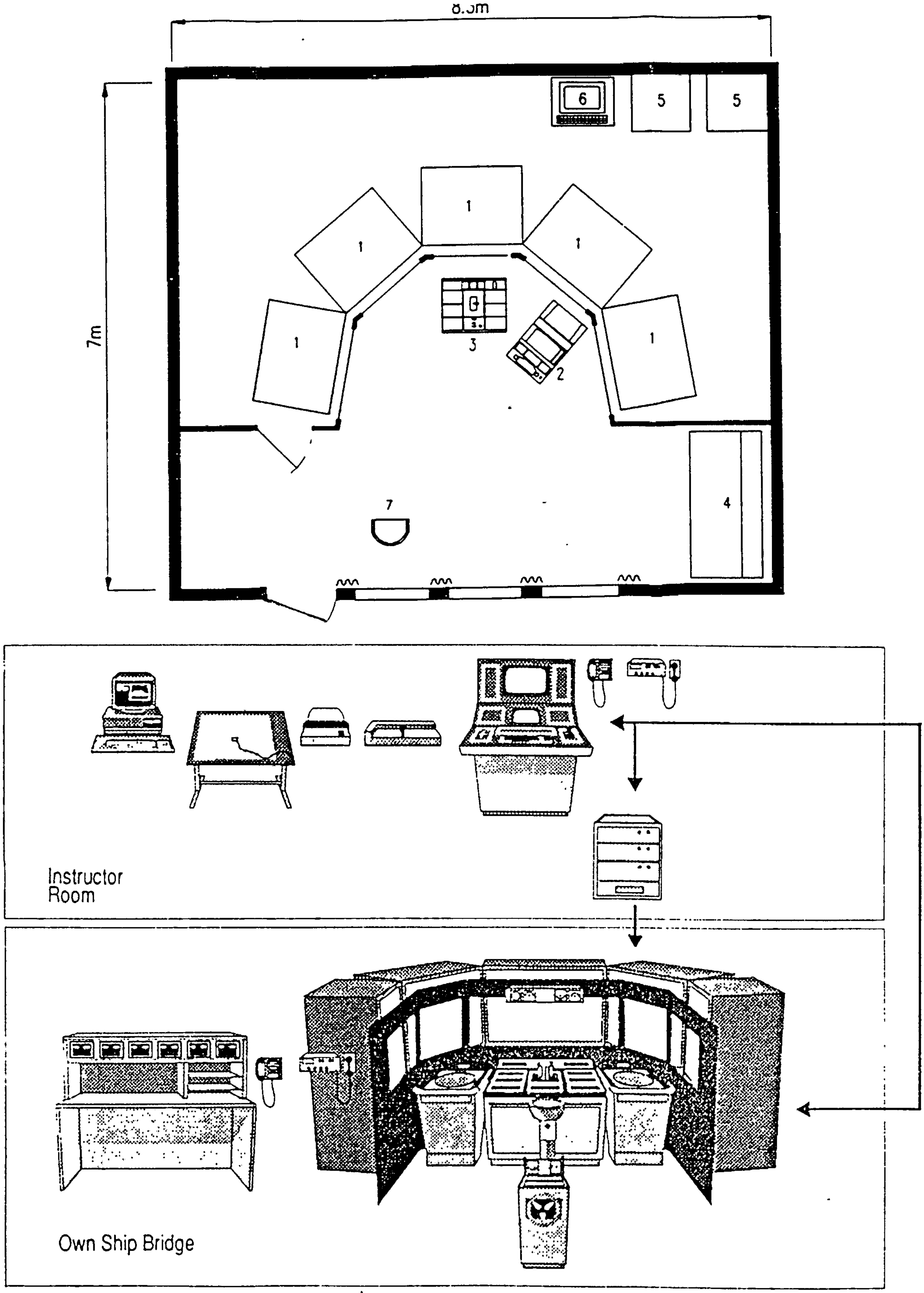


Figure 4.3. Shiphandling simulator using PROJECTOR BOXES

relatively large images without requiring a lot of space. The system uses a series of five projector boxes, each projecting a 40° horizontal and 30° vertical field of view, and is placed behind the bridge's windows.

4.1.2.C. INSTRUCTOR'S STATION

The instructor's station is made for the operator to control and monitor the simulator. It consists of different parts which are as follows:

A. RADAR DATA DISPLAY

The radar data display which is a 20", colour, raster scan display. The radar information as seen in the bridge is displayed with the possibility of overlaying navigation channels, maps, buoys, submerged structures and targets. This enables the operator to see the whole situation at once.

B. DATA DISPLAY

The data display is used by the operator to control and monitor the system parameters, such as ship model and target routing, environmental data, radar specification, time, failure control, recording facilities and so on.

C. STORAGE

The storage system uses a disk system for the storage of data either on hard disk or on floppy disk. The stored data includes hydrodynamic ship models, environmental and radar data base, and exercise programs. Each exercise can be recorded for later debriefing.

D. CONTROL FUNCTIONS

The control functions, which are keyboard, joystick, display, simulation mode panel, and function keys, enable the operator to interact with the machine and input the orders or change the parameters.

E. COMMUNICATION

VHF set for communication with own ship is provided.

F. PRINTING

X-Y plotter and data logger will plot the wanted data for assessment, debriefing and records.

G.SLAVE DISPLAY

Slave displays provide the on line image of the visual scene for the instructor. It is done through five, 14" monitors each representing one of the projectors.

4.1.2.D. DEBRIEFING ROOM

The debriefing room is a section close to the instructor's station. It has a projector, overhead and a board to assist the instructor in the analysis of the recorded exercise for students. The radar display of the instructor's station can be slaved to the projector to demonstrate on a large screen in a classroom. The plotted result of the plotter is also a useful tool for debriefing.

4.1.2.E.OTHER SPECIFICATIONS

A. OPERATION MODES

The system is able to be operated in three modes.

Preprogram mode is used for exercise preparation, demonstration and briefing. Manoeuvre mode is the operational mode and playback mode is used for debriefing.

B. ENVIRONMENT

The operator is able to specify and set the direction, speed and rate of change of current and wind. The yaw of own ship can be adjusted for its amplitude and period. In addition to depth and tide the speed of sound through the water can be fixed by the operator.

C. VISUAL SCENES

The visual scenes produced by the system can represent coastal area, port, and sea with different state and environmental conditions and the objects including own ship's bow image, target ships, navigational marks and lights. The time of day can be selected from daylight to night time through twilight. The visibility can be affected by fog with different density.

D.SYSTEM PARAMETERS

In addition to 500 fixed targets, up to 60 target ships on radar and six on visual scenes are available on each exercise. Few ship's mathematical models are provided but the instructor has the possibility to program the ship model to fit specific requirements. The exercise areas can be up to 221*221 NM at maximum but the area depends on the number of features and objects used.

4.1.3. ENGINE ROOM SIMULATOR

The engine room simulator is a slow speed diesel engine simulator suitable for part task training. The engine room simulator area consists of three rooms, namely an engine room, engine control room and instructor room (see figure 4.4.). The engine room has two sections, one section representing the main engine system contains the main engine and main engine auxiliary controls including lub oil, camshaft and cooling system controls. The second part represents two diesel generators with auxiliary system and local controls. The engine control room is configured as a regular engine control room and students through the control console can operate and monitor the performance of the engine. The instructor room, equipped with necessary instruments for preparing and monitoring the exercises, enables the instructor to create a series of malfunctions and faults in the system during exercises.

This simulator is capable of being linked to the shiphandling simulator to represent a "ship simulator" and to give a better feel and understanding of a real situation on board ship to the trainees. Such a system also can be used for training of dual purpose officers.

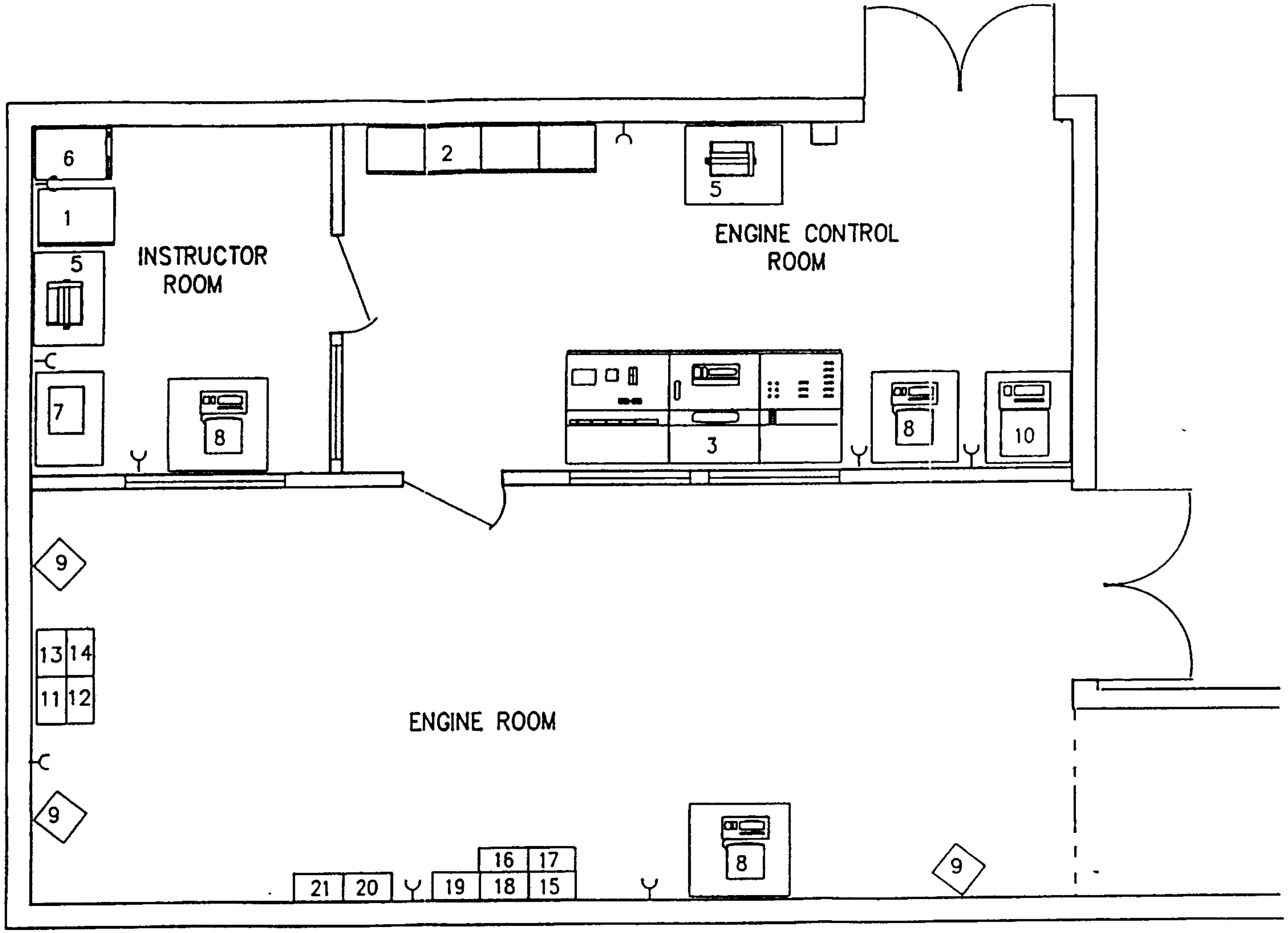


Figure 4.4

1. I/O RACK, TESSELATOR, POWER 24V DC
2. MAIN SWITCHBOARD
3. CONTROL CONSOLE
4. SOUND AMPLIFIER
5. TTY PRINTER WENGER 50x60
6. ND-100 COMPACT II
7. AMPLIFIER
8. TANDBERG TDV 2215-S
9. LOADSPEAKERS
10. COLOUR GRAPHIC

LOCAL PANELS

11. DG 1 AUXIL SYSTEMS
12. DG 1 LOCAL CONTROL
13. DG 2 AUXIL SYSTEMS
14. DG 2 LOCAL CONTROL
15. ME AUX CONTROL
16. ME LUB OIL CONTROL
17. ME LOCAL CONTROL
18. ME CAMCHAFT CONTROL
19. ME SW SYSTEM
20. ME FW LOW TEMP SYSTEM
21. ME FW HIGH TEMP SYSTEM

ISSUE	CO-ORDS.	CHANGES	DATE/SIGN.

