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A Maritime Training Facility (The Physical Set-Up)

by

Alock Kwadwo Asamoah

Ghana

A paper submitted to the faculty of the World Maritime University in partial fulfillment of the requirements for the award of a

Master of Science Degree

in

Maritime Education and Training (Engineering)

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

Signature: ____________________________ Date: 6th of October, 1989.

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Charles E. Mathieu

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Lecturer, Regional Maritime Academy, Ghana.
Dedicated to

the course of

Safer Shipping and Cleaner Oceans
Marine casualty statistics look very gruesome, especially when a familiar country or person has been involved in this unnecessary toll. The marine environment, however, has virtually unlimited resources. One cannot therefore reduce casualties by simply limiting exposure to the unforgiving marine environment.

In almost all marine casualties, investigations have shown that "human error" is an underlying factor. To overcome this factor, people employed in the maritime industry need to be properly trained. This invariably means a training facility well equipped in all facets. This paper looks at the physical ingredients that go into such a training institution.

The environment in which the training facility resides is discussed from both a learning and industry association point of view. The equipment that should go into developing a marine professional is highlighted in view of all the maritime sectors. Safety and survival craft teaching aids for a sound practicing base to alleviate the astronomical marine disasters of our time are also brought to light.

The paper emphasizes the training needs for safer shipping and cleaner oceans coupled with economic profitability.
I am indebted to all those who helped by way of information, guidance, corrections and most of all encouragement to make this paper what it is.

My sincere thanks and appreciation go particularly to:

The Lord God Almighty for looking after me since birth through this project.

The Governments and Secretariat of the International Maritime Organisation for establishing the World Maritime University to encourage safer shipping and cleaner oceans and awarding me this two-year fellowship in the University leading to a Master of Science Degree.

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U.S. Naval Academy, Annapolis, U.S.A.
Warsash College of Maritime Studies, South Hampton, Britain.

and from which some ideas and set-ups have consciously and/or unconsciously been used in this paper.

And finally, I highly appreciate what my colleagues, Messers

Hasnain Syed Masood-ul of Pakistan,
Jamal Hamzah of Malaysia,
Lau Seng Chaun of Malaysia,
Olanda Menelieto of Philippines,
Wainaina Perminus Mungai of Kenya

and Wei Ning of China,

contributed by drawing my attention to pieces of information which I have embodied in this paper.
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International trade is a must for every country, both developed and developing, as total self sufficiency is extremely difficult if not totally impossible to achieve. Climatic and natural resources' uneven distribution are the main reasons for inter-dependency among countries. International trade benefits both sides. It allows each country to specialise, maximizing on resources to produce commodities economically.

These commodities, in international trade, are produced in large quantities. Most of them are raw or semi-processed materials (especially for developing countries in the West Africa sub-region) and hence low value commodities. The cheapest known transportation mode for such commodities (apart from pipe lines for fluids) is the sea, that is, shipping. So until another means more economical than shipping is developed, countries will depend on ships for imports and exports. These other less expensive means will not in the very near foreseeable future be feasible.

In addition to providing a vital transportation mode, the sea is a source of vital nutrition for the majority of mankind. This is well seen in the number of fishing vessels and fish landings in the various coastal towns of the world.

One may argue that a country does not need a fleet of ships, as the country could depend on foreign flag vessels for transportation and fish harvesting.

On the contrary, apart from the above, national sovereignty and defense purposes, which can never be quantified, will best be served by national vessels. It is also an economic advantage to own a national fleet. Couple to this minerals, energy, sand and stone and other
material wealth that the oceans are capable of giving and the seas become a potentially invaluable asset. One must not forget the United Nations' International Law of the Sea Convention for utilization of these resources. This brings to the forefront a worldwide awareness of the seas' virtually unlimited resources. In addition, the inland waters also contribute to most of the above mentioned resources. There is a need to develop ports for the safe harbouring of ships and to provide equipment for all these oceanographic ventures.

Personnel need to be trained to operate these vessels, ports, fishing gear and mining equipment safely and efficiently without polluting the environment.

MARINE CASUALTIES

Maritime casualty statistics makes for very unsavory reading, but people tend to look at them as just facts and figures. As such, they are far removed from real life, especially when reported on a world-wide basis as the following tables of total losses of vessels show.

Summary of Total losses during 1987

<table>
<thead>
<tr>
<th>Category</th>
<th>No.</th>
<th>Tonnage</th>
<th>% of Gross Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founded</td>
<td>101</td>
<td>395,217</td>
<td>30.78</td>
</tr>
<tr>
<td>Missing</td>
<td>4</td>
<td>40,994</td>
<td>3.19</td>
</tr>
<tr>
<td>Fire, Explosion</td>
<td>27</td>
<td>95,672</td>
<td>7.45</td>
</tr>
<tr>
<td>Collision</td>
<td>24</td>
<td>96,031</td>
<td>7.48</td>
</tr>
<tr>
<td>Contact</td>
<td>7</td>
<td>21,341</td>
<td>1.66</td>
</tr>
<tr>
<td>Wrecked, Stranded</td>
<td>43</td>
<td>298,209</td>
<td>23.22</td>
</tr>
<tr>
<td>Lost, etc. #</td>
<td>13</td>
<td>336,697</td>
<td>26.22</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>219</td>
<td><strong>1,284,161</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

### losses other than above (e.g. mines)
In the same way, statistics of lives lost will present a similar picture.

Summary of Lives Lost, 1984 to 1987

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Foundered</td>
<td>523</td>
<td>428</td>
<td>440</td>
<td>317</td>
</tr>
<tr>
<td>Missing</td>
<td>78</td>
<td>85</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>Fire, Explosion</td>
<td>29</td>
<td>29</td>
<td>94</td>
<td>51</td>
</tr>
<tr>
<td>Collision</td>
<td>3,156</td>
<td>448</td>
<td>14</td>
<td>54</td>
</tr>
<tr>
<td>Contact</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Wrecked, stranded</td>
<td>34</td>
<td>27</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Lost, etc.</td>
<td>21</td>
<td>43</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>TOTAL LIVES</td>
<td>3,841</td>
<td>1,067</td>
<td>619</td>
<td>525</td>
</tr>
</tbody>
</table>

If we regionalize these casualty statistics (appendix 1), and better still nationalize (appendix 2), the picture is brought closer to us.

It becomes unbearable when they are further broken down into ships, towns, families or personal names. Then even governments become aggrieved and concerned. Let us take the "Herald of Free Enterprise" case as an example. It leaves being a number (inside a statistics table) to being a heart rending disaster when we look at the persons involved. The ferry itself then reflects on the
owners. The credibility of the managers and crew then comes into play. With pressure from family members of the dead, may their souls rest in peace, and insurance companies, the British Government has then to table motions in respect of roll-on-roll-off passenger vessel resolutions at the international level.

This example may seem far removed from somebody on the other side of the globe. The thirty-eight foot fishing vessel, "Amma Della", registration no. JF54, capsizing during its christening and trial with a choir on board (with crew totalled forty persons), drowning seven persons, brought home the ill effects of a marine casualty to the fishing port of Tema in Ghana. This sad event occurred on the 17th day of August, 1985, just around the fishing season. The "M.V. Keta Lagoon", a heavily laden general cargo vessel grounding just off the Tema fishing harbour for three days, further makes one aware of the expense and delay marine accidents can cost a nation.

There are numerous cases of such accidents. The question now is, "Could these and other such accidents have been prevented?" Is there a small capital cost outlay that could have offset all these big economic losses and social inconvenience? Who is at fault in these marine casualties? Is there enough human knowledge, technology and resources to prevent marine disasters?

Humans always tend to take things for granted until the inevitable (due to our actions) happens. For instance, Nigeria does not worry about marine pollution control until a tanker inadvertently discharges thousands of tonnes of crude oil along her beaches. Should Liberia, Ghana, Seirra Leone or Gambia wait for such a spill before making the necessary plans to control, or better still, prevent such an occurrence?
MARINE CASUALTY PREVENTION

There is enough human knowledge, technology and resource to prevent or at least minimise the severity of marine accidents. In every marine casualty, there is a human error factor which, had it not existed, could have reduced the severity of the accident, if not prevented it totally. Lives need not be lost unnecessarily in the marine environment. Huge financial losses and social sadnesses can be prevented by directing resources properly in the marine industry. It is becoming an accepted adage that "if one goes the cheapest way, one ends up on the expensive side". We must apply both science and art to the marine field. This is because the old form of marine resources reaping, which was an art, is no more valid if marine accidents with its attendant ill effects are to be prevented.

TRAINING

The best approach is to give the people in the marine industry the best training available, and to encourage them to apply the knowledge so acquired to their trades. Everybody will agree that a fire extinguisher in untrained hands will be more of a liability than an asset when there is a fire. Is there any point in entrusting a multi-million dollar set of equipment to an untrained person? How can we entrust life to people who are not properly trained? It will be pure economic suicide coupled to social injustice to all parties involved.

Marine personnel must be trained. This can best be done in an organised set up which invariably means a training institution: an institution where mistakes can be made (simulators) without causing any deaths or economic losses. Under qualified trainers, the tiro mariner can be sure of receiving the best knowledge and remaining abreast
with modern trends - technology and resources and their utilization. The old hands already on the job can also come in for refresher courses.

A Chinese saying goes like this "If your investment is for one year, plant rice. If it is for ten years then plant trees, but if it is for a hundred years, then one of course has to train human beings". The marine industry has been in existence at least since Noah made the ark to save a pair of each species of animals and birds (seven pairs of each clean species) during the flood (Genesis 6-8). And this industry is going to stay with us for sometime more. The marine industry must therefore invest in human training so the marine industry may continue to support us. We do not need to sacrifice human lives, expensive floating and fixed machinery, commodities, etc. when not necessary. Proper training will go a long way in making the oceans safer and cleaner with higher profitability.

There is therefore no doubt that the need for a maritime training facility is of paramount importance to every nation, not excluding land-locked ones. This training institution must have all the necessary facilities to achieve the aforesaid goals; harvesting marine resources profitably without endangering human lives and expensive property.

This paper therefore looks at the hardware ingredients that need to go into such a training institute as this is where the big capital outlay is.

In the end, the paper hopes to have come up with recommendations of a hardware set-up which any new or emerging maritime training institute should plan for, and existing training facilities may use for improvements.
No situation is permanent. The environment in any field is always changing, some of the changes turbulently, others, unnoticeably. Planners and policy makers therefore have a difficult task meeting the demands of such environments. They must take the changing trends into consideration and predict the future needs of whatever field they are dealing in. Without this, they will turn out to be ineffective in their jobs.

LOCATION

The marine industry finds itself in the following situation. The environment is changing constantly. Technology, political and even other non-marine fields have a direct or indirect bearing on the needs of the marine industry. To meet the needs of the industry, one has to be in close contact with it, and this is no less true for educational planners. The manpower turned out of any educational establishment should match the immediate as well as the future needs of the industry that the educational establishment is feeding.

PROXIMITY TO INDUSTRY.

Close contact between the educational institution and the industry then becomes a must. Information flow from one to the other is to be ensured. Reliance on each other becomes a pre-requisite for any improvements and profitability.

With modern technology, this closeness can be achieved in various ways. The postal system can be used. This is good where there is no need for personal presence on the scene nor urgent information transfer which should
be accomplished in minutes or hours. Telephone and radio transmissions coupled with telexes and computers can speed up such transfers. With the space age, the world has even become "smaller" with aeroplanes travelling above the speed of sound (Concord). Any of these transportation and communication systems can be used to bring the maritime training facility close to the marine industry. As many of these communication media as possible should be combined cost efficiently and effectively without losing the objective - closeness of the industry and training facility.

In certain instances, the changes in the marine industry are brought about by research in the educational institution. One does not have to question the interplay or closeness in such a case.

Physical nearness is very important. Trainees have to make field trips to the vessels, ports and other marine installations, especially on equipment that the training institute has not modelled or simulated. Real life size equipment in operation is the best teaching aid any trainer can hope for. As most developing countries have neither the means for a lot of equipment (for the institute) nor for simulators, the location of the training school should be very close to the port facility (and/or the marine industry).

Where transport and telecommunication are a problem, the VHF transmission range should be the limiting distance to enable the educational establishment to contact the industry.

The nearness to the industry allows the institute to take advantage of the experienced staff the various companies in the industry have. This will be in the form of visiting lecturers. In return the institute can provide facilities for tests and investigations to the
industry. Close co-operation can be seen here. Workers can get day (or part day) releases to attend part time courses, to keep abreast with modern trends or to upgrade and still not be absent from work as one can be called in case of need. One must not rule out the possibility of locating the educational institution remote from the "centre of action", especially to a place where cheap and easy transportation and communication facilities are available.

All the same, it is worth noting that, staffing a remotely located institution can be extremely difficult as one maritime academy in Africa has found out too late. Most staff will not like to take up appointments in an out-of-the-way location with limited amenities like transport and telecommunications.

GEOLOGICAL.

The site chosen must be checked for erosion if at the very edge of the sea. Expensive buildings with their equipment can be washed away by sea erosion as another training institute in Africa has learned at a very great expense. A good survey in this respect is called for. Sea defense walls may be erected to check such erosion, but this will depend on the cost factor.

Silt ing can also be a problem if the shore line is to have a "harbour" built on it for sailing practices and a training vessel. If the silt ing is not very heavy, and the institute has students undergoing dredging courses, advantage can be taken of this and dredging equipment and practical training arranged here.

Earthquake zones should be avoided unless quake proof buildings are scheduled. In addition consideration should be given to landslide localities. This phenomena should deter locating the institute in such an area.
Not wanting to go much into geology, it must suffice to say that the kind of rock structure must also be taken into consideration. This will alleviate differential sinkage of buildings leading to cracks and final failure.

ENVIRONMENTAL

Though the educational institute should be near the industry, one should not lose sight of the fact that it is a facility for learning. Learning in this respect goes with serenity. Noise and distraction should be almost zero. (of course except the noise generated by the facility itself). Being situated some three or four kilometers away from any public roads should take care of this.

Fresh air without pollutants is a cheap but healthful ingredient to human living and the training institution should be located away from factories and other industrial sites. Student population density can affect the air quality especially in confined areas such as lecture rooms.

HEALTH, AMENITIES & SAFETY

Insect and bacteria breeding is associated with wet, damp and marshy lands. These areas too should be avoided to curtail diseases and epidemics in the training facility. Good drainage, either natural or artificial should be part of the chosen site. This brings in sewage disposal in connection with good sanitary and potable water supply. The planner has to ensure that these amenities are in easy reach or arranged for. Electric power supply for teaching aids and services is a must in a marine academy. If the national grid is to be the source then for initial cost purposes, this must be considered during this locating stage. In some cases, all these amenities may be catered for by private plants belonging
to the maritime training facility. This arrangement will yield an independence in location though the initial capital outlay and running cost will be high.

Apart from noise, as mentioned earlier, safety of students and staff may demand locating the training facility away from hazards such as highways, railroads and high tension cables.

**SIZE**

The size of the land is determined by the range of courses and activities the institute is going to offer. In any case, there should be enough land space for classrooms, lecture rooms, laboratories, workshops, auditoriums, libraries, store rooms, administrative offices, on campus accommodation, messes, recreational facilities, physical training grounds, sick bay, parking lots and staff quarters.

Depending on climatic conditions and availability of land, these buildings can be spread over a large site or skyscrapered onto a small plot. Price of land too is a great contributing factor in this size selection. A well spaced set of buildings with trees for shade and beauty, with a landscaping to match will be more conducive to learning than the cramped skyscraper type. Good scenery, especially of nature, has a calming effect on a tired brain.

**BUILDINGS**

A master plan is essential for the general layout. This will help a lot in determining the land size required. There are basically seven types of building layouts possible for a training facility. F. G. Knirk in his book "Designing Productive Learning Environments" names them as corridor, finger, courtyard, loft, circular, circular,
cluster and campus types (discussed at length in next chapter "Buildings"). The selection of building(s) for a particular training facility should depend on:

(a) climatic conditions,
(b) curriculum to be followed,
(c) economic limitations,
(d) sizes and special features of rooms, and
(e) space availability.

Where buildings already exist (using an old building or facility) additions and/or modifications may suffice, in which case land size is predetermined. It should of course be borne in mind that the type of buildings chosen can determine land size and land size can put restrictions on the type that can be built.

STUDENT POPULATION

Student population also has a bearing on land size. In any case, future projections should be made when deciding on land size to offset any need that may arise in the future for a total shift to a new site. This will mean land big enough to accommodate any future expansions. There have been instances where whole institutes had to be relocated, or "transported". This is a very expensive undertaking, so as big an area of land as practicable should be acquired.

SPECIFICATIONS

For a student population of two hundred, a land area in excess of zero point three two five square kilometers (0.325 sq. km = 80 acres) with a water front length of six hundred metres (600m) may be needed. It is worth noting that a higher or lesser student population figure may not mean a proportional adjustment in the land size.
BUILDINGS

To house the various equipment and training processes, buildings will be needed. Structures of this nature should basically safeguard the training institution from the elements.

The general outlay of the buildings of the training facility has a bearing on the efficiency of the learning process as stated by F.G. Knirk in "Designing Productive Learning Environment".

TYPES

In some ground plans, e.g. corridor type (see next page for sample plans), natural ventilation is assured which means a generous number of windows should be enough. Stacking of floors is vertical in this corridor type floor plan. The courtyard and finger types have horizontal stacking but if both kinds of stacking are employed, then artificial ventilation comes into play and the possibility of distraction of students in the inner court area should be considered.

One should not forget that the greater the number of exterior walls a building has, the more expensive the building becomes due to heat insulation and strength members required. In any case, in heavily populated urban areas, multiple storey (vertical stacking) is unavoidable.

The loft type of building is very good for air conditioning and frequent student movement, i.e. changing of rooms for different subjects. Unfortunately artificial means would have to be employed to take care of any noise and odour that may be generated by building users due to the poor noise and odour properties of the loft type plan.

For ease of students shifting from one learning room to another during lesson changes with some spacing to
Sample Floor Plans

CORRIDOR

FINGER

COURTYARD

LOFT-OPEN

CIRCULAR - OPEN

CLUSTER

CAMPUS

MULTIPLE-USE
offset poor noise, odour and air conditioning costs, the cluster type may be chosen. This enables one to group related facilities in one area e.g. kitchen, messes and bars in the same cluster.

The campus type arrangement combined with the cluster should give the two worlds of nearness of like facility spaces and spacing. The campus type alone yields long distances of travel in-between locations. Students have to walk (or ride) long distances for short breaks and lunch periods. Depending on the size of the training facility, it can be inconvenient to have only the campus type. On the other hand, marine training facilities on para-military programmes, use the distances between campus type buildings to "double-up" trainees as a form of constant physical training routine. A cluster can also include any one of the other types and various clusters can be formed into a campus. This will be the approach in this paper.

PLANNING

It must be stressed that educational and architectural staff (consultants) will have to work harmoniously to produce the best possible general outlay and even individual room design to yield a maximum efficiency of buildings. All national, state and local rules as to educational buildings should be complied with. The educationist(s) will be incharge of programme specification and this will embody the number and type of spaces including those necessary for the instructional media needs projected. In addition, space utilization for economy (multiple uses) and relationship of spaces will have to be supplied by the educationist. Though no human can predict the future with certainty, fact based assumptions can reduce the error margin appreciably. The
architect then translates these specifications into the physical plans.

In general, a systems approach should be used where each building, room, facility and access-way will contribute to the overall goal as opposed to being disjointed and independent.

Though all buildings should generally be good looking and blend into the general scenery and background, they should not be "award-winning" but rather functional. The structural engineering should be undertaken by qualified competent people.

CLIMATE

Buildings should suit the climatic conditions. Cooling, either by outside air currents or air conditioning, and heating either by "body heat" or external source should all take air changes into account to prevent drowsiness and cold or heat exhaustion. The comfort zones of human beings in respect to temperature and humidity should be maintained. Where specialized equipment is installed, the manufacturers' specifications as to room conditions should be adhered to. Lower temperatures are required in active areas as compared to inactive parts. (An active area is one in which energetic work is undertaken by students as compared to an inactive area where students may sit and only listen to a lecture).

Heat pumps may be considered because they can be reversed during different seasons. Ventilation systems should be flexible enough to allow for 100% outside air and recirculation if and when the need arises. Most designers tend to neglect the heat produced by lighting sources but this can offset a well planned and constructed system.

Colours, in addition to their psychological effect,
have a reflecting and absorbing factor both for heat and light. This too should be considered.

Trade wind direction can be used with windows very economically. The sun rising and setting points during various seasons can be combined with trees for shade and heating (when leaves are shed). This can also cut down on lighting bills if considered in the planning stage. The trees can act as wind breakers if properly embodied. In the same vein, buildings' orientation to one another and the prevailing wind direction should prevent dust, obnoxious and distracting scents from permeating areas where mental concentration is demanded.

NOISE

Acoustics both for the rooms and the general plan is very important. Though the educational facility may be very remote from any external sound source, self generated noise can be a nuisance. A typical example is the power plant workshop containing a couple of medium speed diesel engines. This means some buildings must be removed from others. Sound barriers consisting of any one or combination of hedges, trees, earth-embankments and masonry walls close to the sound source can reduce the sound intensity at the protected area.

Concrete floored corridors acting as sound tubes for footsteps and coughs can be countered with notice boards of sound absorbing materials.

MATERIALS

The materials used in the construction work should be of good quality. They should also be durable and easy to maintain. Availability on the local market should be a must to prevent long waiting periods for replacements especially where foreign currency is hard to come by. One
must consider the initial cost for the available alternative materials and their running and maintenance costs.

ADAPTABILITY OF ROOMS

Flexibility in the buildings should be a must. With fast changing technology, educational facilities quickly become obsolete and incapable of meeting demands. It is therefore an advantage to erect buildings with all loads borne by the external walls. This leaves the internal partitions to be non-load bearing, making internal re-arrangements easy. This adjustability of room size can help the training facility modify room size and arrangement at a very minimal cost. Operable, folding partitions, portable or demountable walls can then be used.

The media for instruction too is changing all the time. Wiring in buildings should also be flexible. Some training facilities even allow over a 400% excess of required conduit piping to allow future additions and alterations without incurring expensive structural (building) modifications. These conduits, are to be in walls, floors and ceilings. This kind of treatment can also aid in complete shifts in blocks. An example is a case where an administrator’s or lecturer’s office is turned into a computer laboratory ten years after constructing the building.

The redundancy expressed here is very inexpensive, compared to the cost of the building. The utilities (wiring and piping) should not restrict space arrangements so conduits should be preferred to open piping and wiring.

Pre-fabricated buildings are becoming commonplace. The construction time is less and some are even re-locatable. "Portable cabins" in the form of containers
can be easily shifted about for small rooms. Some training facilities have a number of these containers combined to form units for simulation laboratories.

SAFETY

The outlets of the buildings are to be such that escape from any point in a building is less than forty meters. This is important for safety purposes. In countries where national safety regulations are more stringent than this, the national rules should apply. The escape in mind here is to the open air where the people will be removed from danger when there is a fire or similar hazard. Where a building is multi-storey, more than one set of staircase may be needed to satisfy this condition.

REQUIRED CLUSTERS

ADMINISTRATION

The Administration block (or cluster) for a maritime training facility, and for that matter any facility, will depend on the size of the facility and its organizational structure. A general guideline therefore will include staff offices, stores and lounges. These should be further broken down into principal's office (may be with a secretary's), assistant principal's office, general office, financial office(s), administrative office(s) and main lobby. There also need be one or two stores in the administrative block (cluster) for storage of stationery.

A sick-bay, conference hall and registrar's office may be found here depending on the size of the set-up and expected functions. A lounge may be provided here for staff relaxation.
The Lecture and learning (classroom) cluster should have enough lecture/classrooms to accommodate all the various classes for academic work. This block should include rooms for navigation, engineering, etc and for the different levels.

In general, the corridor type building with vertical stacking should suffice, but in hotter climates, only one half of this type can be built with the same vertical stacking because of air conditioning bills. The corridor turned into a verandah (and possibly one on each side) should take care of the sun’s glare and provide a cool shade round each floor.

Student Stations.

The maximum number of students per class should be predetermined to know the exact number of student stations to be catered for. As per Edgar L. Morphet’s "Measurement and interpretation of school building utilization", student station space varies from 0.76 square meters to 2.6 square meters depending on the type of furniture used by the students. For marine training where engineering drawings and charts are used, the higher space per student station should be provided. Morphet describes (in his book) an analytic method to compute the exact percentage utilization of a room and of student stations. This should help in determining specifications.

As student numbers can shrink (especially in marine training facilities these days) the movable partitions can be used to full advantage. With workshops and laboratories, the time table can be so arranged that a class (or two if enough classes) may always be in the workshops and laboratories to reduce the number of lecture rooms required. Improper adjustment of the education
programme to room utilization will yield very low figures when Morphet's criteria are applied. Periodic utilization analysis can help determine changes in the programme and/or building spaces required even when the training facility is in operation.

Interior Design.

The interior design seriously affects the adequacy of the building as to its use. A loss of teacher control may result if the room size and shape are not well planned. The teaching aids to be used in each room also should be pre-planned.

An auditorium, large enough to seat all students, should be included if such a gathering is envisaged. It may at times be designed to seat more if a larger audience is expected. This room has the lowest space per student station because of the type of furniture employed.

This lecture/classroom cluster can also house lecturers' private work or consultation rooms. Depending on conditions, there can be one or more lecturers per such private room and the rooms will be sized to match. Academic departmental heads may also have offices in this cluster. In cases where the training facility is big enough then each academic department may have its own cluster of lecture rooms.

LIBRARY

Storage of reference materials will be in the Library. This block should have a serene atmosphere for concentrated mental work. It should therefore be in an area with the lowest possible noise. Closeness to the lecture rooms will be an advantage for quick access but should be balanced with disturbances especially when students are changing rooms during a change of subject as
a lot of shuffling and "small talk" reigns. The library cluster should contain rooms (or divisions) for the storage of the collection, both for reference and borrowing, reading, contacting library staff and library staff office(s). The number of students, subjects covered and their depth will determine library size. The library may also be used as a storage facility for all teaching aids in cases where the maritime training facility is very small (less than one hundred and forty students).

LABORATORIES

In another cluster of the campus arrangement (or in the same lecture rooms cluster) may be situated the Laboratories. Electronics, digital technique, electrical, computer with word processing and pneumatic control laboratories may all be accommodated in this block. In addition, computer controlled simulation i.e. programmable, engine room equipment, navigation equipment (bridge) and overall ship may have a room each. On the other hand, they can be paired or combined in various ways in a room for maximum room space utilization. Some of these laboratories may take a room or more, for example, the navigation simulation may have a room totally devoted to radar simulation where three or more student positions (own ship) with an instructor's console may be installed and other simulators in other rooms. The rooms should be sized according to the equipment to be used in the learning process.

Thermodynamics, materials and chemistry (including fuel) laboratories may also be needed. The thermodynamics lab may be added to the next cluster - workshops, because of the high power equipment (e.g. diesel) which are noise producing. The training facility's tow tank (if a very small demonstration model) may also be located in this
Temperature, humidity and dust control may be required for some of the equipment in the laboratory. The building design and construction should therefore take this into consideration.

WORKSHOPS

The Workshops are where the heavy pieces of machinery (as compared to the light ones in the laboratories) are to be housed. Good general planning is required here for student supervision. Room should be made available for the various power plants, arc and gas welding and cutting, machine tools, bench work, pumps (and other auxiliaries) and refrigeration. The size of each station will primarily depend on the type of machinery and the room size will depend on the number of student stations. These stations happen to have the highest square meter space requirement. The circular-open or loft-open type plan or modification of either can be employed here to good effect.

The workshops are generally isolated from the other clusters because of the noise level. General maintenance shops, for the whole training facility, may be also housed in this workshop cluster. These may include carpentry, plumbing, painting and general works. There should be a tools store and storage facility for the various supplies necessary for the workshops.

The main power station or power distribution center for the training facility should also be installed here to enable the technical staff to have better access and in any case feed the workshops, as they are the largest power consumers in the set-up. Detailed planning of the interior of each workshop is a must. A couple of lecture rooms should also be provided in this cluster to enable
teaching staff to give an explanation to students before and even during the running of machines that violate audio threshold level limits. Offices and teacher working rooms may also be provided.

OUTSIDE WORKSHOPS

Some installations that may be classed as "Outside Workshops" are the fire fighting complex and the lifeboat station. Though all buildings are to be "safety" constructed and fire protected, parts of the fire fighting cluster should be constructed with fire resistant material. Provision should be made for smoke diving rooms, a storage area with machinery space, a briefing/de-briefing room and an office for the instructors.

The lifeboat station ought to be near the sea, river or lagoon depending on the site chosen for the training facility. This will be beneficial for boat launching and sailing practice. Where a training vessel is to be berthed at the training facility, a quay will have its rightful place at this point. Training facilities that have offshore training programmes may then embody the "offshore platform model" into this cluster. It is worth mentioning that an outdoor swimming pool may come under this outdoor workshops as well.

AIDS PRODUCTION CENTRE

The next on the list of buildings is the "teaching aids production center". Mass printing and photocopying room(s) at times can nestle in the administration cluster. On the other hand it could have a room in the other aids center. Where it is economical to make photographic slides, video films, transparencies and posters, the training facility should provide rooms for studios, darkrooms, stores, equipment installation and a repair
shop. Studios for sound recordings will need acoustic planning and visual recordings may need intricate lighting control and both combined in a single room will mean a combination of the two effects.

**ACCOMMODATION**

**Students.**

Students may be housed in a hostel on the training facility or in their various homes. A combination of both is advisable. Pre-sea (cadets) and junior trainees are to be housed in the hostel to enable trainers to inculcate in these students the discipline necessary in marine operations. Single cadets can be paired (or even grouped) per room in this hostel. The grouping of trainees (or pairing) is to instill team spirit in these trainees. Using the corridor or finger plan, rooms for each or the groupings of trainees, space for toilets and washing facilities and a porters' lodge or offices should be provided. A couple of rooms may be arranged as lounges.

**Staff.**

Staff accommodation may have to be provided if the training facility is far removed from the nearest urban area. As a minimum, accommodation should be provided for the Cadet Commandant (and assistants if any) who can then keep a watchful eye on the students. Other staff being accommodated on the compound will have the advantage of less commuting and rather more time for research work and student-staff interaction.

One-, two- and three-bedroom houses may be needed. Corridor type flats may also be built in addition to the houses. The number of each constructed and relative positions to other buildings will depend on the staff member to occupy it. As a rule of thumb, the Principal buildings
(or assistant), heads of departments, some of the lecturers, instructors and general staff will be housed on-campus. This selection will depend on job functions i.e. whether the person may be needed any time in the twenty-four hour period or not.