DIESELSIM DPS 100 SLOW SPEED UNIVERSITY OF SISTAN & BALUCHISTAN ROOM LAYOUT	SCALE 1:50	RPL. FOR
	DRAWN ASJ	RPL. BY
	TRACED IM 17.4.91	DWG. NO
NORCONTROL SIMULATION	CHECKED 21/6/91	HS331079P2
	APPRD. 1	REF.
	APPRD. 2	PAGE

4.2. CADET TRAINING

The objectives of the use of the simulator in cadet training for watchkeeping are to enable the trainee at the completion of the course:

1. To keep a proper lookout by all available means, and maintain a safe navigational.watch in all conditions.

2. To understand manoeuvring characteristics of the vessel and to appreciate the traffic conditions and avoid collision.

There are two methods to achieve the training objectives through simulator training:

A) To add integrated simulator training as the practical training supporting the related subjects.

B) To treat the simulator training as a stand alone subject.

METHOD A:

In this method the training objectives for the cadets, which are achievable by simulator, should be well defined and categorized. Each objective should then be achieved through a related teaching unit as the practical part of that unit. This method could be applied from the second year when the student has the basic knowledge and enough background about that subject.

The objectives can be categorised as follows:

The student should be able to understand

1-SHIP MANOEUVRING

-The manoeuvring capabilities of vessels of different sizes with different conditions of loading.

-The effect of rudder angle and speed on manoeuvring.

-The vessels' manoeuvring tables and curves, and the effect of momentum in acceleration and deceleration.

2-RADAR/ARPA

-The correct setting and use of ARPA and radar with the understanding of limitation and accuracy.

-The radar plotting and understanding of O.A.W triangle

-The relative motion.

-The fixing of the ship's position by radar.

-The determination of target ships aspect and movements.

-The CPA, TCPA and the effect of own ship's manoeuvre on that.

3-COLLISION AVOIDANCE

-To determine when risk of collision exists and apply correct rules of the international regulation for preventing collision at sea to avoid close quarter situation.

4-WATCHKEEPING

-To know the correct procedure of watch transfer and watchkeeping,

-To maintain a proper lookout by all means.

-To ascertain aspects of vessels by visual or navigational light.

-To Participate as a member of the bridge team.

-To identify the situation where it is necessary to call the master.

-To respond to the information and/or malfunction of bridge's equipment.

5-NAVIGATION

-To ascertain the ship's position by visual fix or other means.

-To set the best course to the next way point for different conditions of weather and tide or current.

-To conn the ship to anchorage, berth or single point mooring.

6-PASSAGE PLANNING

-To prepare the plan for passage and monitor the ship's progress according to the plan.

-To prepare, and if necessary apply, the contingency plan.

7-ELECTRONIC NAVIGATION

-To be able to set and read information from all electronic navigational aids in the bridge and plot the position accordingly.

-To consider the accuracy and errors associated with each electronic navigational aids and position fixing systems.

8-COMMUNICATION

-To be able to operate, use and keep watch on VHF radio.

-To be able to transmit and receive emergency messages.

-To send and receive information necessary for determining the safety of own ship in relation to other ships or navigational hazards.

The related teaching units to the above mentioned objectives could be :

I. Radar/ARPA

To objective no.2

II. Rules of the road.
To objective no.3

III. Seamanship
To objectives no.1, 4

IV. Coastal navigation
To objectives no.5, 6, 7

V. Chart work
To objectives no.6, 5

VI. Electronic navigational systems
To objective no.7

VII. Maritime communication
To objective no.8

The exercises should be designed carefully so the objectives of each exercise will depend on the area that has been covered by that subject at that stage.
It is obvious that students will pay more attention to each individual objective and the effectiveness of training in that subject would be higher as the theory and practice will adjust together step by step.

The disadvantage could be that the instructor is limited in defining exercises as the instructor should concentrate merely on that specific topic and a wider aspect of exercise which employs other subjects which normally cannot be covered.This method can be of great help when employing simulation for the first time in the college but after acquiring some experience with the system then method B is more advisable.

METHOD B:

This method provides the simulator training as a new course which consists of classroom and practical simulator hours.

The training program in the Nautical College of Chabahar, like many other colleges, consists of four distinct periods.

These training periods are:

-First college period
-First sea period
-Second college period
-Second sea period

The curriculum is designed on a semester basis and each semester consists of 17 weeks and each year contains two semesters. The theoretical units are 17 hours of classroom training and the practical units are 34 hours of practical training.The simulator training for the college shall be programmed in such a way to fulfil the needs and training objectives of cadets in the next period.

In that respect the simulator training can be divided into three different courses namely:

4.2.1.Familiarization course before first at sea period

4.2.2.Radar/ARPA course for second at college period

4.2.3.Watchkeeping course before second at sea period

Next section describes each in detail.

4.2.1. THE FAMILIARIZATION COURSE

OBJECTIVES:

The objectives of this course are to give the cadets an idea of bridge watches and make them familiar with equipment on the bridge.

The cadet will be able to keep a proper lookout and report to O.O.W .

The trainee will be able distinguish the aspect of the vessel from visual in daylight and from navigational light at night and also will have enough knowledge of appearance of buoys, lights and marks.

The cadet will be able to change the steering system between auto and manual, and be able to hand steer the ship on the specified course and also be able to apply engine orders.

TIME ALLOCATION:

The course should be allocated to the last semester before the first at-sea period, and it should cover about 17 hours based on one hour per week.

TEACHING METHOD:

In the first five weeks the instructor ensures that cadets are familiar with the bridge environment and equipment including electronic navigational aids, radar, steering system and engine controls. Students will also be briefed about watchkeeping responsibilities and simple collision avoidance. The cadets can be divided into groups of eight to ten, depending on the total number of cadets.

In remaining weeks the student will take watch in groups of four, each group consisting of a helmsman, a lookout, navigational officer, and O.O.W.

The responsibility of each student will change in turn after each hour of exercises so each student will receive a chance to act in all four positions.

The responsibility of the helmsman is to steer the given course by gyro compass and magnetic compass alternatively.

The lookout is responsible for maintaining a visual lookout, distinguishing the aspect of other ships and marks and making reports correctly to the O.O.W. He will also take the visual bearing of given objects.

The navigational officer will fix the position.

Finally the O.O.W will collect all data from others then navigate safely and try to avoid danger and manage the bridge team.

The exercise area will be open sea with limited traffic in the first weeks and then graduate to coastal waters with medium traffic.

A few simple risk of collision scenarios for application of the rule of the road should be included. Each class will have about 10-15 minute briefing and debriefing sessions.

TIMETABLE:

WEEK 1	Familiarization
WEEK 2	Demonstration
WEEK 3	Radar
WEEK 4	Responsibilities
WEEK 5	Collision avoidance
WEEK 6+	Related exercises

TIMETABLE IN DETAIL:

Week 1-Familiarization
- -brief description of how the simulator works
- -demonstration of bridge layout and equipment
- -the instructor console and role of instructor

Week 2-Demonstration
- -Primary manoeuvring characteristics e.g effect of rudder and engine movement
- -demonstration of manoeuvring console, steering system and demonstration run for manoeuvring

Week 3-Radar
- -briefing about radar and obtaining primary information such as range and bearing
- -demonstration

Week 4-Responsibilities
- -briefing about bridge watches, responsibilities of each member of bridge team i.e. lookout helmsman, avigational officer and O.O.W .
- -demonstration of ships with different aspect and

heading, and lights and buoys
-a practice on correct reporting of bridge team to O.O.W

Week 5-Collision avoidance
-briefing about the crossing rule
-open sea exercise in light traffic, whith a few crossing situations from both sides alternatively
-debriefing

From the 6th week onwards the training will consist of a pre-briefing whenever an exercise is run. A 10-15 min debriefing will follow.

The exercises will aim to create simple meeting situations in light traffic and cover the application of R.O.R in open sea with clear visibility. In the second stage the aim will be to determine a position from D.R and/or visual bearings in coastal waters. The third step will be the combination of the first and second steps. During each exercise, each student shall practise according to his position and responsibility. Special emphasis on the keeping of a lookout and correct reporting will be made.

4.2.2. RADAR-ARPA COURSE

Objectives:
This course is designed to enable the student to understand the basic principle of the radar and Automatic Radar Plotting Aids (ARPA) equipment.

The student will understand the capabilities and limitation of the equipment and the possible errors that may be associated with the information received from the equipment.

The student will have a sound knowledge of radar plotting and the O.A.W triangle.

The student will be able to choose the appropriate mode of display of ARPA and acquire and track manually and automatically the targets which may create a close quarter situation with own ship.

The student should make appropriate use of operational alarms.

The student will be able to extract the necessary information about the course, speed and closest point of approach of target ships and if necessary take appropriate action according to international regulations for preventing collisions at sea to avoid danger.

The student will make sure that his/her action will not cause another dangerous situations with other vessels or objects.

This course will fulfil the requirement of IMO resolutions A.483(XII) and A.482(XII).

TIME ALLOCATION:
This course should be part of the first semester of the second at college period. It will cover 34 hours over 17 weeks with two contact hours each week.

TEACHING METHODS:

This course will firstly introduce the radar equipment, its capability and limitation and radar plotting technique. It will cover the method of acquiring information from radar and the errors which may result.

In the next step the course will cover the introduction, correct setting and functions of ARPA equipment, the capabilities, limitation and danger of over reliance on ARPA information. The method of acquiring and tracking the targets also includes the assumption that a dangerous situation may exist.

The next step will be the correct use of ARPA and/or radar for safe navigation and collision avoidance.

The number of students in each cubicle should be two. One of the students will be in charge of the watch, the other will be the navigating officer. In case the total number of students in a class exceeds a certain limit, the number of students in each cubicle may be three. The students will change their role to provide the opportunity for each student to experience command.

The first exercise will be in open sea with limited traffic to allow the students to acquire the targets and assess the situation and recognize those targets which present the risk of collision.

The next exercises will be in coastal and confined waters with an increased number of target ships to create more complex situations which are closer to reality.

TIMETABLE:

WEEK	TOPIC
WEEK 1	General
WEEK 2	Radar review
WEEK 3	Radar, plotting
WEEK 4	Radar
WEEK 5	Parallel index technique
WEEK 6	ARPA, principal
WEEK 7	ARPA, setting procedure
WEEK 8	ARPA features,
WEEK 9	ARPA features, testing, warnings, alarms
WEEK 10	ARPA features, errors, limitation
WEEK 11	ARPA, acquisition of target
WEEK 12	ARPA, tracking capabilities
WEEK 13	ARPA, risks
WEEK 14	Exercises, collision avoidance
WEEK 15	Exercises, narrow channel, T.S.S
WEEK 16	Exercises, multiship encounter
WEEK 17	Exercises, ARPA

TIMETABLE IN DETAIL:

Week 1-General

- -Introduction, course outline, aims and objectives
- -IMO performance standard of radar
- -familiarization with radar simulator's equipment and controls.

one hour class- one hour radar simulator

Week 2-Radar review

- -review the principle and practice of correct setting of radar, use of different modes of display
- -acquiring range and bearing and other information

one hour class-one hour radar simulator

Week 3-Plotting

- -the relative motion triangle, plotting technique,
- -simple exercises for practising radar plotting
- -acquiring course, speed and aspect of other ships.

45 min class-one hour radar simulator- 15 min debriefing

Week 4-Radar

- -calculation of closest point of approach with other ships (CPA) and time of CPA (TCPA).
- -Manoeuvring characteristics
- -the effect of change of course and speed on display
- -exercise on radar simulator

40 min class-one hour radar simulator-20 min debriefing

Week 5-Parallel index

-acquiring position by radar information.

-parallel index technique theory and exercise.

45 min class-one hour radar simulator-15 min debriefing

Week 6-ARPA

-introduction to ARPA simulator

-IMO performance standard

-principle of ARPA

-ARPA exercise.

75 min class-30 min radar simulator-15 min debriefing

Week 7-ARPA setting procedure

-familiarization with controls

-ARPA simulator exercise.

45 min class-one hour radar simulator- 15 min debriefing

Week 8-ARPA features

-ARPA exercise.

45 min class-one hour radar simulator-15 min debriefing

Week 9-ARPA features

-Testing, operational warnings and alarms of ARPA

-ARPA exercise.

30 min class-75 min radar simulator-15 min debriefing

Week 10-ARPA features

-errors and limitation of ARPA equipment

-processing delay

-ARPA exercise

one hour class-45 min radar simulator-15 min debriefing

Week 11-ARPA

-sea and ground stabilization

-manual and automatic acquisition of targets

-ARPA exercise.

30 min class-75 min radar simulator-15 min debriefing

Week 12-Tracking capabilities of ARPA

-past history

-ARPA exercise.