CATERING

For feeding purposes, where students are housed on-campus a catering cluster should be built. This facility will also help when work makes staff and students (non-residential) stay over during lunch time. This cluster should house the kitchen, food and catering stores, the serving area, the restaurant (seating area) and most likely a bar. At times, the restaurant may have a staff section cordoned off the students' section. Lounges can be arranged here for relaxation and/or reception. A small games room for before and after meal student interaction will not be out of place.

SPORTS AND GAMES

The climate and popular games in the locality where the training facility is located will determine what becomes part of the outdoor sports complex. The indoor games complex may be situated nearby.

UNUTILIZED ROOMS

All said and done, poorly located rooms must be avoided in all buildings. The more so for classrooms as poorly lighted, heated, and ventilated rooms are always under utilized. They tend to end up as "junk" stores. Remotely located and proximity to other rooms make some spaces unattractive and end up in neglect. Sanitary facilities are therefore to be well designed and stores appropriately ventilated to increase the quality of buildings.
adjacent rooms. Morphet in his utilization measurement book stresses good floor finishing, prevention of stuffiness and dampness as the negative effect of these is to drive both learners and teachers to seek better accommodation elsewhere. This in almost all cases may be offset by simple maintenance. If the buildings cannot be maintained, then they need not be put up in the first place. What is the point in spending money on a building when some of the rooms in it cannot be used?
The aims of the library will be to support the needs of the institution's teaching in the form of reference and research by acquiring an essential collection of information and literature in subject areas relevant to the institution's curriculum; and to serve the national marine industry where there is no such facility. It should also provide advisory service to assist students, staff and any others, to exploit the collection and other information sources fully and economically.

Such a collection will include among others, volumes, periodicals, newspapers, tapes, video tapes and transactions.

STOCK

The library base stock (and most others) should be acquired on recommendation by the faculty members. The onus of quarterly, semi-annually, or annually additions to the base stock should also lie on the faculty and the librarian. These people are to search book sellers' and publishers' catalogues and bibliographies to prescribe additions and replacements as necessary to keep the library current.

The stock is to supplement textbooks. In a small institution, the library can also be in charge of these text books. The stock also provides an aid to teaching, by offering references to all and a range of alternative and further reading for those who have the time and ability to explore some topics in depth.

For class reference purposes, multiple copies should be purchased. This will alleviate students queuing up for a particular volume due to a reference assignment given by
a lecturer. Putting limits on borrowing time (or reference only) may also help.

Though subjects dealt with in a marine institution will basically be marine, electrical and electronics engineering, nautical science and radio, it will be advisable to include material on management, finance, education, economics, law, etc., as all disciplines embody these subjects for fuller application of the discipline. The marine industry needs these even more as competition in the industry is now keen. Where there is financial constraint for acquisition of material in the above subjects, provision should be made for inter-library loaning, and for that matter all other materials not available in the institution's library.

There are over two hundred and eighty (280) periodicals which can be of use to any marine institution. If courses cover shipping, ports, shipyard, ocean-mining, fishing, etc. the list would be even larger. To subscribe to a wide range of periodicals will mean a handsome sum though most of them may be obtained through donations. Here is where the institution's library ought to double as an information source to the national marine industry as a whole. With the institution near the industry, graduates (working in the industry) can use this library facility to aid in their work and developments. If well organized, subscriptions from contributions from the industry can help the up-keep of the library. Periodicals carry recent developments and information. Most even have citations on volumes and other materials available. This source is therefore an invaluable one and should be provided for.

COPYING AND SECURITY

Photocopiers are becoming part of industry and even institutions. A library is therefore not complete without
one unless one wants to write out everything one wants in long hand and draw out complicated diagrams manually. Students and staff may be allowed free copying, a limited free copying or pay for all copies on the copier depending on the financial burden on the library.

It is important that the copier is not used to infringe on copyright regulations.

Books being taken away, accidentally or intentionally, is very common in almost all libraries. We therefore have to consider security (of materials) while discussing stock. The electronic surveillance system is becoming common in libraries. J.K. Roberts says in his 'Report on the Library of the World Maritime University, Malmo, Sweden of 1988' that "an electronic security system installed at the exit can be expected to prevent over 90% of such losses. It is more effective and less intrusive than manual forms of security". He goes on to add that "it is unfortunate and regrettable that it is the most used books which tend to disappear".

Physical preservation of the stock, apart from thefts, can be achieved by air-conditioning and the use of non-harmful chemical preservatives, in the form of insecticides.

STOCK MANAGEMENT

For economic and full stock utilization reasons, a form of cataloguing (most likely card by authors, titles and subject) will be essential. This must always be kept up to date. A record of borrowed material (may also be card system) should also be kept. These will make searches for particular materials easy.

A computer in the library will also be a real asset. A lot of computer based library management systems are on the market which are good for school libraries. They can
help with any combination of the following:
(a) stock lending and control
(b) recording loans
(c) automatic overdue notices generation
(d) book and periodical ordering
(e) inter-library loan request
(f) catalogue preparation
(g) budget control of orders and expenditure
(h) follow up of orders which are slow to arrive
(i) analysing patterns of library usage (with loan records as input) especially of over and under utilized areas of the stock.

A PC with a dot-matrix printer, connected to the telephone network via a modem can even expand the range of use. This can help with on-line searches for a small institution that cannot justify heavy investment in printed abstracts and indexes. This kind of terminal will put the whole world's database at the library's disposal.

ACCOMMODATION

Having dealt with the stock and equipment, one finds that the need arises to house this library. Going back to the aims, one immediately sees the criteria for library accommodation selection which are:

1) to store and preserve the stock of books, periodicals, etc so that they can be readily accessed by staff and students
2) to provide facilities for study, and in particular for work using the stock
3) to provide a place where students and staff may contact library staff for assistance with exploiting the stock and finding other literature and information
4) to provide a workspace for library staff to carry
out the various administrative procedures connected with the library's operation.

STOCK SPACES

On storage, shelving takes priority. Shelves should be arranged such that all material is easily visible (titles and/or call numbers), alleviating unnecessarily disturbing the arrangement. The shelves should also be so arranged that minimum noise is made with enough room among the various banks of shelves for ease of movement of patrons. Of course lighting should be adequate, especially where the lighting is installed in the ceiling. As mentioned earlier, labelling banks of shelves in large block-letters with the cataloguing as a guide should be adopted. The average height of a shelve is between thirty and thirty-five centimeters (30-35cm) with an allowance of 27 volumes per metre of length as recommended by the U.K. University Grants Committee. The shelve width can be anywhere between twenty-two and thirty centimetres (22-30cm). These figures do not preclude any special arrangement for peculiar material in the stock.

The volume to length ratio being the most determining factor, one must agree with J.K. Roberts that 85% effective capacity can be considered as full for practical purposes, and should be used in the planning stage. Space projections should be made for future stock additions, for example, if one thousand (1000) volumes are expected to be added a year for a two hundred (200) student school, then about thirty-seven to forty (37 - 40) metres of shelve length will be needed each year. Floor space for shelving should be about one metre square per hundred volumes.

Materials that are withdrawn should be kept in a "back-date" room or space. In an educational establishment, the need arises, once in a while, for such
material. This "archives" may be operated (where space is not available in the institution) in conjunction with the national library board which will (or should) have room for this kind of material.

STUDY AREA

In addition to the shelving area, study and work area too should be provided. The U.K. University Grants Committee recommends six students per work place i.e. one chair and 0.75m by 0.9m of table top space, occupying 2.4 square metres of floor space. This may be increased depending on the work load per student expected. This work space excludes seats and space for reading current issues of periodicals and newspapers. A set of chairs and standing room should then be arranged in another space for newspapers and periodicals, as discussions and "small talk" prevail in such reading areas which will temper with the atmosphere of the study area. A background of calm and quiet, conducive to concentrated study should prevail in the study area. Some libraries cordon off the shelving space for reference material and use the same as the study area.

WORK AREA

The circulating area is best near the exit, with the exit having the electronic security system. The author, title and subject card indexing can be near here for ease of access and cross checking with borrowed material. Table or counter facilities are to be provided with all other necessary equipment.

The office completes the accommodation spaces of the library. The various administrative jobs of the library are carried out here. Computer, printer, office materials, administrative files and other associated
matter are also housed here. The inter-library loaning, cataloguing and records are all kept in the office.

PLACE OF CONVENIENCE

Finally a toilet facility, though not a must, may be advantageously located near-by. Due care should be given to its positioning to safeguard the learning atmosphere of the library.
TEXTBOOKS

The 1968 Collins English Dictionary, edited by Patrick Hans, defines a textbook as "a book used as a standard source of information in a particular subject". From this then flows the fact that each subject offered in a training institution must have a "textbook" to aid students with this standard information for the subject. The textbook is to complement the lecturer (and other learning media) though there have been instances, mostly in the arts subjects, where textbooks alone have seen students through particular courses. The lecturer (or instructor) will also be using a copy of the same textbook the students are using.

CONTENT

The textbook should be selected with extreme care if it is to achieve its aim. As the textbook is basically meant for student use, the student should be the yardstick for any textbook criteria measurement. The entry and exit qualifications of the student to and from the course respectively must determine the scope and depth of the textbook. A too low or a too high a textbook standard compared to the curriculum will obviate the objective of the learning process. For instance layman's material will waste the time spent on academic work, neither can the students gain if the text is too technical to comprehend.

With respect to the depth and scope, the lecturer may need extra textbooks to cover a wider spectrum, with the selected book issued to the students lying somewhere in the middle of the spectrum. The lecturer will then be in a position to satisfy the special need of brilliant students wanting to know more, and the below average students for whom the lecturer may have to step down from
the average pedestal to give basic explanations. In the same vein, the library may have to stock a copy or two of each of all the textbooks the lecturer uses for students to reference and for further reading. But the students may be issued with only one of the lot. On the other hand, in a subject where a single textbook does not cover all topics, more than one textbook may have to be issued to the students. Particular guidelines as to which of the issued textbooks should be used as the base source of information for a topic will then be needed by the students. In a particular subject, different grades of textbooks may also be used at different stages from entry through graduation.

In addition to scope and depth, the treatment and arrangement of the material in the textbook is important if students are to use the book with reasonable ease. The organization of the content as to the development of ideas should be in logical sequence and flowing order. Inferences drawn should always be justified. The treatment should be topical or chronological, depending on the subject. The tables of content and indexes should be comprehensive and also easily referenced.

The language used should not be above the heads of the students. On this note, care should be taken when a translated book is being used, as translations tend to be the literal rather than the original meaning.

**FORMAT**

Well set out and clearly printed material is pleasing to the eye, which encourages the usage of the book by the reader. (Here reference is to type setting, page proportions which include among others, line spacing, margins and the background grid, and the book size for carrying and shelving.) In addition, the well set out
book helps recall of information both in the long and short terms. Good illustrations (diagrams), well positioned in the text, leave a more permanent imprint on the brain than a thousand words. Add to these a good paper quality and a good binding that can withstand the expected "fair" treatment of textbook by students, and one gets a close to ideal textbook with reference to the physical quality. In this respect, paperback textbooks should be absolutely discouraged. The possibility of reconditioning (rebinding) after a period of textbook usage should not be ruled out when discussing the physical qualities.

EDITIONS

Editions differ from reprints in that the text stays the same in the reprint though cosmetic changes might give the reprint a different physical appearance. Though a better looking reprint may replace an earlier one, it is not advisable to replace former copies with reprints unless age and usage have taken their toll on the old copies. With the same reasoning, a newer edition without "major" changes in the text may not warrant a replacement of the older edition with the new. As basic facts do not change over "short periods" of time, textbooks do not need replacing as often as publishers would like. The publisher's main aim is to sell books and so he is happy to churn out new editions with "minor" changes. Lecturers may therefore inform students of the necessary "minor" corrections needed to update the students' editions.

In spite of the foregoing, textbooks should not be too outmoded before they are weeded out. One solution to this irony is to allow students to keep their textbooks on graduation and the training institution to issue new students with later editions.
It is very advisable to identify books by their International Standard Book Number (ISBN) in addition to the author, title, publisher and date. This is because the ISBN clearly defines a particular edition of book.

THE TEXTBOOK SELECTOR

Textbooks are quite expensive and once acquired, are quite costly to replace. The onus then lies on the selector of the textbook to ensure that the textbook selected satisfies the needs of the training facility. The textbook selector must therefore have some basic qualities.

Though it is not this paper's objective to discuss the personnel to staff the maritime training facility, a word with respect to textbook selectors will not be out of place, but rather ensure that a good set of textbooks is used in the maritime training facility.

The faculty is "supposed" to be expert in the various disciplines offered by the training facility. The lecturers and instructors are "supposed" to be specialists in their individual subjects and hence knowledgeable in the subjects. These specialists are therefore the best judges as to the accuracy, reliability and authority of textbooks. Each subject lecturer is also expected to know the students in the class as to their reading and comprehension skills.

The lecturer (selector) must be familiar with a large portion, if not all, of available textbooks on the subject and in the grade of the students. This knowledge will mean the selector has reviewed all the books he knows and has a system of knowing and covering all current editions. The various authors' previous works and academic standing in the subject can both be knowledge that will enhance the selector's outlook when reviewing.

38 textbooks
Though knowledge of publishers and their previous works can be an advantage, the textbook selector should not depend on these alone as new publishers can also produce good work. The selector should be a fast reader and not depend on a publisher's blurb but rather his own review of the textbook.

Many lecturers accumulate a pack of notes and handouts on the subject they lecture on and refine them over the years. This accumulated material may find its way into a publishing house and end up as a textbook. There is no doubt that books of this nature can be very good. On the other hand, if such a lecturer is to select a textbook, he will invariably choose the one he authored. This brings in the last point in selector qualifications: freedom from biases. Biasness can be in the form of ideas, royalties, nationality, and sexuality among others. A selector should be objective.

To counter biasness and to ensure that a textbook is still used when a lecturer for a subject is changed, a set of guidelines for textbook selection may be drawn up by the training facility. One of these should be a lecturer selecting a textbook and another lecturer redoing the whole process to confirm the selection. There is a wide range of material to aid in this textbook selection process. An example of such material is the UNESCO report entitled "Selecting Among Textbooks". This report was prepared by the Educational Products Information Exchange Institutes.

**SOURCES OF INFORMATION ON TEXTBOOKS**

The faculty members, being experts in their fields, are supposed to read widely and keep abreast with developments through professional journals, magazines and transactions. Most of these publications normally have
columns on literature about to be, or just published.

Textbook publishers make announcements through leaflets which textbook selectors can use to know the latest textbook publications in any particular subject. There are also trade bibliographies which one can use to advantage. An example of this is the "Aslib Book List" published monthly since 1935 by Aslib Publishers of London. This monthly publication contains selected, classified list of new British textbook publications in science and engineering. Though most of the above sources carry reviews, the textbook selector should not depend on these reviews alone. The selector should in addition review the book himself (or herself) by asking for an inspection copy from the publisher. The inspection copy may be returned to the publisher without any obligation whatsoever. Of course a time limit may be set by the publisher and this brings in the selector having to be a fast reader.

One may also learn of newly published textbooks through colleagues in similar institutions worldwide.

To sum up, the textbook selected must meet the information needs. The users must all have copies whether issued by the training facility or acquired by the students through other means. The lecturer must also have a copy of the textbook in addition to a range of other textbooks that will enable the lecturer to cover a wider spectrum in both directions than the course demands. The textbook selector (who almost always happens to be the lecturer) must be knowledgeable in the subject matter and also have textbook selection qualities.
In every knowledge imparting and acquiring process, teaching aids are a must. They take various forms, from a simple chalk and board through audio visual cinemas to a complicated life size half a million tonne crude oil tanker. No matter the form and size, the main aim of a teaching aid is to help in achieving the learning objective.

Instructional materials, according to Henry Ellington in "Producing Teaching Materials" are used to:

"* Form an integral part of the main exposition by providing 'sign-posts', guidance for note-taking, illustrative material, etc
* Provide supplementary material (background reading, remedial or extension material, enrichment material and so on)
* Increase student motivation by introducing visually attractive, interesting or simply different material into an otherwise routine lesson
* Illustrate applications, relations, integration of one topic with another and so on."

These teaching aids are to be used because they are suitable and not because they are available. Neither are they to be used as time fillers for an ill planned lesson. Care and time must be taken in the planning and production of such materials. Invariably, some teaching aids will have to be acquired from outside the training facility and others made internally. Simple teaching aids can be very effective if carefully produced. They do bring understanding where at times a thousand spoken words cannot help the learners comprehension.

Ellington has divided instructional material into seven (7) broad groupings which are:
"1. printed and duplicated materials;  
2. non-projected display materials;  
3. still projected display materials;  
4. audio materials;  
5. linked audio and still visual materials;  
6. cine and video materials;  
7. computer mediated materials."

1. PRINTED AND DUPLICATED MATERIALS

The teaching aids production center of the maritime training facility should be able to print and duplicate all the necessary materials. An electronic typewriter or better still a computer with a printer can be the base for the first original copy. The complexity of materials to be produced will determine the capacity of the computer required. For word processing (up to a 20 page volume of material) alone, a one twenty eight kilo byte (128k) personal computer (pc) with a dot matrix printer will suffice. When complex engineering diagrams with colour are to be produced, then a 640k and above capacity computer should be planned for. Where a draughtsman is to work in addition to the production of engineering diagrams, a plotter capable of five colours minimum should also be installed.

Instructors and lecturers can handle the basic copy of their own teaching notes and thus three or more computers may have to be installed in a two hundred student training facility. On the other hand, if a computer lab is included in the training facility as discussed under laboratories (which is highly recommended) then the work to be done by this computer and peripheries can be moved to this laboratory as appropriate.

On the market are various programmes that can really
aid one in producing enhanced, complicated, well designed colour printed material. Different type sets and arrangements can also be achieved with some programmes. Advise from a consultant on this will be well rewarded rather than computer dealers who just want to market their ware irrespective of customer requirements.

The original copy thus produced (or acquired from another source) can then be run off on a photo copier rather than a cyclostyling (mimeograph) machine. If the machine that produces the first copy is a heavy duty machine, then it can be used to run off the number of copies needed. There are also programmable photo copiers on the market befitting this facility. Such a copier should as a minimum, have the following qualities:

a) able to produce double sided (or single sided by choice of the operator)
b) run off sixty (60) copies a minute
c) hold two thousand (2000) blank sheets in two or three feeding trays
d) hold 100 sheets (of originals to be copied)
e) magnify original up to one hundred and seventy percent (170%) before copying
f) reduce original down to sixty-five percent
g) give ten (10) hours continuous work per day
h) staple produced copies in two places
i) have an automatic alpha numeric display for fault and limit indication
j) produce transparencies for overhead projection.

Some of these machines take up to a metre by two of floor space and stand over a meter high. Air circulation is needed for the cooling of its internal working parts and due provision should be made during space allocation.

Though this copier should be sufficient, a second smaller copier can be installed as a back-up. This will
be used when the main one is being serviced or has broken down, though servicing can be undertaken without any inconvenience if production is well scheduled. The capacity of this machine may for example be a fifth or more of that of the main one. On the other hand, if small copiers dot the other buildings (offices, laboratories and library), then the second (stand-in) machine will not be required.

A cutter for paper with markings for exact dimensions should be included in the equipment in this "printing room". The two kinds of staplers, staple remover and perforators (matching file holes in the country) of the heavy duty types should not be forgotten. A simple heat binder, matched with the proper material, can help make into booklet form sheets up to one hundred and fifty. Beyond this number, external assistance may be needed.

Shelves and lockers in the printing room should be arranged around the walls for the storage of reproduction materials and records. A work bench for the small machines should be included.

Finally a shredder or similar equipment to reduce the size of "waste" and to dispose of excess examination copies or other proprietary information should be installed.

A twenty-five square meter space should be adequate for this room. As copiers work with a humming sound, the space should be isolated or insulated. The computer(s) (if installed in this complex) and the draughtsman's work-room of about the same size can be located next door.

2. NON-PROJECTED DISPLAY MATERIALS

Models, realia and dioramas forming non-projected materials are dealt with under "Laboratories" and "Workshops" (chapters 7 and 8 respectively).
3. STILL PROJECTED DISPLAY MATERIALS

Overhead projection has now formed part of the basic classroom equipment, especially in technical and higher education. With soluble pens, overheads can be used in lieu of the chalkboard. Permanent transparencies for such display can (mostly) be prepared in advance manually or with the aid of computers and photocopiers. Overlays for progressive disclosure can be effectively employed. The biggest advantage is the re-usability of these transparencies especially when prepared with water-proof overhead pens and then cardboard edged. A simple table and chair, a draughtsman's inclinable drawing board and instruments or a computer with graphics capability and a plotter may be all that is required.

Some overhead projectors use opacity. These are not very advisable as room darkening is a must when the material being projected is not reflective. In any case, only the projector is required here and material production is very minimal as original objects or material in already produced books may be projected.

Slides is another form of still projected display. It takes the form of photographic films mounted in cardboard. They can be singles, arranged in circular or rectangular carrier trays. These are good for camera taken photographs, but of course notes and hand made diagrams can also be put on these slides. At times, a set of slides can be mounted on one long cardboard to form a strip. Though re-arranging slides in such a strip is next to impossible it has the advantage of always being in the right order, right way up and does not scatter around when tipped over accidentally during usage. A slide projector may be installed per hundred students in the training facility.
Cameras, films, developing and printing equipment are needed to produce one's own slides. For a maritime training institute of the type being discussed, it is uneconomical to own such production equipment unless a photographic club is going to be encouraged among the students. It will be much better to have just a good thirty-five millimeter (35mm or similar) camera with a zoom lens and flash arrangement. The reel of film may then be sent to a slide specialist (out of campus) for developing and printing.

The office of the aids production centre or the draughtsman's workroom, can house the above mentioned equipment for still projected materials production. The overhead projectors are discussed under "Lecture Rooms" (chapter 6) as this is where they will be used almost all the time, though their repairs and spares may be in the aids production centre or the electronics laboratory.

With respect to audio linked to still visual, for a marine academy, the film slides would be more appropriate for an oral presentation by a lecturer. This is because the lecturer can be stopped at any time for questioning and clarifications. There does not seem to be enough use of the audio linked - still visual to warrant an installation to produce them. This kind of specialized aid is best suited for lecturing where the same lecture is presented with the same slides a couple of times a day without interruption e.g. introduction to tours.

4. AUDIO

Purely audio material may have to be produced where a language laboratory is provided in the training facility. English language is now dominating the maritime field world-wide. The International Maritime Organization
editing is installed then the same may be used for the duplication. In cases where transfer to another form of play-back other than the original is expected, compatibility of dubbing equipment must be given due thought before acquisition. There are recorders that are designed to do fast dubbing. It may be advantageous to acquire set(s) that can combine as many of the above characteristics as possible without sacrificing quality, efficiency and low running and maintenance cost. Professional advice will be well rewarded.

These sound recording machines will be housed in the main audio recording studio which should have a smaller room (with the microphones) attached, partitioned off with a transparent sound proof glass. The smaller room (about four square meters) should have an acoustically designed interior as, unlike human beings, microphones do not filter out undesirable background sounds. Two or three chairs and a table, to seat the required number of persons and hold written material being read, are to be provided in this room. The main room of at least twenty (20) square meters should in addition to equipment have shelves and dust proof chests to hold tapes (or discs) and files. Clocks and timers should also be provided.

If the training facility is doing special research on sound, then bigger rooms with sophisticated matching equipment will be required.

The running of the various forms of cable throughout the audio rooms is very important if the maze of wires are not to hamper work sessions. For the new audio production center, all cables are best concealed in conduits and as stated earlier, spare conduits should be built in for future expansion. Old facilities modifying a room into an audio recording center should also strive to conceal all such cables. Careful thought should be given to power

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supply points for the various equipment. Some may need to be brought in through the floor to the work points. At all cost, one should prevent personnel walking past from unintentionally unplugging a machine from the mains.

6. MOTION PICTURE (AUDIO VISUAL)

Eight, sixteen and thirty-two millimeter (8, 16 & 32mm) cinema films can be used in a maritime training facility as there are a lot of such films on marine matters. Film production is rather highly sophisticated especially when mixing sound and motion picture. It is therefore highly recommended to acquire such films and not to produce them in house.

Contrary to this, video tapes can be easily made with a very small sum and little (if any) training. Portable hand held video cameras with automatic focussing and programmed sub-titling are becoming very common and easy to handle. Fixed video cameras (classroom) can also be used to produce reasonably good movies to aid in teaching. These fixed types include a focusable camera on a tripod connected to a recorder, the whole set running on the mains supply. One (per 100 students) or more of such sets may be required depending on the work load of the production centre.

For editing purposes, two custom-designed video-recorders with a central control unit and monitors can be used. Compatibility of equipment in the video field is essential, considering the different systems available on the market. Careful consultation and planning will be needed before even a single piece of equipment is acquired.

In nations where commercial firms are producing marine video recorded teaching aids, it may be cheaper to get the recordings off the shelf rather than to produce
them. In any case, at least, a single portable camera
(with its own independent power pack) will be handy for
recording things of special interest.

The audio studio, if available, can double as a
storage room for the video recording equipment in which
case the room may have to be increased in size by some
five square meters. Otherwise a not less than seven (7)
square meter room will be needed. Shooting will then be
done in an auditorium, classroom or laboratory if filming
is done on campus.

Audio and video materials for students’ use may be
stored in the library as part of the stock. Those to be
teacher supervised should be stored in the various
departments or in the studio if enough shelving is made
available and there is the threat of dust damage in the
departmental buildings.

A video play back set should be provided per sixty
(60) students, depending on frequency of use. The play­
back sets should be mounted on wheels for mobility.

7. COMPUTER MEDIATED MATERIALS

In this paper, items under computer aided teaching
are dealt with under the various places where they are to
be used.
Learning activities are basically passive, interactive or active with reference to the learners. In passive learning, students put in very little physical effort. A teacher or piece of equipment (say a television set) will be doing the presentation and students, at best, take notes. Active learning demands a lot of physical action from students. This will involve cognitive, affective and psychomotoric qualities of the learner, i.e. learning by doing. The teacher will only be guiding. In between these two forms of learning is the interactive type in which there is a forward and backwards communication between teacher and learner and at times even between learners. Facts are interchanged, question and answers flow back and forth.

The classroom cluster should house lecture rooms, auditorium(s), lecturers' offices and rest room facilities. The lecturers' offices may be lecture room size but divided by movable partitions.

There should be enough rest room facilities on each floor. For each twenty (20) student stations, there should be a toilet bowl, a urinal and a wash hand basin all with taps to match.

The lecture rooms (classrooms) of the maritime training facility must take a very close look at the type of learning activity to be performed in the room. The active type of learning will be in laboratories and workshops (discussed in other chapters) and the remaining two - passive and interactive, will be accomplished in the lecture rooms. A model (small movable) may be brought into the lecture room for a particular demonstration but should not form a "fixed part" of the room setting. More
often than not, it is the lecturer alone who uses an aid (model) of this nature. Students may gather round this model for clearer viewing.

Maritime training institutes that use these lecture rooms for private studies as well should endeavour to provide enough table top space. Charts and blueprints, maritime drawing instruments and several books for reference are often used which will require plenty of space.

The lecture rooms should be large enough to accommodate all expected trainees during sessions. Lecture rooms clearly defined as to their occupancy at any given time is essential for smooth and efficient running of any training institution.

A writing board is a must in any such room. This helps the lecturer jot down things as they are discussed and allow reference in the immediate time frame. The sight is one of the best ways to imprint material onto the memory of humans. The writing board is therefore the basic and easiest means.

The writing board can take the form of a chalk board (blackboard which is these days becoming coloured green or brown to remove glare and reflection). They can be marked with dots at specific distances to enable straight writing and easy proportionate sketching. The chalk board may take up almost the entire width of a wall and students should seat facing this wall. Rollable or slideable chalk boards can reduce the width of wall necessary. The board should be at a height (about 2.2 mtrs from top and 1 mtr from base of board to the lecturer's sole level) that the lecturer can easily reach and still give students at the back unobstructed viewing. A raised podium, just in front of the board, can help in achieving this; though the podium should not be more than twenty-five centimeters.
A batten at the lowest part of the chalk board should be provided to hold chalk and duster. Part of the board may be metallic backed to hold magnetic models and signs.

Though dustless chalk is available (its dustfreeness doubtful), the marker board is gaining popularity when it comes to dirt with reference to writing boards. These marker boards are normally white and marker board pens (felt tipped) in different colours are used. A cleaner (duster) to match the pens are used for erasing. The marker board is generally preferred and is a must for rooms housing electronic equipment such as computers, tapes, etc that cannot tolerate dust. There is also the flip chart which consists of disposable sheets of paper mounted on an easel. This is quite expensive and is therefore used only when the material put on it is to be used more than twice. They are also extremely small when it comes to surface area.

Further, the head of an overhead projector may be used. Soluble felt tipped pens will be used on the platen of the projector. A piece of cloth or sponge will then act as the cleaner (duster). A continuous roll of acetate sheet wound across the platen can serve the same purpose.

Concerning overhead projectors, every lecture room in the training institute should have one as part of the standard equipment. Most overhead projectors operate on domestic mains. A minimum power of two hundred watts (200W) and maximum of four hundred watts (400W) may be required. Normally, these overheads use twenty-four volt (24V) bulbs, in most cases they are of the halogen type. They may be mounted on a trolley or in a student sized table. In any case, side arms or provision for keeping transparencies nearby should be made. The mounting of the projector should be such as to give an image which is high.

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equal in width at the top and bottom. This keystoning is prevented by making the axes of projector and screen perpendicular to each other. There are screens with special material to give special effects e.g., flow in diagrams from over heads. One should therefore select a projector and screen to suit the teaching requirements of the room in question.

The screen may be mounted on railings in the ceiling to facilitate drawing aside to enable the writing board to be used with the least inconvenience. Some screens too can just roll into the ceiling to unveil the board. A combination of both storing mechanisms will be the best. In lieu of these, the screen may be positioned in one front corner of the lecture room.

The overhead being a front (installed in the front of the room) projected form, must be well positioned to prevent obstruction by the lecturer when indicating items on the head. A portable hand held battery operated arrow pointer can help in achieving this.