30 min class-75 min radar simulator-15 min debriefing

Week 13-Risk of over-reliance on ARPA

-manual course and speed input

-ARPA exercise.

one hour class-45 min radar simulator-15 min debriefing

Week 14-Review of relevant rule of road

-ARPA exercise.

30 min class-1 hour radar simulator-30 min debriefing

Week 15-Exercise

-exercise in or near traffic separation scheme

-exercise in narrow channel.

90 min radar simulator-30 min debriefing

Week 16-Multi ship encounter exercise.

15 min class-90 min radar simulator-15 min debriefing

Week 17-ARPA exercise.

90 min radar simulator-30 min debriefing of ARPA course.

4.2.3. WATCHKEEPING COURSE

This course is designed for cadets at their final stage of the college course. They will have had already 12 months of sea service experience. They will have also attended the familiarization course and have gained enough experience in radar and ARPA.

OBJECTIVES:

The student who successfully completes this course will be able to maintain a proper lookout by all available means and keep a safe navigational watch in different condition of visibility.

The student will have a good understanding of manoeuvring characteristics of a vessel and will be familiar with the effect of environmental condition on manoeuvrability.

The student will be able to ascertain the risk of collision to comply with collision avoidance rules in different traffic conditions.

The student will be aware of the importance of passage planning and the need of contingency planning.

The student will be aware of the importance of bridge teamwork and correct bridge procedure during the watch.

TIME ALLOCATION:

This course is placed in the last semester of the second at college period. The 2-hour sessions each week will result in 34 hours over 17 weeks.

TEACHING METHOD:

The students will be divided into groups of 3, each having a different role, one as watchkeeper, one as navigator and one as helmsman. The number of students per group may change to four due to simulator availability and the total number of students. In this case the fourth student will act as lookout. The students will change their role in turn.

The instructor will play the role of master, pilot or vessel traffic service (VTS) operator whenever it is necessary.

The exercises are divided into two groups; one is a series of exercises with different objectives and the other is complete passages which will be more realistic and closer to the future work of the cadets.

TIMETABLE:

WEEK	TOPIC
WEEK 1	Introduction
WEEK 2	Manoeuvring characteristic
WEEK 3	Manoeuvring characteristic
WEEK 4	Passage planning, English Channel
WEEK 5	Passage planning
WEEK 6	VTS, traffic separation scheme
WEEK 7	Transitting English Channel
WEEK 8	Collision avoidance
WEEK 9	Collision avoidance

WEEK	TOPIC
WEEK 10	Passage planning, Singapore Strait
WEEK 11	Transiting Singapore Strait
WEEK 12	Anchoring
WEEK 13	Passage planning, Bremenhaven
WEEK 14	Approach, transit River Weser
WEEK 15	Berthing Bremenhaven
WEEK 16	Channel transit, emergency
WEEK 17	Problem solving, course debriefing

TIMETABLE IN DETAIL:

Week 1-Introduction to course
-Familiarization with simulator and equipment
-Demonstration exercise.
30 min class-90 min simulator

Week 2-Ship manoeuvring characteristics
-Different own ship in different loading conditions
-deep sea
-Familiarization with manoeuvring curves
-Practising crash stop, turning circle, Williamson turn
-Effect of speed on manoeuvring
45 min class-one hour simulator-15 min debriefing

Week 3-Ship manoeuvring characteristic
-Continuation of week 2

15 min class-90 min simulator-15 min debriefing

Week 4-Planning the passage from Bremen to Dover strait.
-Ship at berth in Bremenhaven
-Preparing the ship for voyage,
-Calculation of tide.
-Taking pilot, unberthing
-Entering the River Weser

One hour class-one hour simulator

Week 5-Planning the passage (continue)
-Navigation on River Weser, pilot on board
-River bend, use of rate of turn indicator
-Overtaking and meeting situations

45 min class-one hour simulator-15 min debriefing

Week 6-Entering English Channel, medium traffic
-Disembark pilot, use of VTS system
-Joining traffic separation scheme
-Night time

15 min class-90 min simulator-15 min debriefing

Week 7-Transiting English Channel
-Fog condition, heavy traffic
-Meeting and crossing situation
-Transiting Dover Strait

15 min class-90 min simulator-15 min debriefing

Week 8-At sea
-Day and night, medium traffic
-Collision avoidance exercise
-Handing over the watch

15 min class-90 min simulator-15 min debriefing

Week 9-At sea

- -Medium to bad weather condition
- -Variable visibilities.
- -Collision avoidance exercise
- -Master on bridge. gyro failure

15 min class-90 min simulator-15 min debriefing

Week 10-Planning Singapore Strait landfall and transit

- -Monsoon weather condition day time
- -Singapore landfall
- -Meeting and overtaking situation

one hour class-45 min simulator-15 min debriefing

Week 11-Transitting Singapore Strait

- -Night time heavy traffic
- -Crossing and meeting condition
- -Presence of fishing vessels and small boats

15 min class-90 min simulator-15 min debriefing

Week 12-Planning to anchor in congested simulated area

- -Coming to a single anchor
- -Wind and tide effect
- -Traffic meeting

15 min class-90 min simulator-15 min debriefing

Week 13-Planning passage to Bremenhaven via English Channel

- -Loaded VLCC, heavy traffic
- -Black-out, contingency plan

45 min class-1 hour simulator-15 min debriefing

Week 14-Approach to River Weser

- -ETA deadline, night time
- -Use of VTS, no pilot on board
- -Crossing traffic separation lane

-Steering round a bend

-Use of rate of turn indicator

15 min class-90 min simulator-15 min debriefing

Week 15-River Weser, approach to Bremenhaven port

-Embarking pilot

-Berthing port side with pilot

-Berthing starboard side without pilot

15 min class- 90 min simulator- 15 min debriefing

Week 16-Simulated area, buoyed channel

-Transuding channel, strong current

-Emergency situation, contingency plan

-Short round in channel

15 min class- 90 min simulator- 15 min debriefing

Week 17-Final session

-class discussion

-Problem solving

-Course debriefing

4.3 OFFICER TRAINING

This part of Chapter 4 deals with simulator training for masters and deck officers serving on merchant fleets. It is divided into two subchapters as follows:

A. ARPA TRAINING COURSE
   This course is designed for those who wish to fulfil the requirement of Resolution A.482 (XII).

B. SHIPHANDLING COURSE
   This course is intended to improve the quality of the shiphandling ability of mates and masters. It will give them the chance to gain experience in handling the different sizes of ships in difficult situations and in emergencies.

4.3.1. ARPA TRAINING COURSE

This course is for masters and deck officers serving or intending to serve on vessels fitted with ARPA equipment. The other officers and pilots who are interested in training on ARPA may attend the course.

OBJECTIVES:

This course is aimed to train students to understand the basic principle of ARPA equipment and to exercise decision making based on the use of ARPA. The course will train masters and officers to meet the requirements of IMO resolution A.482 (XII).

The student who successfully completes this course is able:

- to correctly set the ARPA equipment
- to choose appropriate mode of display, plotting and graphic controls
- to acquire information about course and speed and CPA of other ships and track the targets which may cause danger to the safe navigation of own ship
- to make appropriate use of operational alarm

And the trainee has a thorough knowledge of:

- the danger of over reliance on ARPA
- the ARPA as an aid for collision avoidance
- the application of collision regulations when using ARPA.
- the bridge team procedure

TIME ALLOCATION:

The course shall be scheduled for the period when the ARPA simulator is not being used for cadet training. The proposed time could be in the summer break between the two college semesters.

This course is a 5-day course which covers 30 teaching hours that consist of seven hours of lectures and 23 hours of simulator exercises.

TEACHING METHOD:

The students will be divided into groups, each group containing eight students for four cubicles, meaning two students for each cubicle. In each cubicle, one of the students will act as an O.O.W and the second student will be the helmsman.

TIMETABLE:

Note:

"LEC" stands for classroom hours including lectures, prebriefing and debriefing.

"SIM" stands for simulator familiarization and exercise hours.

DAYS	MORNING	AFTERNOON
DAY 1	LEC:Introduction SIM:Familiarization	LEC:Plotting technique SIM:Plotting technique
DAY 2	LEC:IMO standard SIM:ARPA setting up	LEC:Tracking ability SIM:Acquiring target
DAY 3	SIM:Target data :Operation alarm	SIM:Stabilization :Operational test
DAY 4	LEC:Error of data SIM:Error of data	LEC:Interpret error SIM:Exercise
DAY 5	SIM:ARPA exercise	SIM:ARPA exercise

TIMETABLE IN DETAIL:

DAY 1:

MORNING

0.5h-LEC:Introduction to course program and objectives

1h-SIM:Familiarization with simulator

1.5h-LEC:Basic ARPA theory

AFTERNOON

1h-LEC:Revision of plotting technique

2h-SIM:Plotting technique exercise

DAY 2:

MORNING

1h-LEC:IMO performance standard for ARPA

2h-SIM:Setting up procedure of ARPA

:Familiarization to controls

AFTERNOON

1.5h-LEC:Tracking capabilities and limitations

:Processing delays

1.5h-SIM:Manual and automatic acquisition of targets

DAY 3:

MORNING

3h-SIM:Presentation of target information

:Symbols

:Operational warnings

AFTERNOON

3h-SIM:Sea and ground stabilization of target

:Manual and automatic input of course and speed

:System operational test

DAY 4:

MORNING

1h-LEC:Error in displayed data

2h-SIM:Simulator exercise

AFTERNOON

1h-LEC:Error of interpretation

2h-SIM:Possible risk of over reliance on ARPA

DAY 5:

MORNING

3h-SIM:Application of collision regulation

AFTERNOON

3h-SIM:Use of ARPA in multiship encounters

4.3.2 SHIPHANDLING COURSE:

This course is mainly designed for officers who are about to take command as master. The course will also be useful to other groups such as those who are preparing to attend master (class I) examinations, or those who already have command and have served for some time as master but never attended a shiphandling simulator course and need to gain some experience regarding shiphandling and emergencies.

To develop the skills of hands- on shiphandling, the course mainly concentrates on practical exercises and less on theoretical shiphandling knowledge.

OBJECTIVES:

This course is aimed at improving the decision making task of ship masters in difficult situations, emergencies and risk of collisions under influence of environmental forces.

On successful completion of the course the trainee will be able:

-To become familiar with the manoeuvring characteristics of different ships and use the helm and engine controls for ship manoeuvring in different environmental conditions.

-To understand and allow for shallow water and bank effects and the interaction forces between own ship and other ships passing nearby.

-To choose the best anchorage position for the ship and safely anchor there.

-To prepare, execute and monitor a passage or manoeuvre and understand the need for an alternative plan.

-To lead the bridge team and make the best use of manpower available during ship manoeuvring.

-To berth and unberth the ship and to use tugs in a simple berthing manoeuvre.

TIME ALLOCATION:

The time for conducting this course is dependent on the university curriculum and the availability of the simulator facility. The suggested time could be in the summer break between the two college semesters.

The course is spread over 5 days covering 30 hours of simulator exercises and lectures; two sessions per day, each session of three hours: a total of 6 hours of lectures and 24 hours of simulator exercises, briefing and debriefing. A half an hour break between each session is advisable.

TEACHING METHODS:

The students attending this course are divided into groups. Each group contains three students. The students will play three different roles in sequence. The roles in each exercise are: shipmaster who is in command of the watch, navigational officer for radar observation and position fixing and the helmsman who steers the given headings.

The course has two main sections. The first section, which is of three days, is mainly part task training with emphasis on manoeuvring, berthing, anchoring and search and rescue. The second part, covering the last two days, is whole task training centred around passage planning procedure.

The instructor will play the roles of pilot and VTS operator, wherever necessary. He will also communicate to own ship by acting the roles of officers of target ships.

TIMETABLE:

DAYS	MORNING	AFTERNOON
DAY 1	LEC:Introduction SIM:Familiarization	LEC:Manoeuvring characteristics SIM:Simple exercises
DAY 2	LEC:Environmental effect SIM:Canal transit	LEC:Search and rescue man overboard SIM:Man overboard exercise
DAY 3	LEC:Anchoring, berthing SIM:Anchoring exercise	SIM:Berthing exercise LEC:Passage planning
DAY 4	SIM:Passage planning exercise LEC:Debriefing	SIM:Passage planning exercise LEC:Debriefing, preparation of next passage planning
DAY 5	SIM:Passage planning exercise LEC:Debriefing, preparation	SIM:Passage planning LEC:Debriefing The End of The Course

TIMETABLE IN DETAIL:

DAY 1:

MORNING

1h-LEC:Introduction to course, program of the week and objectives.