There is also the opaque overhead projector (episcope) mentioned earlier. The power consumption of these machines are high (about a 1000 watts compared to 250 watts for the transparency type). They also tend to be heavier in weight. Though it has the advantage of being able to project directly from a sheet of paper or book, one needs complete darkening of the room which in some cases can be very difficult to achieve. With photo copying being very cheap and easy these days, it will be most economical to photostat the material straight onto a transparency sheet and then use the transparency overhead projector. All the same there is the advantage of using the opaque projector for enlarging material which can then be traced. One or two opaque projectors for the whole training facility should be enough.
On the rostrum in the front of the room will be the lecturer's table and a chair to match. A chair with arm rests, adjustable height, padded seat and back will be an advantage. The table should have about 0.75 square meters of top surface area and may have a set of drawers on the side for the storage of writing materials.

The students seating area should have tables and chairs, arranged in rows with walking spaces in between rows and lines to aid lecturer-student inter-action and ease of movement. The table top area may range from 0.38 to 0.75 square meters depending on materials to be used by students during a lecture. Figures near the high side of the range should dominate all lecture rooms if they are to double as private study areas for the students.

The size of the lecture room should take the student station area applicable into consideration plus a percentage for frontage. There is no strict area specification but the rule of thumb of between one to three square meters per student station will generally suffice.

A couple of cupboards may be built into parts of the walls for storage purposes. Their capacity should vary from one to a couple of cubic meters, depending on materials to be kept in them.

On the rear wall of the room should be located bulletin boards. Notices, special articles and posters to aid learning may be posted here.

Arrangement for room darkening (in the form of window blinds) should be provided in all lecture rooms.

Rooms, also lecture room sized, should be provided for student lockers. Each student station should have a locker capacity of at least 0.20 cubic meters. The lockers may be fitted with hangers and shelves. Where the provision made in the lecture rooms are not enough, more
space in specially designated locker rooms should be made available in the lecture room cluster for storage of materials not directly allocated to students. Corridors and verandahs will not be satisfactory for lockers.

AUDITORIUM

The auditorium in the lecture room cluster is the room in which all large sitting functions will be held. It should be large enough to seat the whole student body plus another percentage (about 20%) thereof. The exact size will depend on the expected crowd.

The auditorium should house, for front projection a transparency overhead projector and slide projector, and for rear projection a sixteen or thirty-two millimeter (16 or 32mm) moving picture projector. The slide projector may be doubled if a break in viewing will be disadvantageous with only one slide projector. The movie projector should be set in the rear, most likely in a smaller adjoining room which may also act as a store for tapes, films, etc. and conceal sound amplifiers and cables. The projected image will be thrown on the screen through a pigeon-hole (recess) in the rear wall.

The length of the auditorium will determine the luminous intensity of the various projection equipment. Definitely, these machines will be more powerful than those to be used in the classrooms. Power supply should be well designed into walls, floors and ceilings as the need might be.

Screen(s) for various projections should be sighted in the front and well aligned for full utilization of the screen area and prevention of keystoning. The screen may be set at an angle to the vertical, i.e. top inclined forward so that the axis of the projected image is perpendicular to the screen.
Microphones, amplifiers and loudspeakers may be needed depending on the size of room (more than 10mtrs from speaker). At least two microphones may be needed on the podium. They may have long extension cables. On the other hand, one fixed and another cordless may serve just as well. The amplifier(s) used must match the system.

The loudspeakers should be set in the walls with the acoustics of the room in mind. In a large room (more than 140 sq. mtrs), multiple speakers will be needed. These are to be positioned to prevent "words overlap" from two speakers to a listener due to distance effects. Echoes are also to be dealt with by good acoustic design. The moving picture sound track should be connected into this sound system. Where there are enough video recorded films on the teaching material, a video set may replace or be added to the movie projector. One can then opt for one big electronic screen in the front or multiple television display units supported from the ceilings round the auditorium. These television display units should have at least eighty (80) characters per line if they are to be used for computer demonstrations as well. This will prevent truncation of lines of data. For multiple display units, multiple outlet equipped video set or adopter will be required. Infra red, extended cable or any other form of remote control will be needed for sets that are not within easy reach.

In a training facility where more than one language may be used in the auditorium, (e.g. during seminars), provision ought to be made for translators' cabins with the various necessary electronics. Every seat in the auditorium will then be provided with a channel selection system and a pair of earphones. Each translator's cabin will be insulated audibly but visually and electronically linked. This system will mean more wiring with fixed
seats in the student seating area. The translators cabins should then be partitioned with glass.

It has already come out, howbeit indirectly (previous paragraph), that fixed seats may be installed. They should be well contoured and comfortable, most probably self folding when not in use. This will allow for walking room in between rows. To the arm rests should be attached writing tablet arms. These writing aid should be retracted into the arm rests when not in use. Where non-folding seats are used, enough spacing should be provided in between rows. The rows of seats may be arched with the rostrum as the focal point.

To prevent view obstruction, the floor of the auditorium may be given a very gentle slope (about 10 degrees maximum), the rear being at a higher level compared to the front. The legs of the seats will have to take this inclination into consideration. A seating to match this gradient may be "uni-legged" chairs or a row of seats mounted on a single "beam structure" which will then be fixed to the floor. At times the floor may be stepped in lieu of the slope. Each step may accommodate a row of seats. This second alternative has its problems of cleaning and the danger of tripping people over.

In such rooms where there will be large gatherings, with lots of electrical wiring, fire hazard should be given serious thought. Hydrants and portable extinguishers should be suitably located in and around the auditorium. Enough exits are to be provided remembering not more than forty meters (40m) from any seat to the nearest. These doorways should be wide enough, and well lit "exit" indicators should always be on when the auditorium is in use. This applies when even there is power failure. There should be at least three exits for any auditorium seating more than a hundred (100) people

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and each exit not less than a metre wide. The materials used for the furniture, etc., should have fire retardancy.

Lighting is of paramount importance. Facility for controlling the light intensity (dimming) will be far better than just an on-off switch. Just as in the lecture rooms, window curtains for total darkening is a must due to the visual aid installations.

The student-station area should be around zero point seven five (0.75) square meters for folding chairs. A percentage will then be added for aisle and frontage. For say two hundred (200) students, a seating area of about one hundred and fifty (150) square meters plus thirty (30) square meters for aisle and frontage will yield a one hundred and eighty (180) square meters of auditorium floor.

The rear projection and equipment room may be say twenty (20) square meters of floor area and each translator's cabin four (4) square meters. It is needless to say that for any number of translations, an extra cabin will be required for the translation control equipment.

There may be more than one auditorium. The smaller sized ones may be less sophisticated compared to the main auditorium. These smaller ones will be used for smaller gatherings. Where a laboratory is big enough for such smaller gatherings, it may serve as well and auditorium duplication can then be discarded.

OFFICES

Heads of department and lecturers' offices should be in the lecture room cluster. In cases where academic advisors are different from the above, their consulting rooms may also be located in this cluster.

The size of each office will depend on individual rank which also determines the work load and the
facilities required. A working table and a comfortable height adjusting chair ought to be provided in each office. Shelves and cupboards (filing cabinets if security is a concern) should also be provided in adequate volume for storage. A reception lounge may be arranged for each head of department.

A secretary for each department in the training facility will be an advantage where the student population is large. The secretary's office should adjoin the head of department's. A table top personal computer with printer, filing cabinets, shelves and furniture to suit should be housed in the secretary's office. An intercommunication system between the head of department's and secretary's offices may be arranged. Where the training facility is a small one, the principal's secretary can double up for all other secretarial functions. A secretarial pool may also replace the individual secretaries. The personal table top computer may be replaced by a work-station hooked up to main frame computers where the latter is the norm of the training facility. The individual lecturer's offices may also be endowed with computer facilities to aid the lecturers in notes and hand-out preparations and other necessary work. Of course the computer laboratory may be used to the same end. Each head of department's office should have a table top photocopier, capable of normal and transparency photocopying.

Some of the laboratories of the training facility, discussed elsewhere in this paper, may be located within this lecture room cluster. These will be the non-noise and non-odour producing ones. This will depend on the general outlay of the whole training facility.
The laboratory cluster is an important part of the maritime training facility. The extent to which the various laboratories are going to be equipped will depend on the entry requirements of the training facility. Where entrance level is low, basic physics and chemistry experiments will have to be performed to bring out the basic principles. On the other hand, a high entrance level will mean trainees are familiar with fundamentals and the equipment required will be in the upper grade.

The laboratory cluster should be the corridor or finger type floor plan vertically stacked. As mentioned earlier, the less noisy laboratories may be accommodated in the lecture cluster. Amenities for the laboratories are of utmost importance. Water may be needed in large quantities in some rooms. Power demand (electrical) may be high and varied in voltage and type (alternating or direct current). It may at times go down to unimaginably low figures, an example is power for electronic work.

"Noise" can also be a nuisance. It can be electronic, electromagnetic, hydraulic pressure or pneumatic noise. Computers, radio frequency transmissions, electronic and pneumatic control signals can all be disturbed by variations in various parameters. Serious attention should therefore be paid to these in the planning, building and equipping stages of the laboratories.

The laboratories, though outlined under different headings, may be combined in the same room depending on compatibility of equipment and utilization factor of each set of equipment. It is cheaper to buy mass produced industrial equipment and devices and then adapt them to
the specific needs of the laboratory. These modifications can be done by the laboratory staff if they are worth their salt.

Most items mentioned should be provided at each work station unless programmed otherwise.

CHEMISTRY AND HAZARDOUS MATERIALS

Chemicals and their reactions form a basic part of the marine industry: from chemicals being transported, through chemical corrosive effects on structures to the treatment of fluids like boiler water and sewage. For maritime professionals to deal effectively with this chemical field, the basic understanding should be acquired which implies a chemistry laboratory.

The chemistry laboratory can comfortably double up as the hazardous material laboratory as both are basically dealing with chemicals. Where the work load is high and different classes will be deal with different things at the same time, a separation in the two laboratories may be necessary.

In addition to basic chemistry laboratory equipment (see appendix 3 for examples), electronic weighing scales, AC and DC power supply, compressed air and also evacuating devices (for vacuum creation) should be provided. One may need the infra-red and ultra-violet spectrometers depending on the research capabilities envisaged. A chemical oven for drying out substances will aid some kinds of work in this laboratory.

For the hazardous experiments, students may not be allowed to use the chemicals and their equipment. These chemicals should be exclusively for demonstration and only instructors may perform these experiments with students as spectators. A couple of fire extinguishers must always be on the ready and all chemicals should be used in only very

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laboratories
small quantities. Good distances should be observed when dealing with explosives. The bench should have a protective cabinet built on it to seclude the experimental environment as far as practicable. A couple of sinks may also be so protected to allow for over-the-sink work. Toughened transparent glasses that can withstand heat and pressure waves and still allow viewing of the process should be used for this protection. Complete chemically protective suits should be provided. They will include helmets, face shields and clothing including shoes.

Exhausting of noxious fumes and mists should be arranged from the whole laboratory and specifically from the hazardous chemical protected experimenting areas.

Drenching facility (shower) should be provided in the chemistry laboratory for total douching of the body in case of a chemical spill or splash. An eye wash or fountain will not be out of place.

A distillation column and digital or analogue pH meters can help students to understand some of the principles in heating and cooling of fluids.

PHYSICS

Like chemistry, this laboratory will lay the roots of all basic principles. Dealing with matter, energy, motion and forces, the practical training to be acquired in this laboratory will help students cope with the complex physical effects in the marine industry. This laboratory should therefore be equipped in mechanics, light, sound and electro-magnetism. Experimental data may be fed into computer to aid repetitive calculations. Automated experimenting should be totally discouraged to familiarize students with various measurements and sharpen observation qualities.

Use of basic measuring equipment should be practiced

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laboratories
together with their calibration and error margins expected.

Different voltage sources may be required. AC ranging from 50V to say 300V and DC from almost zero to 50V will suffice. There may be only the national domestic mains provided and transformers and rectifiers used in supplying all the different requirements. Portable generators, electric motor driven, may also be utilized.

The distinction between physics laboratory and some of the other laboratories may not be well defined. A combination with another such laboratory under the same roof will therefore not be out of place.

ELECTRICAL

Electricity is the most common means of transporting auxiliary power from one point to the other on marine installations. Despite the good that this form of power supply is, it is very dangerous (fatal) if not properly handled. It is therefore a must to give practical training in this area before a mariner graduates from the training facility.

The electrical laboratory should have AC and DC motors and generators. A switch board (busbar) for power distribution should be found here. It may be a good idea to have some of the motors and generators sectioned and others with glass windows for viewing. The switch board, whether dead or live front, must be visible as well. Transparent material should be used for panelling. As these are for training, everything inside them should be easily accessible or as near to real as possible. The switch board must have the whole works including meters, indicators, switch gear etc. Paralleling should be manual though the automatic gear may also be installed for demonstration only.
Excitation control equipment, conversion and transforming devices together with load measurements should all be embodied. This will mean acquiring electrodynamometers and others.

Equipment should be duplicated as much as the number of student stations envisaged, though only one switch board is necessary for the power supply to the equipment.

Various colour coding (of materials), wire sizes and insulation materials must be given due consideration. This will give trainees the opportunity to learn the use of fault detecting instruments.

ELECTRONICS

The chip has slowly but surely infiltrated into marine science. Measurements, analysis and control of processes are quickly and efficiently performed by electronic circuits. Students in maritime training should be exposed to the working principles and then build upon these principles to deal with complicated electronics they will encounter as professionals.

This laboratory is basically for circuit building, monitoring and control. In this laboratory, various boards for mounting demonstrative circuits should be installed per student station. A wide range of resistors, capacitors, reactors and other circuit building components for basics should be made available.

Power supply with a range for electronic work must be provided. Each student station must have a power isolation switch. There should be provision for power and function generators. Oscilloscopes, counters, multimeters and other measuring devices should also be installed. In some laboratories, more than one student may work at a student station. The number of student stations will depend on the size of the training facility but a very big

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figure for floor area per student station should be used.

For advanced circuit building and project work analysis, computer(s) may be introduced in this laboratory. This is because complicated circuitry faults are difficult to trace with the normal instruments.

PNEUMATICS

Like the electronics laboratory, this will also be for control technology. Dry clean air is a prerequisite. Various valves, filters, cylinders, throttling devices, connectors, air vessels, levers/linkages, pressure switches and measuring equipment will be needed. Where there are electronic or electrical cross-overs to pneumatic, the necessary inter-connecting equipment should be supplied.

Various controlled parameters may be simulated in the pneumatics laboratory with respect to proportional, integral and differential or any combination thereof. These will lead to real life situations.

Circuits can be built up to pneumatically control any process. A typical example is the gradual build-up of an engine starting control system.

The electronics and pneumatics laboratory may require anything in the region of twelve by eighteen metre room (12m x 18m). But again, size of the facility (total number of trainees) is a determining factor.

MATERIALS

Knowing what material one must use for a particular application is one of the major steps in achieving a good end result. To make a good selection one must know the properties of the various materials and the qualities demanded by the job. The materials laboratory should give the students the practical knowledge so required.
Tensile, fatigue, hardness (Vicker's diamond) and impact (Charpy swinging pendulum) testing machines should all be located in this laboratory. Microscopes for inspecting fractured and measuring dented surfaces are a must. Though most of these machines would be manually operated, electronic hook-ups for graphs and print outs may be installed for research work. A heater for temperature effects studying may also be embodied.

Samples for the above mentioned tests may be produced in-house (machine shop) or bought externally. Internal production of samples may be cheaper if also used as a studying assignment by the trainees.

Jobs done by students in the "Workshops" may be brought into this laboratory for non-destructive testing. Equipment for crack detection should include the magnetic particle (magnetic flux source and filings), dye penetrant, ultrasonic and possibly X-raying. The last should be installed if the maritime training facility is likely to get involved in research work for the maritime industry.