1h-LEC:Simulator facilities

:Bridge equipment

:Own ships characteristic

1h-SIM:Familiarization with simulator's bridge and its equipment

AFTERNOON

1h-LEC:Manoeuvring characteristic and curves

:Use of helm, engine and thruster in manoeuvring and delay time

1.5h-SIM:Few simulator short runs

:Hands on manoeuvring of different ship sizes in different loading conditions

1.5h-LEC:Debriefing

DAY 2:

MORNING

1h-LEC:Environmental effects, such as wind and current, on manoeuvring

1.5h-SIM:Buoyed canal, day time, clear visibility

:Shallow water and squat experience,

:Passing ship nearby

:Overtaking in canal

0.5h-LEC:Debriefing

AFTERNOON

0.5h-LEC:Man overboard procedure
:Search and rescue patterns

2h-SIM:Open sea, clear visibility, variable wind and current
:Man overboard after few minute, marked with a buoy, Williamson turn, making a lee
:Search and rescue, different patterns such as spiral, sector and square

0.5h-LEC:Debriefing

DAY 3:

MORNING

0.5h-LEC:Anchoring, effect of wind

1.5h-SIM:Coastal water, variable wind and current
:Selecting anchor position, conning the ship, anchoring

0.5h-LEC:Debriefing

0.5h-LEC:Berthing and unberthing
:Use of tug

AFTERNOON

1.5h-SIM:Port area, variable weather, day and night
:Embarking pilot, passing through break water, berthing, unberthing, swing then berthing with other side of the ship

0.5h-LEC:Debriefing

0.5h-LEC:Passage planning procedure

0.5h-LEC:Planning of a passage

DAY 4:

MORNING

2.5h-SIM:Approaching Singapore Strait, bad weather
:Land fall, traffic encounter, traffic separation scheme, anchoring at Singapore anchorage

0.5h-LEC:Debriefing

AFTERNOON

2.0h-SIM:Night, variable weather
:VLCC loaded from Singapore anchorage, deep draft route, traffic encounter

0.5h-LEC:Debriefing

0.5h-LEC:Preparation for planning next passage, English Channel berthing at port of Bremen

DAY 5:

MORNING

2h-SIM:VLCC, half loaded, unberthing, Weser River, emergency, short round and back to Bremen, anchor, Weser River, overtaking close to another ship, Channel bend, rate of turn, VTS entering English channel, engine failure, anchor

0.5h-LEC:Debriefing

0.5h-LEC:Discussion, Ending session

4.4 PILOT TRAINING

The pilot training in I.R.Iran is under the authority of the port and shipping organization. They enrol a group of students each year, most of whom have no sea experience. The students will attend certain theoretical lectures about ships, ports, piloting and pilothouse rules plus other related subjects. The trainees will then be assigned to their ports and join the ships as an assistant to an experienced pilot. They should gain certain practical experience before they are promoted as an independent pilot or as an assistant pilot of larger sized ships. As Muirhead pointed out:

> "As many pilot and pilotage authorities are discovering, the simulator can especially if geographical areas of their locality are available, enhance the skill and experience of the pilot in many meaningful ways. The emergency situation within the approaches or confines of a port need no longer be dealt with in a unenlightened manner. The strategies and actions to handle difficult situations can be experienced at first hand."
>
> Muirhead (1985,140)

Pilot training in Iran can benefit and improve its quality by effective use of the simulator facility available. This subchapter will offer a training program for the pilots, who have adequate assistant piloting experience and are familiar with the fundamentals of shiphandling and piloting. The complexity and level of exercises should be adjusted to the experience and proficiency level of pilots. The more experienced pilots are subject to larger sized ships and more severe conditions and situations. As mentioned, the exercise area shall preferably be the pilot's local port area, provided it is available or the cost of design can be afforded. In the case where no specific port area is available, the use of other port areas on the data base can be used to achieve the training objectives. An exception is the case of training for a newly built port or when major changes have occurred in the structure of a pilot's existing port.

Research has been carried out by the CAORF centre (1985) on pilot training programs. Part of a report from this research has compared the generic versus port-specific training. Some of the advantages of a generic port which is attractive over modelling specific ports are as follows:

1. It involves a high cost to create a specific port base.

2. The pilot's attention will not be drawn towards comparing the detail of the model to that of his own real port.

3. Using the generic port makes it possible to bring pilots from different localities with different experiences together to share their valuable ideas during training.

4. To achieve specific training objectives, the generic port can be "fine tuned". It is not realistic to change a specific port for that purpose.

Gynther, et al(1985,6)

COURSE OBJECTIVES:

This course is aimed at providing pilots with wider practical knowledge and skills where their own port can only provide limited experience of manoeuvring in a limited range of environmental conditions. Particular attention has been paid to emergency situations.

On successful completion of the course the pilots are able to:

-Understand the manoeuvring ability of different sizes of ships in different conditions of loading and in various environmental conditions;

-Efficiently and safely berth and unberth the ships with or without help of tugs and allow for and make use of environmental conditions in doing so;

-Know the responsibilities and apply local and international rules to avoid collision;

-Communicate correctly with other ships and port traffic control authorities;

-Be ready and respond correctly and as fast as possible to emergency situations;

-Have a thorough knowledge of shallow water, bank and interaction effects;

-Make the best use of radar parallel index technique and ARPA equipment;

TIME ALLOCATION:

The time for conducting this course is dependent on availability of the simulator facility. The suggested time could be in the breaks between the two college semesters.

The course,s duration is 5 days, covering 30 hours including 24 hours of simulator exercises and 6 hours of lectures. Each pilot will get the chance to be in command for about 8 hours.

TEACHING METHODS:

The pilots attending this course will be divided into groups. In each group three pilots form a simulator team with different roles for each member. The roles of pilot, navigational officer or assistant pilot and helmsman will rotate.

TIMETABLE:

DAYS	MORNING	AFTERNOON
DAY 1	LEC:Introduction SIM:Familiarization	LEC:ARPA SIM:ARPA exercise
DAY 2	LEC:Manoeuvring characteristic SIM:Manoeuvring exercise	SIM:Exercise continues LEC:Anchoring technique SIM:Anchoring exercise
DAY 3	LEC:Environmental effect SIM:Exercise LEC:Advance instrumentation	LEC:Passage planning SIM:Exercise
DAY 4	LEC:Emergencies SIM:Exercise	LEC:Berthing and unberthing technique SIM:Exercise
DAY 5	SIM:Free run exercise	SIM:Exercise continues End of the course

TIMETABLE IN DETAIL:

DAY 1:

MORNING

0.5h-LEC:Introduction to course, objectives, program of the week

0.5h-LEC:Simulator facilities
:Bridge equipment and controls

2h-SIM:Simulator run for familiarization

AFTERNOON

1h-LEC:Advance instrumentation
:ARPA
:Principle of plotting technique,vectors
:Acquisition of information, PAD, PPC
:Different features of ARPA

2h-SIM:Simulator exercise with emphasis in use of ARPA features.

DAY 2:

MORNING

0.5h-LEC:Manoeuvring characteristics
:Use of manoeuvring course and data
:Effects of controls, rudder, engine thruster and delay time
:Power/weight ratio

2.5h-SIM:Manoeuvring exercise with different sizes of ships in different conditions of loading

AFTERNOON

1h-SIM:Continue of previous exercise

0.5h-LEC:Anchoring technique

1.5h-SIM:Anchoring in different current and weather condition
:Single and double anchoring

DAY 3

MORNING

0.5h-LEC:Environmental effect
:Shallow water and bank effect
:Interaction effect between ships

2.5h-SIM:Canal transit

:Manoeuvre in shallow water
:Meeting and overtaking situations
:Advance instrumentation

AFTERNOON
0.5h-LEC:Passage planing
2.5h-SIM:Approaching ports and canals
:Rate of turn

DAY 4

MORNING
1h-LEC:Emergencies
2h-SIM:Emergency manoeuvre
:Turning round in canal
:Turning on anchor
:Engine or rudder failure

AFTERNOON
0.5h-LEC:Berthing and unberthing technique
2.5h-SIM:Berthing and unberthing either side
:Use of tugs
:Use of anchor
:Use of current, thruster, spring

DAY 5

MORNING
3h-SIM:Free run exercise
:Experiment of different techniques have been discussed during course
:Environmental conditions and ships varied to pilot's advice

AFTERNOON.
2.5h-SIM:Exercise continues
0.5h-LEC:Final debriefing

CHAPTER 5

LIMITATIONS OF SIMULATION

5. LIMITATIONS OF SIMULATION

Simulators are one of the most sophisticated, expensive and effective training tools in existance today. this technology is being used more and more in the maritime training world.Although simulators physically cannot replace the real environment, experts in this field try to simulate the real world to the maximum extent possible.

Today the state-of-the-art in maritime simulation technology is very good, especially in regard to shiphandling simulators, but the technology has not yet reached its ultimate capability and has some limitations. There are some operational difficulties, the most obvious area being the visual scene display.

This chapter will discuss the major limitations which are divided into operational and visual, although other restraints may be imposed on training centres.

5.1. OPERATIONAL LIMITATIONS

The operational limitations are those which are imposed by shortcomings of mathematical modelling or the physical limitations of the simulators. The shortcomings which will be mentioned here are mostly able to be solved with present technology. The low demands in the market and the high cost of research in this field have caused these problems to be unaddresed up to now. The following are the main examples of such limitations.

HYDRODYNAMIC EFFECTS:

The mathematical modelling for hydrodynamic effects on manoeuvring, such as bank effect, shallow water effect and interaction, have not been developed to the extent of deep sea manoeuvring. The reason is that deep sea equations are calculated by practical trial manoeuvring of real ships, while the mathematical modelling for the effects mentioned above is done mainly by model tests and ship design curves. This will not have great effects on cadet training but pilot training validation remains a problem.

One of the solutions to this problem today is to use a model basin simulator. The pilots, who have used model ships in a carefully designed basin, have demonstrated the effectiveness of this system.

ENVIRONMENTAL EFFECTS:

The effect of wind, tides and currents on shiphandling has been modelled very closely to the real world. This modelling is valid for simple situations of wind and current encounters. However, the equations for complex situations when other factors are involved need very complex and sophisticated modelling. The factors which may interact are cross current, ship loading conditions, windage area, passing close to other ships or obstructions, and sudden changes in water depth.

Similar problems also result from wave effect. This problem has been solved to a great extent in simulators provided with motion platforms.

ANCHORING:

The use of a single anchor, especially in the case of holding fast to the sea bed, can be simulated to a high degree. The modelling does not prove to be 100% realistic when situations are more complicated such as multiple anchoring, dragging in different kinds of sea bed especially when a change of tidal direction causes the ship to rotate.

VISUAL UPDATE RATE:

Due to the limited capability of many simulator computers today and the large mass of visual data that the computer has to calculate, the refreshing or updating rate of the screen is limited.. This fact causes the relative and true movement of objects not to appear quite realistic. The limited up-dating rate of the computer may not be seen for distant objects but it is obvious for the nearby objects especially for high speed and fast moving vessels.

The greatly increased capability of computers in recent years enables most simulators to produce smooth movement on the screen at modest speeds. Speed, however, is still a problem.

OTHERS:

There are other limitations one can experience with simulators but they are of less importance. A few are mentioned below:

-Berthing modelling needs further improvement especially in regard to pier forces, thruster effects in dock and mooring forces.

-Slow and zero speed own ship performance in manoeuvring for ahead as well as stern speed.

-Tug model effects need refinement especially in the field of bollard pull and the effects of towing angles.

5.2 VISUAL LIMITATIONS

Visual limitations are still the biggest handicap of simulators. The ships models are calculated and designed for a three dimensional world but visually are represented in a two dimensional picture. This creates distance and perspective judgment problems and therefore the visual scene does not appear the same as in the real world.

The other factor which limits the realistic appearance of visual scene is the relatively low memory capacity of the computers. Due to the above mentioned facts the number and details of features and cues are limited, causing simpler and less realistic scenes.

Muirhead (1985,53) discussed the importance of the realistic visual scene in simulator training. In research covering a series of tests carried out on shiphandling simulators at Hamburg and Cardiff on different groups of seafarers, the results showed the importance of " visual reality rate" in the mariners mind.

As the visual cues are increased and more realistic scenes are created the performance of mariners is improved. The results of the shiphandling assessment program showed a 50% improvement by the final stage.

Other limitations of the Computer Generated Image (CGI) visual system are discussed as follows:

ANGULAR PERSPECTIVE:

The visual scene is presented on the screen by a series of projectors, the screen being circular. The only position that the projected picture is free of parallax error is at the centre of radius of the screen's arc, at which point the pelorus is normally located. Any angular measurement taken outside of this point is not correct. This effect is markedly visible with respect to own ships bow image which will bend over toward the side that the observer has stood.

In order to overcome this limitation, the O.O.W or pilot should use this point when manoeuvring, especially in approaches and transits. The use of leading marks and other visual cues are necessary.

DISTANCE PERSPECTIVE:

The judgement of relative distance or position between two visible objects in the visual screen is very difficult. The important factor for the mariner is to get the feeling of speed and line of approach by using visual cues and this is normally done by considering the change of distance to and between objects.

The lack of depth perception is a handicap of the simulators as the presentation of pictures on a flat surface causes the objects to seem be nearer than they are. This causes problems, especially in berthing and transiting buoyed channels, as the perception of distance to piers and buoys are different in reality.

One of the solutions is for the instructor to play the role of an officer on the forecastle or poop and for the mariner to call the officer forward or aft for the actual distance until he gets used to the system.

FIELD OF VIEW:

The restricted field of view (FOV) in most of the shiphandling simulators makes the trainees unable to perform effectively or with confidence in shiphandling exercises.

A 360-degree field of view obviously is the best solution for a shiphandling simulator to minimize the limitation. The reason why most existing shiphandling simulators have less than a 360 degree FOV is an economical consideration. The increased FOV requires extra projectors with additional computer capacity which involves a large investment.

Maritime colleges try to compensate between the demands for standards of training and the restriction of capital investment; in other words the cost/benefit equation. There is no specific threshold for the angle of FOV but Gropentin (1978) tried to establish a criteria. He proposed that a minimum FOV of 120-degrees is good enough for conducting simple navigation exercises and to assess own-ship motion relative to its environment.

A minimum FOV of 240-degrees is suitable for complex manoeuvring and navigation tasks especially for restricted areas and/or traffic situations. Grapentin proposed 40 degrees of vertical field of view for complex manoeuvreing situations including berthing.

With an FOV of less than 360-degrees, the simulator normally loses rear vision. This limitation can be a severe handicap, especially when manoeuvring out of a port or a canal and the pilot needs to use the leading marks astern of the ship which have been used when entering. The drift and swing of the ship is difficult to judge without a vision of movement of the stern.

In the case of berthing and docking the best possible solution for a restricted FOV could be the use of a bridge wing simulator which enables the instructor to switch over the simulator visual scene from forward view to wing view.

BRIGHTNESS:

The present projection systems are restricted in projecting daylight as bright as real daylight. Consequently, the ambient light of the bridge should be kept low in all conditions.

MINIMUM SIZE OF LIGHTS:

The minimum size of lights at night is restricted to minimum picture element (pixel) of the simulator visual system which depends on the resolution of the system. This factor affects the depth of the picture during night simulation.

FIELD CONTINUITY:

The projection system uses multiple projectors to create one complete picture. A problem that occurs is to match the edges of the pictures from individual projectors in such a way as to receive a continious picture. The solution for this problem could be to use the bridge window frames to cover the edges.

WAVES:

The modelling of waves can be presented in a realistic way as long as wind is not too strong and waves are not too high. The limitations occur when simulating heavy weather. The waves are not simulated visually more than to a certain height which then makes it unrealistic. The reasons are limited computer capacity and narrow vertical field of view.

5.2.1 VISUAL ENHANCMENTS

Manufacturers are trying everyday to reduce the limitations of their products. Some achievements in enhancing the visual scenes are as follows:

ANTI-ALIASING:

To smooth the edges of the objects which are represented by inclined lines, the computer is modified using an anti-aliasing technique. This will reduce the staircase appearance of the edges and will give the lights and surfaces smooth motions across the screen.

THREE DIMENTIONAL PERCEPTION:

In order to make three dimentional pictures in a two dimentional presentation look real, the following techniques can be used:

-Perspective drawing
All ships, objects and piers will be drawn with correct size, height and angles with respect to the viewing location.

-Distance shading
Colour tends to become less intense or darker with increasing range.

-Surface smooth shading
Smooth shading is used to avoid noticeable lines between ship, objects and land masses.

ILLUMINATION:

The side of an object which faces the light source should appear brighter than the opposite side.

WAVES:

Waves are drawn at reduced size as the distance to own ship increases.

SIZE JUDGEMENT:

Known objects such as containers or cars can be placed in harbour areas to aid the judgement of object size and distance.

5.3 TRAINING LIMITATIONS:

The limitations which simulators may create in relation to training programs fall into a different category, some of which are listed below:

-The number of students who can be trained at the same time is very limited.

-The required training hours per student are high. Because of the above mentioned limitation, the total teaching hours on a simulator for one class of students can be very high.

-In simulator based training, the training programs are totally dependnt on a single system which in the case of breakdown may cause total disorder to the training program.

-The level of training is limited by the capability of the facility which is not easily modified.

-The instructor is limited in designing exercises to the available exercise areas and types of ownship.

-The mathematical modelling of each ownship is calculated only for two or three conditions of loading i.e. fully loaded, ballast and sometimes half loaded.

-Simulation technology is advancing very quickly; to keep up with these developments can be very costly.

CHAPTER 6

VALIDATION OF TRAINING

6-VALIDATION OF TRAINING

Once a training program has been established, it should be tested for its effectiveness. There is a need to see whether the program has been successful and is eligible to continue. Is the training program able to achieve the training objectives? If so, to what degree is it successful? Is there any need to change or adjust? These assessments are done through the validation process.

The validity of the training program is dependent on achieving the training objectives and raising the competence of trainees through positive transfer of training to the real world.

As Muirhead (1988) mentioned, because simulators are not able to produce a mirror copy of the real world, the validation outcomes are always less than perfect. This limitation in validity can be overcome if the instructor is completely aware of it.

There are several stages of validity that have been mentioned, two of which are very important, namely training validity and performance validity. (Hammel, et al 1979)

TRAINING VALIDITY:

In this stage validity of the program relates to the improvement of each trainee during the simulator program. It means assessment of the change in performance of each individual before simulator exercises and at end of the exercise. The assessment can be done in two sections, firstly before a simulator run, and secondly after completion of exercises. Comparing the two results will give a good indication of a student's progress.

PERFORMANCE VALIDITY:

In this stage the validation study refers to transfer of training from the simulator to the real work environment, that is on board the ship. The assessment should ideally be done at sea after completion of the course to compare the trainee's reaction in real situations with those of the simulated ones.

Different attempts have been made to evaluate training programs. As an example, an evaluation of simulator based training in Cardiff will be discussed. As a part of research, an experimental trial was conducted, one on a ship simulator and the other one on navy frigates (Reeve et al 1984). The simulator had the same layout as the frigate and the exercise areas chosen were the same in both cases.

A group of twelve cadets were chosen. They were randomly allocated to two groups, each consisting of six trainees: A-sea trained group, B-simulator trained group. The objectives were to validate the training program by assessing the degree of transfer of skills to sea, with comparisons between the two groups.

The system was the same for both groups. Both were assessed before the training started, then the same exercise scenario was done by both groups, one at sea and the other one on the simulator. At end of the training both groups had an assessment exercise. The roles of each student rotated in the exercises. The students were interviewed after each exercise run. The final stage was the assessment of both groups at sea. The methodology was to collect enough data to be able to assess more precisely. The collected data consisted of:

-Personality profile
-Performance assessment done by instructor
-Video and audio recording of the bridge
-Audio recording of the debriefing
-X,Y plotting of ships track
-Manoeuvring data printout

The collected data was carefully analysed, weighted and the final validation of the training program determined.

In the above mentioned evaluation the results showed that all sea trained students achieved the criteria which had been set. The simulator trained students had different results as three of them failed but the other three got the highest marks in the groups.

One year later a second trial was conducted, taking into account lessons learned from first trial. In this trial nine students participated. The results showed that seven students successfully passed the criteria in which three of them achieved a first class pass.

The other crucial factors which play an important role in validating training programs, apart from training methodology is the limitation of simulator equipment which relates to its fidelity and the role of the instructor.

SIMULATION FIDELITY:

The simulators are built to represent the real scene which can be controlled by the operator. The aim of the manufacturer is to produce simulators which can reproduce the real visual scene as closely as possible.

As has been mentioned in Chapter Five, the high degree of reality means a high cost in investment. It should always be born in mind that the crucial aspect of effective simulation is that it represents task demands rather than producing exactly the real situation. (Reeve, 1981)

It also shows that the level of reality required is dependent on training objectives and the level of trainees. The instructor should consider the fidelity of the simulator if he is to develop successful training programs.

The low fidelity does not necessarily mean low levels of training. The carefully designed exercise when associated with required level of stress for the trainee can give the best results. The unnecessary extra cost for requiring high levels of fidelity are sometimes wasted when the level of training does not require trainee to have the benefit of extra cues and the complexity included.

INSTRUCTOR'S ROLE:

The simulator is just a machine under the control of its operator. The instructor is the one who should guide the simulation system. The amount of stress is under his control. If he assigns too low a level of stress the student will not be motivated to actively participate in the exercise. A high degree of stress introduced by the instructor will have a negative effect as it reduces the student's learning rate.

The correctly adjusted level of stress will create a high learning environment as it causes the student to participate in the execution of an exercise in such a way that he will soon forget that he is in a simulated environment and not in the real world.

The instructor is the one who directs the training in such a way to ensure that the training objectives are achieved. He can control the student's learning and direct it to specified objectives by introducing carefully adjusted feedback in different ways at the correct time.

In general the instructor must clearly define the objectives and be sure that the tasks selected for each training program are relevant to those objectives. He should ensure that training objectives have been met in the course by assessing the program outcomes. He can ensure the validation by continuously monitoring the training and control its effectiveness by providing the students with correct feedback and stress levels.

In practice, the simulator can, if correctly used by a skilled instructor, create a highly effective training system.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7. CONCLUSION AND RECOMMENDATIONS

7.1. CONCLUSION

Maritime simulators have undergone several major changes, especially in visual presentation, from the first generation until now (chapter 2). Such changes have caused a reduction in the handicaps and limitations of these tools. The advanced Computer Generated Image (C.G.I) system, along with the more accurate and reliable mathematical modeling available today, makes the simulator a highly effective and realistic device for training seafarers.

It is shown that through well adjusted training programs for the simulator (chapter 3 and 4), seafarers can achieve the main training objectives necessary for them to be competent.

Although some limitations still exist, as described in chapter 5, these are not a major burden in achieving the training objectives. Simulators available in the Nautical College of Chabahar (refer to THE COLLEGE) are valuable state-of-the-art and effective training tools which may achieve the required objectives.

There are other important factors which assist in attaining the objectives, namely training programs and the instructor. The training programs presented in chapter 4 are so designed as to be suitable for the college curriculum and training system. They are spread over the whole training period to enable the cadets to acquire and build up the required experience in the course of time.

The point that should be emphasised is the importance of conducting part task training by the trainee before the main courses on the shiphandling simulator. The shiphandling simulator is an expensive and costly training medium and it should not be used for training for the simple basic tasks. The student should have the fundamental ideas of basic knowledge and skills such as rules of the road, chart work, watchkeeping procedures, and the operation and use of electronic navigational aids including radar, before attending the main shiphandling courses. The radar simulator course covers most of these training requirements and the theoretical classes cover the rest.

In order to have a better understanding of practical tasks, the shiphandling simulator should be used for demonstrations with a large group of students at the initial stage.

Although this paper has not discussed the matter in detail the most important role is given to the instructor. He is the one who can can provide the assurance that the course will cover its objectives. He should control the exercises in such a way that the trainee is under stress beyond his current level of experience in such a way to gain more experience. This has two advantages. Firstly the trainee will forget that he is in a fake environment and secondly the forced decision making allows trainees better judgment skills to be aquired. Too low a stress level will cause low motivation whilst in contrast high stress will reduce the student's learning rate.

The instructor, through pre-briefing and post-exercise de-briefing, ensures that students receive enough feedback information to gain the required knowledge and skills. Any weaknesses can be identified by the instructor through monitoring the exercise and useing the recording facility. Through repetition of part or all of a simulation exercise the chance will be given to the same student to try again to correct the mistake and gain the required preset skills and overcome his weaknesses.

Although simulator training cannot take the place of real shiphandling experience, it should be born in mind that the kind of manoeuvres and circumstances it is possible to try in a simulator are limited or unavailable due to cost or safety reasons in the real world for the mariner to experience. This causes the mariner to aquire high confidence in emergencies and critical situations which helps in making correct judgements and subsequently good decision making.