For the magnetic particle tests, the direct current produced by the arc welding transformers may be used for the magnetic flux generation. With the ultrasonic tests, special equipment consisting of a probe (transmitter/receiver), an ultrasonic (frequencies above that of sound) producer and an oscilloscope electrically hooked-up should be acquired. This set can detect some faults in welds and can be used for plate thickness measurements as well. Limitations of each piece of equipment should be highlighted to the trainees.

Pressure testing of vessels (bottles) can be performed with compressed air (not more than 7 kilos air pressure to be employed). On the other hand, water (or oil) may be used in conjunction with a hand pump.
Hydraulic testing is advantageous as a rupture in the test vessel will not cause an explosion due to the comparatively non-expanding property of water.

THERMODYNAMICS

Heat and work forms the basics of thermodynamics. All engineering applications of one of these energy sources invariably gives rise to the other. At times, the science is to change one form to the other. This is why the marine engineer has to be well versed in this subject theoretically and coupled with the practical aspects which the thermodynamics laboratory should provide.

A small sized boiler may produce steam at a given pressure for measurement and not for application purposes. Thermometry, throttling and separating of steam may all be analytically dealt with in this laboratory. This small boiler may be electrically fired (or oil fired) and all other systems made as real as possible though on a very small scale. Automatic feeding, nuzzling and heat transfer (insulation) can all be studied with this equipment.

The bomb calorimeter and combustion experimental kits will help with determining all parameters including air sample analysis.

In this laboratory, fuel analysis, viscosity measurements, compression of gases, and other affiliated experiments should take place. Heat exchangers too may have their place here for heat transfer studies.

A propane operated gas turbine may be installed for study work. This may be a very small working model. If a steam turbine is required, it may be incorporated in the thermodynamics workshop where the heavy duty power plants are. On the other hand, a small working model (though very inefficient) may also be installed in this laboratory.
FLUID DYNAMICS

This room of about fifteen meters by fifteen meters (15m x 15m) is recommended to house various pipings and trunkings. These flow passages should have venturi meters, gauges for pressure drops, tanks and restrictions and various forms of sensors for measurements. Different weir and orifice sizes will be needed for the training in fluid dynamics. This insight will aid the trainees in their future professions.

There should be various pumps (centrifugal and reciprocating) delivering against given heads and sucking from different pressures. A working model of refrigeration plant (vapour compression type) should also be installed with quite a few transparent piping, valves and parts. The refrigeration plant may have as many measuring points as practicable for close study and analysis.

Viscosity, pressure drops and resistance to flow measuring devices should all be embodied. Siphon effects may be demonstrated with simple equipment.

HYDRO-DYNAMICS

Though dynamics is the name of this laboratory, a couple of static experimenting kits can be housed here in addition to the dynamical ones.

About ten to twenty (10-20) stations of zero point five by one meter (0.5 x 1m) aluminum tanks with ship models to march tank size should be provided for static tests. These tanks, about 0.5 meters deep when filled with water will be used in demonstrating heeling, trimming, sinkage and waterplane area effects when the models are loaded. Calibrations on both tank internal walls and ship models will aid in these measurements.
Provision for metacentric effects should also be made. With a bit of ingenuity, these models and tanks can be produced in the training facility. The models may be constructed with aluminum, wood, fiber glass, steel and any other suitable material. Whatever material is used, protection should be considered. This is particularly true for steel and wood if the ship models are to last any appreciable length of time.

Similar but a little bit bigger tanks are required if offshore rigs will be used as models.

TOW TANKS

For very elementary towing experiments, simple tow tanks may be provided. These tanks should be up to three metres (3m) long each and models be in the region of zero point two metres (0.2m) in length. The models should be arranged to have towing strings with weights running over pulleys. The tanks should be mounted high enough to prevent the weights from hitting the ground. Simple arresters may be used to achieve this.

The bigger tow tanks may be one or two in number depending on whether the training facility is dealing with undergraduates alone or post graduate and research in addition. In the first instance, a tank of eighteen meters by one and a half meters and one meter deep (18m x 1.5m x 1m) may supplement the simple tow tanks. It should have a carriage on railings and a control station. A wave maker (compressed air type or cam operated matted metal) is recommended. To obviate wave echoes from tank walls affecting experimental values, rafts should also be installed at one end of the tank (opposite the wave maker) to absorb the energy of the waves.

The control station will house the computer to which all measured signals will be input. Sensors strewed over laboratories
the model with lead cables into instruments will measure stresses, pressures, flow patterns, etc. as required.

For postgraduate and research purposes (for example for a near-by shipyard), a tank of at least forty meters by three meters should be planned for. This should have more sophisticated equipment with better accuracy. The depth of this tank should be in excess of 1.6 meters noting that enough bottom and side clearances will be needed to offset "suction effects". If the tank is very long (over 100m) then correction for the earth's curvature will have to be made in the railing.

Models used can be made out of fibre glass but mostly wood for ease of manufacture and correction. Various provisions can be made to test or verify things. Examples are bulbous bow attachments, propelled tests, appendage effects and interchangeability of fore and after bodies.

A model building shop may be needed unless the machine workshops are going to perform this function as well as the normal duties ascribed to it in this paper. For big tanks, cranes for model movement to and from the tow tank area and a model entry point should be provided. A basin for hook up of sensor leads and inspection should be made. The point of attachment of model to carriage is important as the total power required to tow the model will be measured here.

WATER TUNNEL

A flume tank (water tunnel) with transparent windows should also be built in this facility. Trunkings for studying under water bodies such as fishing gear (weighted down, buoyed up, etc.) are recommended. Studies on propellers, rudders, submarines and missiles, can also be made in this tank depending on sophistication level required. Buoying materials and shapes too can have their
behaviour in currents monitored in this flume tank.

The pumps to circulate the water should be matched to water speeds expected to be used in this water tunnel with attention to the fact that corresponding speeds are used in model experiments. All high speed modelling may be conducted here.

The whole hydro-dynamics laboratory ought to be sheltered from the elements as they can have an adverse effect on the measured values. The size of the hydrodynamics laboratory housing will depend on the size and number of tanks installed. All the same, enough room must be allowed for all the different maneuvers and movements the experiments are going to entail. For post graduate work a hydro-dynamics lab area of about four hundred and seventy (470) square metres may be required. On the other hand undergraduate work may be provided with only two hundred (200) square metres of floor area.

Care of the water is a must to prevent marine growth and frequent water renewal. This treatment may be chemical or just simple exclusion of sunlight from the tank environment. It is advisable to use fresh water in the tow tank and the necessary corrections applied to the results obtained.

The towing tank is one area the maritime training facility can make some money for itself, as well as train the students. Research can be undertaken for outside organizations on paying basis. In this respect, it is advisable to install a big tow tank in the region/excess of one hundred metres by six meters and four meters deep (100m x 6m x 4m).

LANGUAGE/COMMUNICATIONS

The purpose of the language and communications laboratory is to aid the teaching of English as a maritime
language and the use of the various forms of communication media in the marine field. The aids production center's audio studio might produce the taped voices for the main learning in this laboratory.

For the language part, there should be an instructor's console controlling the various student consoles which should be housed in cubicles. The front part of the cubicles should advantageously be of transparent material for viewing the instructor who should be facing the trainees. The other two sides of the cubicles may be constructed with opaque material. The fourth side need not be closed. Each station should have a tape recorder/play back with controls. Earphones and microphones with hook ups may complete the set. The instructor should have the option to address the whole class or individuals and control replies to the same effect. The cubicles should be numbered for identification purposes. The recording facility will help to play back for revision, repetitions or whatever useful end it might be. It can also aid students in proceeding at their own pace.

VHF transceivers may be installed for practice purposes. Portables (walkie talkies) may be added to give trainees practice in the usage of this item. Telephone systems, morse transmission and receiving and most probably signal lamps also may be installed. Where addition of all this equipment will complicate the laboratory setting, two rooms may be allocated, one for language and the other for communication.

There are times when typing lessons may also be taken in this language laboratory. This will be determined by utilizing just ordinary type-writers or computers. In the latter case, the computer laboratory will be used for the typing practice.
A writing board, overhead projector and screen should also be installed in this room.

Language cubicles take a bit more floor space than ordinary tables. Because of this, a student station area above two (2) square meters should be planned for. With twenty student stations, an area of forty (40) square meters plus about fifteen (15) square meters for frontage and in between row spaces will yield about fifty-five (55) square meters of floor space. This figure should be increased considerably if other communication equipment is also installed in this room.

COMPUTER

In this age of computerization and advanced technology, every maritime training facility will need a computer laboratory if the graduates are to function effectively. In addition to computer applications in science and technology, secretarial jobs are rendered far easier and faster with the computer as a word processor. Ship automation, cargo work, financial analysis, personnel records and management use computers for speed and efficiency. Trainees should therefore be given lessons in at least computer programme utilization. Hence it is recommended that the computer laboratory be equipped with terminals or work stations.

Personal computers (PCs) with capacities big enough for big programmes such as ship designing (in graphics) should be installed. Each should have a capacity of not less than one thousand kilo bites (1000K) unless some will be intended for low capacity work. Two disc drives for each set is recommended for ease of loading programmes. Of course, hard disc facility to increase capacity above one point five mega bites (1.5M) will be required if advanced computer aided designs are undertaken. Only one
disc drive then needs to be provided.

The display units should always be more than fourteen inches (14") to prevent eye fatigue. They should also be coloured to aid in graphics work. A couple of dot matrix or lasser printers will be needed noting that the lasser printers are faster and give a finer printout but a bit more expensive. The work load of the laboratory will determine which type of printer to install. Mouses and plotters (with at least four colours) should also be provided. There might be an instructor's machine or any one of the student's may be used to the same effect. A big display unit, not less than thirty inches, should be mounted from the ceiling for instructor's demonstration.

It must be stressed at this point that all computers and their peripheries should be compatible. It will then be easy to use programmes on any set and they can "talk to each other". Installing one brand of machine will make spares easier to control though one should not forget that the supplier's prices for spares might then be un-negotiable.

In contrast to personal computers, main frame machine(s) may be provided in an appropriate room and work stations installed in the necessary buildings in the training facility with the computer laboratory getting the needed number of student stations. This may arise where the total number of computers in the whole training facility exceeds forty (when the economics of the main frame may outweigh the PCs). There will then be wiring to match. This setup can give unlimited working capacity (compared to the PCs) per work station. Various forms of hard copy production will then be needed together with backup copies.

There is a third option. The training facility may rent computer time from a big computer center out of the laboratories.
training facility. To accomplish this, there should be a telephone link, a modem and a training facility network. The network in the training facility will consist of a computer main center machine and work stations linked by wiring. The peripheries will still be needed in the facility.

One will have to do a cost analysis, consider conveniences or otherwise before selecting any of the above mentioned three modes.

Temperature control will be needed if very powerful machines are installed in one room. Cognizance should be taken of power failure. A temporary back up power system (battery) may be installed to help "save" any work in the memory when there is an unscheduled blackout. Audible alarms should be arranged to give a "save" warning.

Because of the numerous wires running back and forth in this laboratory, conduit and fixed tables (or worktops) should be given the necessary thought. Portable extinguishers fit for electrical fires will be needed here.

It is recommended to install one computer terminal per seven students in the computer laboratory. Where students are issued computers as standard supplies, this number may be reduced. The utilization factor may also change the total number required. Each computer terminal should be allocated four (4) square metres of floor space in the laboratory.

NAVIGATIONAL AIDS

Apart from learning to operate navigational aids, the underlying working principles of these aids will have to be learned by the trainees. The aim is for a fuller understanding and most likely knowledge of repairs and maintenance of this equipment. For this matter, old
equipment with the basic working principles should be installed in this laboratory. They can be acquired at a moderate cost from ships being scrapped. The trainees are going to "play around" with this equipment.

Cut-away views, dismantлеable and handleable aids is to be the objective. This equipment should include, among others, magnetic and gyro compasses (with repeaters), speed log with sea connections (tubes), radar with antennae and echo sounders. All these should be full size working models. Depending on student population and scheduling, equipment may be in multiple copies. All working parts (intestines) of this equipment should be visible, at least after dismantling. Any damage caused by students' ignorance should not cause any harm.

In this laboratory may also be installed working models of radio transmitters and receivers, radio navigation equipment, electro-mechanical hook ups for auto pilot and typhoon as found on board. There are also to be practice models for students in troubleshooting and repairs.

Where the above machines are duplicated, it will be advisable to have working ones as well as non-working. These will help students to learn the effects various mal-adjustments and settings have on the signal output.

SIMULATION

A simulation laboratory allows a trainee to make a mistake without causing any economic loss or hazard to safety. The simulator also reduces the time span of the operations. An example is raising steam in a boiler. In real life, it may take not less than four hours. The simulator could do the same thing, through the same number of operating sequence and procedures, in ten (10) minutes. A ship can be brought to stand still in five minutes from laboratories.
twenty (20) knots when simulated. The same effects and feeling are given to the trainee but compressed into a small time frame for learning purposes.

A computer forms the main brain of any simulation process. There is then the programme (software) which may be permanently installed (pre-programmed) or installed when using (programmable). The signals from the computer, depending on the interaction of input signal and the programme, are then fed into various items for display and actuations.

There is therefore the possibility of the maritime training facility assembling its own simulators from acquired components. Some of these components may be acquired in sets, e.g. computer, television display units (or liquid crystal display units), mimic boards, etc.

It is advantageous to put together a simulator like this because repairs and maintenance will become easier as the repairer also happens to be the builder. There are a lot of expensive simulator sets (and for that matter other expensive equipment) lying idle in various institutions because of a minor defect which needs an expatriate repairer. In a maritime training facility, where students undergo training to repair and maintain, in some cases design complete set ups, there is enough knowledge and manpower (if properly harnessed) to tackle this kind of job.

Simulator assembling will need time, coordination of various human resources and pure hard work. The finished work will be the pride of the team and it is well known that this team which has put so much work into it, will ensure that the simulator is maintained to achieve its teaching functions.

Of course if money is available (which most training facilities do not have) and time is limited, then buying
The complete set, including installation, will be best. The instructors will then have to undergo troubleshooting courses for repairs, otherwise high down-time must be expected. There are companies that have gone deep into simulator production and any of the good companies can meet any demand of a maritime training facility.

These days virtually any process can be simulated, sound, vibration, scenes on screen and heating. Port facility, berthing, cargo arrangement, engine behaviour among others can all be simulated. The maritime training facility can earn some money by doing some of these simulations for outside organizations.

RADAR SIMULATOR

A personal computer controls this kind of simulation. The capacity of the computer will depend on the number of ships and targets that will be simulated.

At least four ship student stations, each with radar display unit should be installed. Each should be capable of tracking at least twenty targets at a time. The control of the exercise will be from an instructor's console which has the capability of looking at each student station display on its own (instructor's) display. A plotter installation or any form of tape should be able to record the exercise to enable analysis after the exercise. In some cases, a simple video recorder, filming the instructor console's display may suffice.

The individual student station should have the full set of real radar control knobs (tables) with their effects being equal to real life situations when actuated but in a shorter time frame.

The instructor must have the capability of moving ships and targets to simulate real life situations.
SHIP HANDLING

The ship handling or bridge simulator (as it is sometimes called) is a very helpful tool in the training of pilots and ships' officers. From the fact that some certificating authorities give remission of sea service for training with this kind of equipment goes to show its effectiveness in training.

Like all other simulations, the size and type of ship, the port or coast and the disposition of targets and their movements can be changed to suit any particular mode. This is achieved by changing the computer programme and the panoramic films being projected (or electronically screened). It is therefore better to have this simulator than a ships' bridge as a ships' bridge and outside conditions can only be changed at a very high cost. (Of course a training vessel has its place.)

This simulator should be exactly like a ships' bridge setting. There should be a wheel for manual steering, auto pilot arrangement hooked into a gyro compass system, magnetic compass, two sets of radar, course indicator, engine controls with indications and alarms function. In addition, there should be rate of turn indicators, echo sounder, whistle, navigational lighting, visual radio direction finder, satellite navigation equipment, speed indicating log, VHF for communication and a chart table (may be electronic). All these instruments should advisably be hooked up to the computer and to help in giving the trainee the effects of the various actions (or inactions) that he takes.

At least a two hundred and twenty (220) degree wide outside panoramic view should be provided by projections onto screens set into the "windows" of the wheel house. Into this panoramic viewing will be incorporated the ship motions, e.g. rolling and pitching due to sea state. This
view should also embody confined waters, maneuvering and berthing for pilot training.

Together with the computer programmes, the tasks on the bridge will determine the number of student stations. Due to the heavy cost of such a simulator, only one need be installed in the training facility and trainees preferably work in teams at a time.

Up to thirty (30) ships in the locality may be simulated. This will be controlled from the instructor's console which should be situated behind an enclosure "behind the bridge". The instructor should have the capability of seeing but not be seen by the trainees on the bridge. On his screen will be displayed all the tactical situations and moves executed by the trainees.

The simulator should have the capability to run a pre-programmed exercise, a free exercise or a play back of a recorded exercise for reviewing. This means there should be a recorder installed in the system.

Some ship handling simulators are combined with radar simulations. In such cases, there may be say one bridge, not less than three (3) own ship cubicles with radar gadgets, an instructor's console and an electronic room (with the computers installed here).

ENGINE

The engine room simulation laboratory can go a long way in training people for shipboard and shore based power plants. It is recommended that the laboratory have the appearance of an engine control room with all the necessary mimic boards, panels, switches and push buttons. Depending on whether a steam or diesel plant is being simulated, a programme with particular characteristics will be installed in the computer.

The laboratory should have the main engine(s)
controls with all the attendant measuring and indicating equipment located in the central part just as in a real situation. All auxiliary machinery starting, stopping, controlling and indication should also be in this panel. Then the electrical power switch board may be located behind the operator (when seated or standing facing the central control panel). This switch board should be capable of paralleling, load sharing, overload protection, under voltage tripping, earth fault indication and all other functions expected of a real electrical switch board.

Simulation for fire alarms, deviations in temperature, pressure, speed levels and critical situations, together with starting and running malfunctions are recommended to be incorporated.

Everything should be very close to real. Sound tracks can give the feeling of machinery stopping and starting (these should be real life recordings).

A dummy engine room may be included in this laboratory. In the engine room may be installed some "engines, boilers, pumps, pipings and valves, air trunking with fans" and so on depending on the size of room and effects required. Electrical heaters in trunking can yield a heated engine room. Light flickering can simulate fired boilers while unbalanced masses rotated by a small electric motor can give a vibrating machinery effect on deck plating. "Valves" may have limit switches which will in turn control indicators and functions pneumatically. Some faulty modes will need to be "rectified" in this dummy engine space.

The instructor’s console can introduce faults in the system which trainees will have to trace (and possibly rectify). It will be interesting for a group of trainees to watch some counterparts at work from the instructors.
position. They will then understand how they respond and how to control their actions when they are in the control room.

This laboratory may also double for control fault diagnosing especially with the electronic card circuitry system. Some pneumatics may be incorporated.
WORKSHOPS

Though professionals gain knowledge and experience while in the field, it is worth giving trainees a foundation on which to build their knowledge and experience later. One's attitude towards a profession is normally set in the initial contact stage with the profession. It is therefore highly recommended that the maritime training facility gives the best possible foundation in the career of the marine professional. For cognitive and psychomotor developments, the workshop is the environment that can meet this need.

The workshops and laboratories are difficult to distinctly demarcate. In this paper, the workshops are those areas housing the heavy machinery, noise producing equipment or any others that are housed outdoors (which in themselves are also not well defined). In effect, one has to position equipment in the most convenient way.

In training facilities, workshops are designed to complement theoretical work with practical exercises as much as possible. This means that the extent to which workshops will be equipped will depend on the graduation certificate attainable in the training facility. However, every maritime training facility should cover the practical aspects in metallurgy, machining, bench work, pumps and piping, refrigeration, seamanship, etc.

The workshop cluster should be situated at least two hundred metres from any of the other clusters. Guidelines as to sound insulation as outlined under "Buildings" (chapter 3) is of utmost importance if other learners are not to be disturbed. In training facilities where this isolation is unachievable, the materials used for building construction ought to be non-sound and vibration transmitting. The equipment should be mounted on workshops

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resilient foundations.

This workshop cluster should be made of (or a modified form of) the circular or loft open type floor plan with some adjoining lecture rooms. The number of spaces will depend on the number of each type of equipment to be installed. There should be no vertical stacking in this cluster. This is because the machines are heavy; extreme strengthening in the floors and columns will be required if serious structural (and equipment) damage is to be prevented. Exhausting and air changes in the workshop cluster are a must to rid the environment of heat and fumes. Exhaust funnels of engines should be centralized with flap valves and flexible trunkings from each smoke producer to the main exhaust. This will ensure clean air in workshops and still prevent a maze of chimneys sticking out of roofing and sides of buildings. On the contrary, engines with thermodynamic measurements should have their own individual chimneys so as to get the right exhaust gas back pressure values.

Skylights and lighting installation should be well planned to complement each other. Fluorescent lighting based on frequency should be discouraged in areas with rotating machinery. This is because the rotating machinery might seem to be stationary due to a stroboscopic effect.

Wide aisles and passageways should be provided between rows and lines of equipment. For un-obstruction, these passageways should be clearly marked and must be at least one metre wide. For safe operation and maintenance, ample working spaces around equipment should also be provided. The workshops have the highest student station floor area because of equipment sizes. This can be as high as eleven (11) square metres per station for certain types of machinery. Also for safety, all rotary parts
must be equipped with guards. Rotating parts that have to be visible should have transparent shields. Fire fighting equipment ought to be located in easily seen and accessible positions. First aid cabinets should be well stocked especially for treatment of cuts and bruises. Though noise levels ought to be as low as possible, ear muffs should be available at several locations in the workshops.

Apart from very heavy machines like lathes, shapers, millers, big diesels, etc., most machines and equipment in the workshops may be mounted on wheels. This will facilitate ease of movement, re-arrangements and renewals. Each of the equipment that has been sectioned for demonstration should be provided with a mobile trolley.

Changing rooms tend to be dirty and littered. Sinks get mucky when located in changing rooms. It is therefore advisable to position sinks in the workshop proper (not in changing rooms) where an eye can be kept on trainees. The trainees will then, hopefully, keep the surroundings clean just as they do in the work area. Boards capable of rotating through ninety degrees (90 deg) in between vertical stands can double as seats and demarcators for aisles. These boards may be about fifty by fifteen centimeters and three centimeters thick. They may be synthetic or wood.

In the tool room, there should be shelves fitted with hooks, drawers, etc. Each single tool in this store should be tagged and have an allocated position. The tags can be (like coins) used against one’s name any time one borrows from the store. At the end of the day, a glance at all shelves will tell one immediately the tools that have not been returned.

A spares room should be provided. This room should have shelves with different spacing for different sizes of workshops.
parts. The spare parts tally may be computer based if the stock is in excess of forty different items. There should also be a store for materials used in the workshop practice exercises. Rods, bars, plates, slabs, pipes, etc of different materials must all be neatly arranged for ease of identification and selection. Storage of consumables (such as oils) and expendables (like rags, emery clothe) should all be catered for in the workshop cluster.

BENCH WORK

Introduction to and practice in the use of hand tools can never be over-emphasized.

Benches to which vices are fixed should be basic equipment for every workshop complex. There should be heavy duty vices and light duty ones. Approximately two metres of bench length should be allotted to each vice. A bench of one and a quarter metre width or more can accommodate two rows of vices, that is a row on each edge of the bench. In some cases, guards of soft metal (e.g. copper) will need to be provided for the vices to prevent job indentation by the vice jaws' gripping marks. Some vices too may be the swivel-lock type.

Cutting and shaping tools for bench work should be provided. Examples of these tools are listed in the appendix of this paper (appendix 4). Hand tools for marking, pushing and screwing duties are the tools one should plan for among numerous others.

For measuring, the workshop tools room should store steel rules graduated on both sides and other types of rules such as hooked and fillet. Depth and height gauges should be provided. Normal and vernier calipers (inside and outside) together with inside and outside micrometers can help in performing precision work. Where precision
measuring instruments will be damaged by humidity and sea salt in the atmosphere. A thin oil film may be smeared on them or they may be kept in desiccators. Protractors can be the vernier bevel type.

In laying out work, the marking table is of importance. This table will be flat, steel topped and set absolutely horizontal with a wooden or metallic cover to protect the top surface when not in use. Scribes, punches, different types of dividers, trammels, angle plates and surface gauges should be provided for working on the layout table. Dial indicator gauges are also of immense help in marking out.

MACHINE

Industry depends on machine tools for quick components manufacture. There are several tasks that engineering cannot accomplish without the aid of machine tools. For shafts within very close tolerance limits, turning machines are always employed rather than casting or blacksmithing. Some jobs too require a great deal of power to get done, and it is machine tools that can provide such power without much human labour. The shaping machine is a typical example.

The machine tool room should be close to the benchwork area for ease of transfer from one to the other. Floor space occupied by machine tools should range from one square metre for a pedestal-mounted electric grinding stone to eleven square metres for a three metre between centers engine lathe.

The machine shop should house power saws. Depending on the size of workshop, there should be one or more power hacksaws (one for up to one hundred and fifty students). Arrangements for clamping up to twenty-five centimeter width jobs and coolant dispensing will need to be made on workshops.
each hacksaw. A minimum power of two kilowatts should be expected. A vertical band saw with saw band shear, grinding and welding capabilities will train students in internal hole making. The cutting capacity of the workshop should be completed with some manual and some powered shears. The powered shears should have up to twenty-five millimeter squared facility in addition to the straight cutting.

Sensitive table top drill presses taking up to thirteen millimetre drill bits will be needed for small drilling work. Belt and pulley arrangements will enable speed selection. The drill head should have vertical movement while the clamping arrangement should aid movement in the horizontal plane.

For heavier jobs, vertical drill presses with gears for speed selections should be provided. Drill chucks to take up to forty millimetre drills with power feed should suffice. Drill presses in the workshops (definitely the big ones) should have depth stoppers. The drill head should be graduated for drilled depth gauging. Drill chucks and sleeves should cover a very wide range to enable the students to have practice in a wide variety of work. The table with the job holding arrangement should have a vertical and swivel lock incorporated. For twist drills above thirteen millimeters, the dispensing of cutting oil is going to be provided.

Radial drill presses also taking up to forty millimetre twist drill bits must be installed. The drill press head should have up to one metre displacement facility coupled to speed selection. The turntable for holding the job should have freedom of motion in all three directions and all three should be graduated for precision work. In addition to straight and tapered shank chucks and sleeves, there should be drifts and drill bits for

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counter sinking, counter boring and flute drilling. Reamers too should not be forgotten.

The holding down of jobs should be taken seriously for the safety of personnel. Every job must be firmly held down by holding down devices and not human hands. This will mean vices, clamps, straps, T-bolts, angle plates, V-blocks and any other such devices.

The engine lathe is one of the machines that revolutionized engineering. Its capability limits are very wide. There are specialized sets but for the maritime training facility, the all-purpose standard types are recommended. Their sizes should range from the zero point seven five to the three metres (0.75 - 3m) between centres. They should be rigidly mounted to the floor of the machine tools room. The geared head stock will aid speed selection and the saddle and cross slide on the carriage should have automatic feed and micrometer stops. The compound rest should have a three hundred and sixty degree swing provision. Taper and straight turning should be possible. Internal and external thread cutting should also be possible.

A face plate, drive plate, self and independent centered chucks are some of the accessories that ought to be provided. Lathe dog, steady and follow rests, mandrels, taper turret and tool posts should be attachments to the saddle and bed. Revolving and dead centres with chuck facilities should be provided by the tail stock which should also slide on the bed.

Each lathe machine should have its own accessories box near it. The use of accessories from a different box should be strongly discouraged.

Turning and boring tools for roughing, turning, facing and necking should be provided for left handed and right handed jobs. Parting, knurling and centre drilling workshops
tools must all be catered for on the engine lathe.

Some grinding stones may be designated sharpening stones for engine lathe tools. These stones should then be used only for the said tools as the stone contour seriously affects the lathe cutting bits which in turn determine the cutting efficiency and job finishing of the lathe.

Actual grinding of jobs can be arranged on the engine lathe saddle where acquisition of a grinding machine is considered too expensive. Electric or pneumatic stone mounting accessories can accomplish this.

For flat jobs, the shaping machine can remove chunks far faster than a filing or chiseling process. The shaping machines in the training facility workshop should be the horizontal type. Both the travel and the speed of the ram should be adjustable. The tool head should be endowed with a clapper box. It should also have a vertical feed facility and swivel in the vertical plane. The table on which the job will be held should have vertical and horizontal movement capabilities. All these movements will be by graduated screw threads for ease of reference. In addition to the holding accessories like the drill presses, the shaper should be equipped with parallels. A spirit level will also be needed when setting the job in the holding arrangement. Cooling fluid supply must be arranged if tools are to last long and jobs are to have a good finish.

There are two types of milling machines - the horizontal (knee and column) and the vertical spindle. It is good advice to install both types in the maritime training facility workshop. The horizontal one should have arbors for different milling tool arrangements. The swivel table will also enable longitudinal, transverse and vertical feeding.
The vertical type milling machine in addition to the above should have a vertical feeding possibility with the head carrying the cutting tool. A seventy centimeter longitudinal table travel can be the right size machine for this training facility. In addition to the arbors, collet, adaptors and holders will form part of the accessories. An indexing attachment will be needed for gear cutting and similar jobs where constant spacing is required on a circumference.

Cutters should be the peripheral and facing types. They should come in different shapes and sizes.

Each machine tool should have its power supply from a distribution board. Where the machines in the workshop are many, sectional boxes for groups of machines should be used. A fuse (or tripping device) should be provided here. These switches should be well marked for each machine.

At the work station (on the machine), there will normally be a switch and a push button for starting the motor. With certain machines, like the engine lathes, a lever may then be added to get the motion transferred to the actual moving head.

METAL JOINING AND CUTTING

Gas and electric arc welding are the most widely used metal joining procedures though forge welding is the origin of the welding process. Welding by forging, if students are still to be given this training, will fall under blacksmithing which this paper treats as heat treatment.