7.2. RECOMMENDATIONS

- In order to get better results from the proposed training program for the cadets, the curriculum of the college should be updated and adjusted for the theoretical lectures to incorporate the use of the simulator. In some cases the classroom hours could be reduced to a certain extent.

- It should be recognized that the simulator is an expensive machine to operate, therefore the college can compensate for some of the expenses by arranging external courses for other industries. The proposed training programs for master, mates and pilots offers a good ground for this activity. Further fine adjustment to the training program may be needed according to a client's training objectives.

- The fuller use of this valuable asset is possible with the use of this equipment for research, investigation and evaluation of new technology. This should be done by cooperation with other universities and training institutes and/or ports and shipping administration and companies.

- Further improvements in simulator training needs expansion of the simulator facilities, especially for part task training. The first priority should be given to communication and the GMDSS simulator or equipment and electronic navigational aids simulator. The next step in improving the training programs is possible by aquiring a cargo handling simulator.

- The updating and upgrading of the instructor plays an important role in effective training. The instructor should update his practical experience to enable him to produce life-like exercises and create the conditions and situations which the trainee will encounter in reality .

- The maritime administration should be persuaded to recognize the simulator as one of the best devices for evaluating the competency of officers attending the certificate of competency examination, as is the practice in some other maritime nations.

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APPENDICES

RESOLUTION A.482(XII)

Adopted on 19 November 1981
Agenda item 10(b)

TRAINING IN THE USE OF AUTOMATIC RADAR PLOTTING AIDS (ARPA)

THE ASSEMBLY,

RECALLING Article 16(i) of the Convention on the Inter-Governmental Maritime Consultative Organization,

BEARING IN MIND the provisions of Regulation 12, Chapter V, of the International Convention for the Safety of Life at Sea, 1974, and the proposed amendments to that Regulation,

RECOGNIZING that the proper use of automatic radar plotting aids will assist the interpretation of radar data and could reduce risk of collision and pollution of the marine environment,

NOTING resolution 18 of the International Conference on Training and Certification of Seafarers, 1978, which recommended that radar simulator training be given to all masters and deck officers, and resolution 20 of that Conference which invited IMCO to prepare appropriate training requirements or recommendations on training in the use of collision avoidance aids when it had adopted international carriage requirements and operational performance standards for collision avoidance aids,

RECALLING ALSO resolution A.422(XI) by which the Assembly adopted a recommendation on performance standards for automatic radar plotting aids and recommended Governments to ensure that adequate training will be established in the proper use of automatic radar plotting aids to enable masters and deck officers to understand the basic principles of the operation of automatic radar plotting aids, including their capabilities, limitations and possible errors,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its forty-fourth session,

1. ADOPTS the Minimum Requirements for Training in the Use of Automatic Radar Plotting Aids (ARPA) set out in Annex 1 to the present resolution and the Recommended Training Programme in the Operational Use of Automatic Radar Plotting Aids (ARPA) set out in Annex 2 to the present resolution;

2. RECOMMENDS Member Governments:

(a) When developing training programmes for courses in the use of automatic radar plotting aids (ARPA), to ensure that such programmes conform to standards not inferior to those specified in Annex 2 to the present resolution;

(b) To require all masters, chief mates and officers in charge of a navigational watch on ships fitted with automatic radar plotting aids (ARPA) to be trained in the proper use of such equipment;

(c) To ensure that no officer required to undertake ARPA training should conclude such training without having been trained in radar observation and plotting to the standards recommended by IMCO;

3. INVITES Governments to propose, at an appropriate time, relevant amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978.

ANNEX 1

MINIMUM REQUIREMENTS FOR TRAINING IN THE USE OF AUTOMATIC RADAR PLOTTING AIDS (ARPA)

(relevant to Chapter II of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978)

1 Every master, chief mate and officer in charge of a navigational watch on a ship fitted with an automatic radar plotting aid shall have completed an approved course of training in the use of automatic radar plotting aids.

2 The course shall include the subject matter set out in the Appendix to this Annex.

APPENDIX

MINIMUM TRAINING PROGRAMME IN THE OPERATIONAL USE OF AUTOMATIC RADAR PLOTTING AIDS (ARPA)

1 In addition to the minimum knowledge of radar equipment required by paragraph 4 of the Appendix to Regulation II/2 and paragraph 3 of the Appendix to Regulation II/4 of the 1978 STCW Convention, masters, chief mates and officers in charge of a navigational watch on ships carrying ARPA shall be trained in the fundamentals and operation of ARPA equipment and the interpretation and analysis of information obtained from this equipment.

2 The training shall ensure that the master, chief mate and officers in charge of a navigational watch have:

.1 Knowledge of:

.1.1 the possible risks of over-reliance on ARPA;

.1.2 the principal types of ARPA systems and their display characteristics;

.1.3 the IMCO performance standards for ARPA;

.1.4 factors affecting system performance and accuracy;

.1.5 tracking capabilities and limitations of ARPA;

.1.6 processing delays.

.2 Knowledge of the following and ability to demonstrate that knowledge in conjunction with the use of an ARPA simulator or other effective means approved by the Administration:

.2.1 setting up and maintaining ARPA displays;

.2.2 when and how to use the operational warnings, their benefits and limitations;

.2.3 system operational tests;

.2.4 when and how to obtain information in both relative and true motion modes of display, including.

- identification of critical echoes;
- use of exclusion areas in automatic mode;
- speed and direction of target's relative movement;
- time to, and predicted range at, target's closest point of approach;
- course and speed of targets;
- detecting course and speed changes of targets and the limitations of such information;
- effect of changes in own ship's course or speed or both;
- operation of the trial manoeuvre;

.2.5 manual and automatic acquisition of targets and their respective limitations;

.2.6 when and how to use true and relative vectors and typical graphic representation of target information and danger areas;

.2.7 when and how to use information on past positions of targets being tracked;

.2.8 application of the International Regulations for Preventing Collisions at Sea.

ANNEX 2

RECOMMENDED TRAINING PROGRAMME IN THE OPERATIONAL USE OF AUTOMATIC RADAR PLOTTING AIDS (ARPA)

1 GENERAL

1.1 In addition to the minimum knowledge of radar equipment required by paragraph 4 of the Appendix to Regulation II/2 and paragraph 3 of the Appendix to Regulation II/4 of the 1978 STCW Convention, masters, chief mates and officers in charge of a navigational watch on ships carrying ARPA should be capable of demonstrating, to the satisfaction of the Administration, a knowledge of the fundamentals and operation of ARPA equipment and the interpretation and analysis of information obtained from this equipment.

1.2 Training facilities should include simulators or other effective means approved by the Administration capable of demonstrating the capabilities, limitations and possible errors of ARPA. In introducing this training programme, Administrations should pay due regard to the phasing in of the implementation of the carriage requirements specified in the amendment to Regulation 12 of Chapter V of the 1974 SOLAS Convention.

1.3 The facilities mentioned above should provide a capability such that trainees undergo a series of real-time exercises where the displayed radar information, at the choice of the trainee or as required by the instructor, is either in the ARPA format or in the basic radar format. Such flexibility of presentation will enable realistic exercises to be undertaken, providing for each group of trainees the widest range of displayed information available to the user and thus consolidating his ability to use effectively either basic radar or ARPA systems.

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1.4 The ARPA training programme should include all items listed in paragraphs 3 and 4 below.

2 TRAINING PROGRAMME DEVELOPMENT

2.1 Where ARPA training is provided as part of the general training requirements specified in the Appendices to Regulations II/2 and II/4 of the 1978 STCW Convention, masters, chief mates and officers in charge of a navigational watch should understand the factors involved in decision making based on the information supplied by ARPA in association with other navigational data inputs, having a similar appreciation of the operational aspects and of system errors of modern electronic navigational systems. This training should be progressive in nature commensurate with responsibilities of the individual and the certificates issued by Administrations under Regulations II/2 and II/4 of the 1978 STCW Convention.

3 THEORY AND DEMONSTRATION

3.1 The possible risks of over-reliance on ARPA

3.1.1 Appreciation that ARPA is only a navigational aid and that its limitations, including those of its sensors, make over-reliance on ARPA dangerous, in particular for keeping a look-out. Need to comply at all times with the basic principles and operational guidance for officers in charge of a navigational watch.

3.2 The principal types of ARPA systems and their display characteristics

3.2.1 Knowledge of the principal types of ARPA systems in use; their various display characteristics and an understanding of when to use ground or sea stabilized modes and north-up, course-up or head-up presentations.

3.3 IMCO performance standards for ARPA

3.3.1 An appreciation of the IMCO performance standards for ARPA, in particular the standards relating to accuracy.

3.4 Factors affecting system performance and accuracy

3.4.1 Knowledge of ARPA sensor input performance parameters – radar, compass and speed inputs; effects of sensor malfunction on the accuracy of ARPA data.

3.4.2 Effects of the limitations of radar range and bearing discrimination and accuracy; the limitations of compass and speed input accuracies on the accuracy of ARPA data.

3.4.3 Knowledge of factors which influence vector accuracy.

3.5 Tracking capabilities and limitations

3.5.1 Knowledge of the criteria for the selection of targets by automatic acquisition.

3.5.2 Factors leading to the correct choice of targets for manual acquisition.

3.5.3 Effects on tracking of "lost" targets and target fading.

3.5.4 Circumstances causing "target swop" and its effects on displayed data.

3.6 Processing delays

3.6.1 The delays inherent in the display of processed ARPA information, particularly on acquisition and re-acquisition or when a tracked target manoeuvres.

3.7 When and how to use the operational warnings, their benefits and limitations

3.7.1 Appreciation of the uses, benefits and limitations of ARPA operational warnings; correct setting, where applicable, to avoid spurious interference.

3.8 System operational tests

3.8.1 Methods of testing for malfunctions of ARPA systems including functional self-testing.

3.8.2 Precautions to be taken after a malfunction occurs.

3.9 Manual and automatic acquisition of targets and their respective limitations

3.9.1 Knowledge of the limits imposed on both types of acquisition in multi-target scenarios, effects on acquisition of target fading and target swop.

3.10 When and how to use true and relative vectors and typical graphic representation of target information and danger areas

3.10.1 Thorough knowledge of true and relative vectors; derivation of targets' true courses and speeds.

3.10.2 Threat assessment; derivation of predicted closest point of approach and predicted time to closest point of approach from forward extrapolation of vectors, the use of graphic representation of danger areas.

3.10.3 Effects of alterations of course and/or speed of own ship and/or targets on predicted closest point of approach and predicted time to closest point of approach and danger areas.

3.10.4 Effects of incorrect vectors and danger areas.

3.10.5 Benefit of switching between true and relative vectors.

3.11 When and how to use information on past position of targets being tracked

3.11.1 Knowledge of the derivation of past positions of targets being tracked, recognition of historic data as a means of indicating recent manoeuvring of targets and as a method of checking the validity of the ARPA's tracking.

4 PRACTICE

4.1 Setting up and maintaining displays

4.1.1 The correct starting procedure to obtain the optimum display of ARPA information.

4.1.2 Choice of display presentation; stabilized relative motion displays and true motion displays.

4.1.3 Correct adjustment of all variable radar display controls for optimum display of data.

4.1.4 Selection, as appropriate, of required speed input to ARPA.

4.1.5 Selection of ARPA plotting controls, manual/automatic acquisition, vector/graphic display of data.

4.1.6 Selection of the time scale of vectors/graphics.

1.1.7 Use of exclusion areas when automatic acquisition is employed by ARPA.

1.1.8 Performance checks of radar, compass, speed input sensors and ARPA.

1.2 System operational tests

1.2.1 System checks and determining data accuracy of ARPA including the trial manoeuvre acility by checking against basic radar plot.

1.3 When and how to obtain information from ARPA display

1.3.1 Demonstrate ability to obtain information in both relative and true motion modes of lisplay, including:

- identification of critical echoes;
- speed and direction of target's relative movement;
- time to, and predicted range at, target's closest point of approach;
- courses and speeds of targets;
- detecting course and speed changes of targets and the limitations of such information;
- effect of changes in own ship's course or speed or both;
- operation of the trial manoeuvre.

.4 Application of the International Regulations for Preventing Collisions at Sea

.4.1 Analysis of potential collision situations from displayed information, determination nd execution of action to avoid close quarter situations in accordance with International legulations for Preventing Collisions at Sea.

RESOLUTION A.483(XII)

Adopted on 19 November 1981
Agenda item 10(b)

TRAINING IN RADAR OBSERVATION AND PLOTTING

THE ASSEMBLY,

RECALLING Article 16(i) of the Convention on the Inter-Governmental Maritime Consultative Organization,

NOTING the minimum knowledge requirements for the operation and use of radar prescribed by Chapter II of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, for the certification of masters, chief mates and officers in charge of navigational watch,

NOTING ALSO resolution 18 of the International Conference on Training and Certification of Seafarers, 1978, which recommends that radar simulator training be given to all masters and deck officers,

RECOGNIZING that collisions have frequently been caused by improper use of radar,

RECOGNIZING FURTHER that practical experience alone without adequate training may lead to improper use of radar,

HAVING ADOPTED resolution A.482(XII) on training in the use of automatic radar plotting aids (ARPA), which, *inter alia,* recommends Member Governments to ensure that ARPA training should be preceded by training in radar observation and plotting to the standards recommended by IMCO,

CONSIDERING that it is essential that all masters, chief mates and officers in charge of a navigational watch on ships fitted with radar should have received adequate training and be capable of undertaking manual plotting for anti-collision purposes, whether or not the ship is fitted with ARPA,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its forty-fourth session,

1. ADOPTS the Recommended Training Programme in Radar Operation and Plotting annexed hereto;

2. RECOMMENDS that Member Governments:

(a) Ensure, when developing training programmes for courses in radar observation and plotting, that such programmes conform to standards not inferior to those specified in the Annex to this resolution and are complementary to the Recommended Training Programme in the Operational Use of Automatic Radar Plotting Aids (ARPA) adopted by resolution A.482(XII);

(b) Require that the radar installation is under the control of a properly trained radar observer when radar watch is being kept at sea;

(c) Encourage masters, chief mates and officers in charge of a navigational watch to gain experience and maintain ability in radar observation and radar plotting by practice at sea when it is safe to do so and when radar observations can be checked visually and misinterpretation of the radar display or false appreciation of the situation would not be potentially dangerous.

ANNEX

RECOMMENDED TRAINING PROGRAMME IN RADAR OBSERVATION AND PLOTTING

1 GENERAL

1.1 The following training programme should be undertaken to fulfil the minimum training requirements of paragraph 4 of the Appendix to Regulation II/2 and paragraph 3 of the Appendix to Regulation II/4 of the 1978 STCW Convention. In order to achieve the practical aims of this programme, demonstrations of and practice in radar observation should be undertaken where appropriate on live marine radar equipment, including the use of simulators or other effective means approved by the Administration. Plotting exercises should preferably be undertaken in real-time in order to increase the student's awareness of the hazards of the improper use of radar data and improve his plotting techniques to achieve a standard of radar plotting commensurate to that necessary for the safe execution of collision avoidance manoeuvring under actual sea-going conditions.

2 THEORY

2.1 Factors affecting performance and accuracy

2.1.1 Elementary understanding of the principles of radar; range and bearing measurement. Characteristics of the radar set which determine the quality of the radar display; the radar antenna; polar diagrams; the effects of power radiated in directions outside the main beam; non-technical description of the radar system including variations in the features encountered in different types of radar set. Performance monitors. Equipment factors which affect maximum and minimum detection ranges and accuracy of information.

2.1.2 Marine radar performance specification (Assembly resolution A.222(VII)).

2.1.3 Effects of the siting of the radar antenna, shadow sectors and arcs of reduced sensitivity, false echoes, effects of antenna height on detection ranges, etc. Siting radar units and storing spares near magnetic compasses; magnetic safe distances.

2.1.4 Radiation hazards. Safety precautions to be taken in the vicinity of antenna and open waveguides.

2.2 Detection of misrepresentation of information including false echoes and sea returns

2.2.1 A knowledge of the limitations to target detection is essential to enable the observer to estimate the dangers of failure to detect targets. The following factors should be emphasized:

.1 performance standard of the equipment;

.2 brilliance, gain and video processor control settings;

.3 radar horizon;

.4 size, shape, aspect and composition of targets;

.5 effects of the motion of the ship in a sea-way;

.6 propagation conditions;

.7 meteorological conditions; sea clutter and rain clutter;

.8 anti-clutter control settings;

.9 shadow sectors;

.10 radar-to-radar interference.

2.2.2 Factors which might lead to faulty interpretation: false echoes, effects of nearby pylons and large structures, effects of power lines crossing rivers and estuaries, echoes from distant targets occurring on second or later traces.

2.2.3 Aids to interpretation: corner reflectors, radar beacons. Detection and recognition of land targets; the effects of topographical features; effects of pulse length and beamwidth. Radar conspicuous and inconspicuous targets; factors which affect the echo strength from targets.

3 PRACTICE

3.1 Setting up and maintaining displays

3.1.1 The various types of radar display mode; unstabilized ship's-head-up relative motion, ship's-head up and north-up stabilized relative motion, true motion.

3.1.2 The effects of errors on the accuracy of information displayed; effects of transmitting compass errors on stabilized and true motion displays, effects of transmitting log errors on a true motion display, effects of inaccurate speed settings on a true motion display.

3.1.3 Methods of detecting inaccurate speed settings on true motion controls. Effects of receiver noise limiting ability to display weak echo returns, effects of saturation by receiver noise, etc. Adjustments of operational controls; criteria which indicate optimum points of adjustment, importance of proper sequence, etc. Effects of maladjusted controls, detection of maladjustments and correction of:

.1 controls affecting detection ranges;

.2 controls affecting accuracy.

3.1.4 Dangers of using radar equipment with maladjusted controls.

3.1.5 Need for frequent regular checking of performance, relationship of performance indicator to range performance of the radar set.

3.2 Range and bearing

3.2.1 Methods of measuring ranges; fixed range markers, variable range marker. Accuracy of each method and the relative accuracy of the different methods. How range data are displayed; ranges at stated intervals, digital counter, graduated scale, etc. Methods of measuring bearings; rotatable cursor on transparent disc covering the display, electronic bearing cursor and other methods. Bearing accuracy. Inaccuracies due to: parallax, heading marker displacement, centre maladjustment; how bearing data are displayed; graduated scale, digital counter, etc.

3.2.2 Need for regular checking of the accuracy of ranges and bearing, methods of checking for inaccuracies and correcting or allowing for inaccuracies.

4 PLOTTING TECHNIQUES AND RELATIVE MOTION CONCEPTS

4.1 Practice in manual plotting techniques including the use of reflection plotters should have the objective of establishing a thorough understanding of the interrelated motion between own ship and other ships, including the effects of manoeuvring to avoid collision. At the preliminary stages of this training, simple plotting exercises should be designed to establish a sound appreciation of plotting geometry and relative motion concepts. The degree of complexity of exercises should increase throughout the training course until the trainee has mastered all aspects of the subject. Competence can best be enhanced by exposing the trainee to real-time exercises performed on a simulator or using other effective means.

4.2 Identification of critical echoes

4.2.1 Position fixing by radar from land targets and sea marks.

4.2.2 Accuracy of position fixing by ranges and by bearings.

4.2.3 Importance of cross checking accuracy of radar against other navigational aids.

4.2.4 The value of recording ranges and bearings at frequent, regular intervals when using radar as an aid to collision avoidance.

4.3 Course and speed of other ships

4.3.1 Different methods by which course and speed of other ships can be obtained from recorded ranges and bearings;

.1 unstabilized relative plot;

.2 stabilized relative plot; and

.3 true plot.

4.3.2 Relationship between visual and radar observations; detail, accuracy of estimates of course and speed of other ships. Detection of changes in movements of other ships.

4.4 Time and distance of closest approach of crossing, meeting or overtaking ships

4.4.1 Use of recorded data to obtain:

.1 measurement of closest approach distance and bearing;

.2 time to closest approach.

4.4.2 The importance of frequent, regular observations.

4.5 Detecting course and speed changes of other ships

4.5.1 Effects of changes of course or speed by other ships on their tracks across the display.

4.5.2 Delay between change of course or speed and detection of that change.

4.5.3 Hazards of small changes as compared with substantial changes of course or speed in relation to rate and accuracy of detection.

4.6 Effects of changes in own ship's course and speed or both

4.6.1 On a relative motion display; effects of own ship's movements, effects of other ships' movements; advantages of compass stabilization of a relative display.

4.6.2 On a true motion display.

4.6.3 Effects of inaccuracies; of speed and course settings on a true motion display, of compass stabilization data driving a stabilized relative motion display.

4.6.4 Effects of changes in course or speed by own ship on tracks of other ships on the display.

4.6.5 Relationship of speed to frequency of observations.

5 APPLICATION OF THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA

5.1 Relationship of the Regulations for Preventing Collisions at Sea to the use of radar.

5.2 Action to avoid collision; dangers of assumptions made on inadequate information and the hazards of small alterations of course or speed. The advantages of safe speed when using radar to avoid collision. The relationship of speed to closest approach distance and time and to the manoeuvring characteristics of various types of ships.

5.3 The importance of radar observation reports being well defined; radar reporting procedures.

5.4 Use of radar in clear weather, to obtain an appreciation of its capabilities and limitations, compare radar and visual observations and obtain an assessment of the relative accuracy of information.

5.5 The need for early use of radar in clear weather at night and when there are indications that visibility may deteriorate. Comparison of features displayed by radar with charted features. Comparison of the effects of differences between range scales.

Resolution 17

Additional Training for Masters and Chief Mates of Large Ships and of Ships with Unusual Manoeuvring Characteristics

THE CONFERENCE,

RECOGNIZING the importance of relevant experience and training before assuming the duties of master or chief mate of large ships and ships having unusual handling and manoeuvring characteristics significantly different from those in which they have recently served,

NOTING that such characteristics will generally be found in ships which are of considerable deadweight, length, special design or of high speed,

RECOMMENDS that:

(a) prior to appointment to one of such ships masters and chief mates should:
   (i) be informed of that ship's handling characteristics particularly in relation to the subjects listed in paragraph 7 of the Appendix to Regulation II/2 - "Mandatory Minimum Requirements for Certification of Masters and Chief Mates of Ships of 200 Gross Register Tons or More" of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978;
   (ii) be thoroughly familiar with the use of all navigational and manoeuvring aids fitted in the ship concerned, including their capabilities and limitations

(b) before initially assuming command of one of the ships referred to above, the prospective master should have sufficient and appropriate general experience as master or chief mate, and either:
   (i) have sufficient and appropriate manoeuvring experience as chief mate or supernumerary on the same ship or as master, chief mate or supernumerary on a ship having similar manoeuvring characteristics; or
   (ii) have attended an approved ship handling simulator course on an installation capable of simulating the manoeuvring characteristics of such a ship;

(c) the additional training and qualifications of masters and chief mates of dynamically supported craft should be in accordance with the relevant guidelines of the IMCO Code of Safety for Dynamically Supported Craft,

INVITES the Inter-Governmental Maritime Consultative Organization:

(a) to keep the Recommendation contained herein under review, in consultation or association with other international organizations, as appropriate, particularly with the International Labour Organisation, and to bring any future amendments to the attention of all Governments concerned;

(b) to communicate this Resolution to all Governments invited to the Conference.

Model Course 1.09

Radar Simulator

IMO

Model course developed under the IMO - Norwegian programme

Part A
Course Framework

■ Scope

The course is essentially practical and consists of a series of exercises performed on a radar simulator with two or more "own ships" and a number of others controlled by the instructor. Each exercise will involve observing the movement of ships seen on the radar, recognizing those presenting a threat of collision and taking action to avoid collisions. Trainees will act either as master or as an observing officer for the exercises, and will change roles to allow each a turn in command of an "own ship".

As the course progresses, exercises of increasing complexity will be set to provide realistic practice in the use of radar for navigation and collision avoidance in confined waters with heavy traffic.

Each exercise will be followed by class discussion, giving participants the opportunity to analyse the actions taken and discuss possible alternatives.

■ Objective

Those successfully completing this course will be able to make efficient and effective use of radar as a navigational aid in congested, confined waters, recognize potential threats and make valid navigational and collision-avoidance decisions based on sound radar observation and plotting in compliance with the International Regulations for Preventing Collisions at Sea (COLREG) 1972. They will be aware of the time needed to appreciate that a dangerous situation is developing, to decide upon and take appropriate action, and to ascertain that such action is adequate and does not give rise to further conflicts with other vessels. They will also realize that excessive speed in poor visibility reduces the time available to assess a threat and to take appropriate action.

■ Entry standards

Those wishing to enter this course should be the holders of certificates satisfying the requirements of regulation II/4 or II/3 of the 1978 STCW Convention and entitling them to act as officer in charge of a navigational watch; they should also have completed a course of training which meets or exceeds the standard set out in IMO Assembly resolution A.483 (XII) - Training in radar observation and plotting (IMO model course No. 1.07).

■ Course certificate, diploma or document

On successful completion of this course, a document should be issued certifying that the holder has successfully completed a course on radar simulator training as recommended by resolution 18 of the 1978 STW Conference.

■ Course intake limitations

Course intake should be limited to a maximum of three trainees per "own ship" station.

■ Staff requirements

The instructor should hold a certificate as master and have a minimum of two years' watch-keeping experience with radar. He should also be thoroughly familiar with the operation of the simulator. If more than three "own ships" are in use, an additional similarly qualified instructor is needed to assist during exercises.

■ Teaching facilities and equipment

The simulator should include two or more "own ship" stations, each with separate helm and engine controls, and should be capable of simulating 10 or more target ships. The simulator and each "own ship" radar display should comply with IMO Assembly resolutions A.574(14) - General requirements for electronic navigational aids and A.477(XII) - Performance standards for radar equipment. Each "own ship" display, together with its control panel, should be installed in a room or cubicle provided with a plotting table, plotting charts and instruments, and a reflection plotter. Each station should be provided with a manoeuvring book and pilot card in compliance with the provisions of the IMO Assembly resolution on the provision and display of manoeuvring information on board ships.*

An X/Y plotter, or other means of graphically recording the progress of exercises, is required.

A room equipped with an overhead projector and a blackboard or flipchart should be provided for briefing trainees before exercises are carried out and holding group discussions following each exercise.

■ Teaching aids (A)

A1 Instructor Manual (Part D of the Course).

■ IMO references (R)

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 1978) (IMO Sales No. 938 78.15.E).

R2 International Conference on Training and Certification of Seafarers, resolution 18 - Radar simulator training (IMO Sales No. as R1).

R3 Assembly resolution A.483 (XII) - Training in radar observation and plotting.†

R4 Assembly resolution A.431 (XI) - Recommendation concerning vessels restricted in their ability to manoeuvre when engaged in an operation for the maintenance of safety of navigation in a traffic separation scheme.†

R5 IMO/ILO Document for Guidance, 1985, appendix 3 to section 1 (IMO Sales No. 935 87.08.E).

R6 International Regulations for Preventing Collisions at Sea (COLREG) 1972, as amended (IMO Sales No. 904 85.01.E).

R7 Ships' Routeing (IMO Sales No. 927 84.03.E).

* Submitted for adoption by the fifteenth IMO Assembly, November 1987.

Part B
Course Outline

Subject Area	Hours	
	Lecture	Simulator
1. Familiarization with the Simulator's "Own Ship" Characteristics and Controls	1	1
2 Review of Basic Radar and Plotting	2	4
3. Open Water Exercises in the Application of COLREG 1972		6
4. Exercises in Navigation and Collision Avoidance in Confined and Congested Waters	2	8
5. Exercises in and near Traffic Separation Schemes	1	5
SUBTOTALS	6	24
TOTAL	30	

Note: Because of the nature of this course and the uncertain duration of each exercise, no course timetable is provided.

Model Course 1.22

Ship Simulator and Bridge Teamwork

IMO

Model Course developed under the IMO – Norwegian programme

Part A
Course Framework

■ Scope

This course is essentially practical and consists mainly of a series of exercises performed on a ship handling simulator. Some classroom lectures, to provide the necessary theoretical background for the exercises, are included. Particular items dealt with in these lectures are illustrated either by including them as part of an exercise or by a separate simulator demonstration.

Exercises are controlled by an instructor and, initially, allow the trainees to become familiar with the equipment, the controls and the instrumentation provided by the simulator.

The exercises increase in complexity as the course progresses and as trainees become familiar with the manoeuvring characteristics of the ship model and its response to the engine and helm in various conditions. The final exercises deal with the planning and execution of a coastal passage from port to port and will make use of the knowledge and skills learned in all of the previous exercises. Equipment failure or malfunction may be introduced during an exercise to afford trainees practice in taking emergency remedial action.

During exercises, trainees are expected to make use of effective bridge procedures, to comply with the International Regulations for Preventing Collisions at Sea, 1972 (COLREG 1972) and to observe the basic principles of keeping a navigational watch, as set out in regulation II/1 of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW 1978). They will assume the different roles of the bridge watchkeeping team, the roles being rotated to allow each trainee an opportunity to act as master for some of the exercises.

Each exercise will be preceded by a session for briefing and planning and be followed by a group discussion, led by the instructor, to analyse the actions and decisions of the trainees.

■ Objective

The trainees who successfully complete this course will have gained experience in handling ships under various conditions and will make a more effective contribution to the bridge team during ship manoeuvring.

In particular, trainees will gain:

- familiarization with the use of engines and helm for ship manoeuvring;
- an understanding of the effects on the behaviour of the ship of:
  - wind
  - current
  - shallow water, banks and narrow channels
  - condition of loading;
- a greater awareness of the importance of planning a passage or manoeuvre and the need for an alternative plan; and
- a greater understanding and awareness of efficient bridge procedures during watchkeeping and ship handling.

■ Entry standards

Trainees wishing to enter this course should have a minimum of six months watchkeeping experience as officer in charge of a navigational watch and should also have completed a course of training which meets or exceeds the standard set out in IMO Assembly resolution A.483(XII) – Training in radar observation and plotting (see IMO Model Course 1.07).

■ Course certificate, diploma or document

On successful completion of this course, a document should be issued certifying that the holder has successfully completed a simulator course in ship handling and bridge teamwork.

■ Course intake limitations

The course intake will, to some extent, be dependent on the facilities provided by the simulator and the number of qualified instructors available. To allow each trainee to spend a reasonable proportion of the time engaged in exercises, the intake should be limited to two bridge teams, each consisting of three or four persons. Typically, one team would be carrying out an exercise while the other is being debriefed and planning the next exercises. The two teams are identified as Group A and Group B in the timetables.

When recruiting trainees for this course, consideration should be given to their length of watchkeeping experience and the sizes and types of ship for which they require training, so that persons with widely differing experience and training needs are not in the same group.

■ Staff requirements

The instructor in charge should hold a certificate as master (or equivalent), have a minimum of two years' experience in handling ships and have the training and experience necessary to operate a ship handling simulator as a training aid. An additional instructor with similar qualifications and experience will be needed to supervise each group of trainees. All instructors should have a theoretical knowledge of the hydrodynamics of ship behaviour beyond that required by STCW 1978. It is recommended that, in addition to receiving instruction in the operation of the simulator, instructors should have attended a course in the use of a simulation facility for training purposes.

■ Teaching facilities and equipment

This course requires a ship handling simulator with a fully equipped bridge, including instruments showing course, speed, rudder angle, rate of turn, engine RPM and propeller pitch and relative wind direction and speed. Whenever possible, the model in use should be of similar size and manoeuvring characteristics to the ships in which trainees will serve. The models must generate realistic responses to the use of engine and rudder under various conditions. Special attention should be drawn to slow speed situations. The simulator must have a visual system capable of handling a number of ships in addition to land masses. The simulator must generate realistic radar signals and echo soundings and simulate or emulate navigation receivers providing at least one alternative means of fixing position.

Manoeuvring information, in the form set out in IMO Assembly resolution A.601(15), should be provided for the model in use. The bridge should be equipped with a simulated VHF telephone, connected to the instructor station, for communicating with pilot stations, VTS, port services and other ships during exercises. The instructor will act as the other stations in answering or initiating calls. Similarly, an internal telephone to the engine-room should be connected to the instructor station.

Means of producing the sound signals required by COLREG 1972 must be provided for other ships in the vicinity as well as for own ship.

Adjacent to the simulator there should be a room where briefing and debriefing may be held. Preferably, there should be a wall projector showing the scenario as it is seen from the instructor station. The room should be suitable for displaying charts on the walls and have an overhead projector and a blackboard.

■ Teaching aids (A)

A1 Instructor Manual (Part D of the course).

Each group will require the following:

A2 Charts, tide tables, current charts, list of lights and sailing directions for the exercise areas.

A3 Equipment manuals and tables of corrections for simulated navigational aids.

A4 International Chamber of Shipping, *Bridge Procedures Guide*, 2nd ed. (London, Witherby and Co., 1990).

A5 A ship's log-book.

A6 Manoeuvring information for the ship model in use.

■ IMO references (R)

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW 1978) (IMO Sales No. 938 78.15.E).

R2 ILO/IMO Document for Guidance, 1985 (IMO Sales No. 935 87.08.E).

R3 International Regulations for Preventing Collisions at Sea, 1972 (COLREG 1972), as amended (IMO Sales No. 904 85.01.E).

R4 IMO Assembly resolution A.601(15) – Provision and display of manoeuvring information on board ships.

R5 IMO Assembly resolution A.678(16) – Amendment to the International Regulations for Preventing Collisions at Sea, 1972.

■ Textbooks (T)

No specific textbooks are recommended for the use of trainees.

Part B
Course Outline

Subject Area	Hours	
	Lecture	Simulator
1 Review of basic principles	2	*
2 Familiarization with the bridge	–	1.5
3 Standard manoeuvres	0.5	3
4 Wind and current effects	0.5	1.5
5 Shallow-water effects	1	3
6 Bank, channel and interaction effects	0.5	1
7 Anchoring and single-buoy mooring	0.5	2
8 Planning and carrying out a voyage	1	12
	6	24
	30	

* A short demonstration on the simulator could prove useful.

Ship Simulator and Bridge Teamwork Course Timetable (Group A)

Period\Day	Day 1	Day 2	Day 3	Day 4	Day 5
1st Period (1.5 hours)	1 Review of basic principles	3 Simulator exercise 3 Debriefing 4 Wind and current (lecture)	5 Preparation 5 Simulator exercise 6 Bank, channel and interaction effects (lecture)	8 Preparation 8 Simulator exercise	8 Preparation 8 Simulator exercise
2nd Period (1.5 hours)	1 Review of basic principles (contd.) 2 Familiarization with the bridge	4 Simulator exercise 4 Debriefing 4 Simulator exercise	6 Bank, channel and interaction effects (demonstration) 7 Anchoring (lecture)	8 Simulator exercise (contd.) 8 Debriefing and preparation	8 Simulator exercise (contd.) 8 Debriefing and preparation
3rd Period (1.5 hours)	2 Familiarization (contd.) 3 Standard manoeuvres (lecture) 3 Simulator exercise	5 Shallow-water effects (lecture) 4 Debriefing	7 Anchoring (demonstration) 7 Preparation 7 Simulator exercise	8 Simulator exercise 8 Debriefing	8 Simulator exercise 8 Debriefing
4th Period (1.5 hours)	3 Debriefing and preparation 3 Simulator exercise 3 Debriefing and preparation	5 Simulator exercise 5 Debriefing 5 Simulator exercise	8 Planning a voyage (lecture) 7 Debriefing	8 Preparation 8 Simulator exercise	8 Debriefing (contd.) 8 Final debriefing
Extension (see page 21)		5 Debriefing		8 Debriefing	

Ship Simulator and Bridge Teamwork Course Timetable (Group B)

Period\Day	Day 1	Day 2	Day 3	Day 4	Day 5
1st Period (1.5 hours)	1 Review of basic principles	3 Preparation 3 Simulator exercise 4 Wind and current (lecture)	5 Simulator exercise 5 Debriefing 6 Bank, channel and interaction effects (lecture)	8 Simulator exercise 8 Debriefing	8 Simulator exercise 8 Debriefing
2nd Period (1.5 hours)	1 Review of basic principles (contd.) 2 Familiarization with the bridge	3 Debriefing 4 Simulator exercise 4 Debriefing	6 Bank, channel and interaction effects (demonstration) 7 Anchoring (lecture)	8 Preparation 8 Simulator exercise	8 Preparation 8 Simulator exercise
3rd Period (1.5 hours)	2 Familiarization (contd.) 3 Standard manoeuvres (lecture) 3 Preparation	5 Shallow-water effects (lecture) 5 Simulator exercise	7 Anchoring (demonstration) 7 Simulator exercise 7 Debriefing	8 Debriefing and preparation 8 Simulator exercise	8 Debriefing and preparation 8 Simulator exercise
4th Period (1.5 hours)	3 Simulator exercise 3 Debriefing and preparation 3 Simulator exercise	5 Debriefing and preparation 5 Simulator exercise 5 Debriefing	8 Planning a voyage (lecture) 8 Preparation	8 Simulator exercise (contd.) 8 Debriefing and preparation	8 Debriefing 8 Final debriefing
Extension (see page 21)	3 Debriefing				