A gas bottle storage room, remote from areas where any hot work will be done, should house the oxygen and acetylene bottles. Spaces should be clearly marked for filled and empty bottles. Oxygen and acetylene may be stored separately. The strapping down of the bottles is
very important as any inadvertent piercing will turn a filled bottle into a dangerous missile. Safety caps should always be used to cover the valves on the bottle unless the bottle is in use with gauges attached. Piping (of approved material) from the gas spaces should supply individual working cabins with oxygen and acetylene. Colour coding of piping should not be neglected. Each gas bottle should have a main valve located on top of it with a bursting disc and fusible plug arrangement. A reducing/regulating valve in combination with pressure gauges will reduce the gas pressure to a maximum of seven kilogrammes per centimetre square in the main line after which further reducing valves in the individual cabins (pipe branches) can bring the pressure down to working values. The regulators must have ball check valves to prevent back flow of the gases, and bursting discs for safety should be added.

Rubber hoses (also safety approved) should lead the gases finally to the torches. Each cabin should have shut off valves in addition to the finer regulating needle valves on the torch. It would be good practice to have left handed couplings for one gas and right handed for the other to prevent wrong connections and operations. Normally acetylene is in red or brown piping and left-hand threaded connectors, whereas oxygen is in blue or black piping and right-handed. For each station, a gas welding handle and a cutting handle (torch) should be provided with the full range of tip sizes to give the required flame for the operation at hand. Brazing can also be done with this setup.

One straight cutting machine and another for shape cutting can help students understand the versatility of the gas cutting set.

Each cabin (student station) should also be equipped

workshops
with an electric arc welding set. The electrical mains will supply power to the transformer which should have tapping points (or settings) for currents up to three hundred amperes for striking the arc. Two leads, the earth which is electrically connected to the job and the other to the electrode holder, should be provided. The cable size should match the highest current value with a safety factor of at least two. The electrode holder's electrical insulation is of paramount importance if fatalities are to be prevented. Switches and fuses are to be provided just as in the machine shops.

A work table of steel having at least one metre square working top should be in each cabin. Part of the work top may be in the form of a grate to help hold the work pieces. There should be chipping hammers and wire brushes in these cabins. The walls of each cabin will have to be light-proof to ensure that the high intensity light produced in these processes does not harm passers by.

Protective clothing should be worn by anyone who enters a cabin while work is in progress. Flame and electric resistant booths, leather aprons and gloves and appropriately darkened goggles (or masks) should be worn. Definitely no sunglasses are allowed. A set of rules as to the hazards in this area should be posted clearly and permanently. The electrical, blinding, fire and explosion risks are to be seriously impressed upon staff and trainees alike.

HEAT TREATMENT

Metal properties alter when metal is heat treated. This is very true for steel which is used in most workshop practice work in training institutions just as in the engineering industry. Annealing, normalizing, tempering
and hardening are some of the processes to be undertaken here.

A connection from the oxy-acetylene system in conjunction with hoses, torch and nozzles will be enough for flame hardening (flame of up to 3500 deg C) and some of the heating processes. This means the heat treatment shop should be near the welding shop.

At least two ovens should be provided. The first should have temperature control for up to one thousand three hundred (1300) degrees centigrade. This range should cover the needs of all hardening and tempering processes the trainees will deal with. The other oven should be capable of temperature control for up to six hundred (600) degrees centigrade for lower temperature jobs. These ovens may be electrical, gas or oil fired. The electric furnace tends to be cleaner and easier to regulate (air changes and temperature wise).

Oven temperature may be measured by an electric pyrometer made of appropriate material for the temperature range. A heat resistant carburizing box with fitted lid should be provided. A quenching bath of oil, another of water and an air ducting will help with the metal cooling processes. At times the cooling is done in the oven or the open air. Tools for handling hot objects can be in different forms and lengths, e.g. tongs.

For forging, a blacksmith's hearth can handle the very small jobs while the ovens take care of the big ones during heating. This blacksmith's hearth should be equipped with electric motor driven air blowers instead of bellows. There should be anvils with horns and holes. These should be mounted on wooden blocks. Forging hammers and cutting tools should be provided for the smith's shop.
Marine engines, just like shore based engines, have changed from steam to diesel. The gas turbine is also a contender if materials to withstand high temperatures can be developed. The nuclear power plants can boost the number of steam turbines in operation if environmental fear can be overcome. It is therefore not the intention of this paper to back any particular engine but to highlight the marine technology sectors a maritime training facility must train people in. There are enough diesel plants in the marine field to warrant this workshop space allocation to the diesel engine.

Basically there are the two-stroke and the four-stroke engines. It is therefore good for the training facility to give training in both types and their ancillary, not that there is a very great deal of a difference between them.

For a feeling of size and expected values, the diesel engine workshop should house a main engine, two diesel generators, a couple of small diesel engines and various components to depict working principles and settings as a minimum.

The main engine is very likely to be a two-stroke slow speed real size working engine. It should have all the instrumentation, automation and manual controls. Thrust block, transmission shafting with plummer blocks, a tail shaft in stern tube and a propeller rotating in a sealed tank of water should complete the working design. The "propeller tank" should have transparent windows to view what is going on inside. The tank should be made of re-enforced concrete.

This kind of engine can be very expensive, the more so if a modern one is acquired which is the ideal case. The automation set may be left out. If it is just the
working principles that are required, then an old engine going for scrap may be picked up. On the other hand, a one- or two-cylinder engine may be acquired together with all necessary instrumentation. In some cases, a non-working model is used for training in which case the other diesels will have to take a certain configuration.

The necessary staircases, platforms, cranes, engine component stands, etc should be arranged for mock overhauls and practice whether the engine is a working copy or not. A couple of parts like liners, cylinder heads, pistons and rings, bearings and others should be near-by for ease of reference and inspection.

The auxiliary diesel engine shop should have at least two engines each coupled to a three phase four hundred and forty (or so) volt alternator set. The power output of each should be at least two hundred kilo-volt-amperes and connected to a switch board for paralleling and distribution practice. These auxiliary engines should be four-stroke medium speed.

Where there is no two-stroke slow speed main engine installation, one of these generators should be two stroke. It should be a good idea if at least one of the engines is turbo-charged.

The instrumentation of these auxiliary engines should be exhaustive to enable students to take readings when various parameters are altered. Peak pressure and normal indicator card instruments are to be provided. Thermometers in all fluid flow inlets and outlets, pressure measuring instruments and possibly an oscilloscope for electronic indicator diagrams where the speed is too fast for the power and out of phase cards should all be installed. Protective equipment should be under-lined. Over speed trips, low pressure alarms and shut down devices and temperature alarms and trips should
be arranged for each engine.

There should be one or two medium or high speed diesel engine(s) for thermo-dynamic work. They should have in addition to the instrumentation specified for the auxiliary diesels, measurements for fuel quantity (in as small as millilitres) in a given time, calorimetry for cooling water and exhaust gases, dynamometer (water brake), gas sampling, different fuel mixture injection and compression ratio adjustments without opening up the engine.

In addition to these working engines, some non-working engines will be needed. It would be good to have as wide a variation as possible in these engines. "V" cylinder configuration with connecting rod arrangements, those with wet and dry crankcases, and such will enable students to learn the "slight differences". If possible, various items can be acquired in pieces and their principles just explained. Things like cam operated valves both cooled and uncooled, jacket and bore cooled parts and the whole variance in diesel engines may be represented by parts. Most of these parts are going to be sectioned for ease of comprehension.

In any case, student stations for fuel injector and pump servicing, testing and adjusting of opening pressures should be provided. Bearings fitting on crankshafts and other cylinder head valves maintenance should all have student stations.

Mechanical and hydraulic governor models which are electric motor (instead of engine) driven should be provided for effects of adjustments. These motors should have an analogue variation in speed. Where just the parts are to be explained the governor should be half or quarter sectioned.

All appropriate tools for working on the diesel workshops
Engines must be stocked.

Centrifugal purifiers (fuel and possibly lubricating oil) may have to be installed in the diesel engine room, but definitely a small sectioned model will be needed for explaining the real inside works. Where there is a main engine, auxiliaries and other working equipment, the training can extend even into watchkeeping by the trainees under competent staff or juniors under senior trustworthy trainees.

There should be air compressors with air bottles and their piping for starting engines (if not battery or hydraulically started) and for other services. Pumps for cooling and lubrication should be arranged if not integral parts of the respective engines.

In effect, this power plant should bring home to the trainees the real marine environment with respect to diesel engines.

**BOILER (STEAM)**

If the steam engine (turbine) is to be studied then a boiler workshop will be needed. The mini-boiler in the thermodynamics laboratory will then not be installed. The size of the boiler will depend on the steam consumption of the turbine installed. The turbine should be multi-stage with low pressure astern wheels. It would be a good idea to limit the maximum steam pressure to seven (7) bar with a super heat of about twenty centigrade degrees. This low pressure will reduce the risk of accidents. The boiler should have an economizer, evaporator and superheater. The turbine may replace the diesel main engine discussed above. It should have high pressure and low pressure ahead turbine wheels.

Contact and surface heating should be arranged. Bleeding off for/or re-heating (inter stage or
regeneration) can bring out the practical aspects of this thermodynamics phenomenon. Hot well, deaerator and condenser(s) should all be arranged for. The air ejectors on the condenser should not be forgotten. Pumps for feeding and circulation should be incorporated and steam traps for heating service lines should be installed. Just ordinary water tanks can be used for dumping the heat in these steam heating lines. Where the training facility is in a cold climate, advantage may be taken of this to supplement heating requirements of the buildings.

Just as on the diesel engine, instrumentation should abound on the boiler and turbine plants. Reducing, safety and all other valves pertaining to steam should be installed in the system.

In this room, units such as different types of heat exchangers - plate type with different reliefs and tube type with different expansion arrangements should also be installed. These may all be cut-away models. A model distillation plant should also find its place here. Impulse and reaction turbine sectioned models with particular detail of nozzling can be installed. Types of blade profiles and fixing to wheels should be mounted on display boards. A wheel with a full set of blades and locking devices will help students understand the root fixing technology.

Water testing and treatment equipment for chemical dosing should be accommodated here. Though the basics may be taught in the chemistry laboratory it would be good practice to bring the trainees to the real world by their testing and dosing in the boiler room.

STEERING GEAR

The steering gear workshop should contain the full telemotor system and the power unit leading to the rudder.

workshops
Though an electric telemotor system may be installed to show how that works, a hydraulic one is advisable. This is because the basics of the operation can be seen and individual actuations isolated for careful study.

The telemotor transmitter may be mounted about a meter or two higher than the receiver to give the system a good simulation in space orientation. The transmitter housing should be open to allow students to see the rams and pinions move. The charging valves and automatic bypass valve (for pressure equalization in transmission piping) should be easily identified and possibly made with transparent material. Oil level indication by dip stick or sight glass too should be well marked.

The receiver, with its mid-position return spring, should be near the rudder stock and pumps with the floating lever joining the three items. A local control (on telemotor receiver) position should be established such that only bridge or local control will be possible due to a mechanical locking device. Glands in the sliding parts of the telemotor should be robust and air bleed valves should be made tight. All valves and pipes in the system should be labelled numerically or alpha-numerically for explaining sequences. The limiting nuts are to be positioned (on receiver) for limiting maximum rudder movement to each side.

The hydraulic power pack should consist of a tank and variable delivery pump (delivering from zero to maximum in both directions). This electric driven pump may be duplicated for a back-up. A dummy second pump set with dummy piping blanked at ends to show students the setting of the real situation may be employed instead of the duplicate pump.

The actuator may be the rotary vane type but the ram type is recommended. The ram version makes the movements
visible and easy to follow with measurement possibilities. A cut away model of the vane type will be required anyway for study purposes. For cost purposes two rams may be installed but for cylinder unit(s) cut out demonstrations, four rams will be needed.

The stock in a thrust bearing may have a plate (rudder) attached and a spring on each side can give the required "water" force for demonstration. All shock absorbing springs, relief valves and other safety features are to be fitted on the system. The effect of worn linkages can be taught by having a set of undersize linkage pins in addition to the normal pins.

Charging and bleeding arrangements together with air introduction into hydraulic systems should be made for training purposes. Pressure gauges should be fitted in pipe lines (though this is not done in normal practice).

For studying the electric type of steering gear, the electro-hydraulic system may be miniaturized for demonstration. On the other hand, the telemotor system may have an electrical one parallel to the hydraulic. The linking of constant delivery pump with solenoid valves' chest for control would have to be ingeniously interposed. One then gets the two worlds of hydraulic and electrical telemotor systems in one.

A hydraulic desk and power pack may also be installed here for remote valve actuation and power delivery. For the valves, pistons in cylinders should be arranged and for power transmission hydraulic motors will be needed.

**PUMPS**

The practical (maintenance and repairs) aspects of pumps should be dealt with in this workshop as compared to the theory and design part undertaken in the fluid dynamics laboratory.
Pumps are dynamic or positive displacement type. The dynamic ones are rotary. Of course there are some positive displacement types that are rotary as well.

The rotor dynamic pumps are basically impellers rotated by shafts in a volute casing. The centrifugal pump would be shown in the various forms of impeller and casing arrangements. The vanes forming the impeller can be straight or curved and closed on both sides, one side or none at all. There can be more than one impeller giving a parallel single stage or multi-stage pump. Some impellers have single eye entry (unbalanced assembly) and others double entry (balanced). All these kinds of centrifugal pumps should have their samples displayed in this workshop. It would also be an excellent training aid to have them mounted for real pumping of water.

In addition, the axial flow propeller type in contrast to the mixed flow should be represented.

Various types of ball, roller, thrust and plain bearings for pumps should all be stocked in addition to how they are set up for alignment and their care. Mechanical seals and glands of different working principles and arrangements should also be found in this workshop.

The clearances permitted in wear rings, their measurements and effects on pumping capacity can be shown here with the aid of different size rings. Corrosion, cavitation and other centrifugal pump defects should be clearly taught with samples of pumps having these defects.

It would be worth having a central priming system with, for example, the water ring priming pump and a vacuum tank as a demonstration set up.

The spur, helical, lobe and herring bone gear type pumps will highlight rotary displacement principle of pumping. The rotary vane and screw types should
complement the gear type. The driving system for the gear and screw with its clearance setting and adjustments together with bearings can help students see what goes on inside the pump. Cut-away models are always the best realia when it comes to knowledge acquisition. Like the centrifugal pumps, methods of balancing out thrust or taking it up should also be underlined in the model pumps chosen.

Variable delivery pump principles should also be taught with the radial (Heleshaw) and axial (swash plate) piston type pumps. Cut-away and dismantleable models should be acquired as these pumps seem to confuse trainees the most.

The reciprocating pump, which is not rotary, will depict the purely displacement principle. Piston, diaphragm and plunger types which are distinguished from each other by their form of sealing should also have models installed. Single and double acting models coupled to the valve arrangements which determines the direction of flow should all be represented in the workshop.

In all pump model cases, the pressure regulation devices and shock absorbing equipment (where necessary) should be installed in cut away models. On working equipment, the effects of adjustments of these controls can be easily demonstrated.

Special feature pumps such as submersibles, emergency bilge and super cavitating pumps which happen to be modifications of the basic pumps to suit special applications, should also have stations in this workshop.

On the working pumps, suction, filling and air pipes should be arranged with different piping to show the effects on pumping. For instance, a header connection to a pump may be arranged to be five meters before, a meter or so before and some distance after the pump. Valves in
the three different lines will be used to determine which line the header is connected through with the system. Tests can then be run to show effects on discharge pressure of pump as to the location of header connection with respect to pump.

The different kinds of valves too should all have samples in the pump workshop. Non-return, gate, screw down, globe and quick closing valves among others should be mounted on stands. Deaerating and overflow arrangements should also be given a fair representation as well as packing materials.

A quarter sectioned model of an oily water separator should be installed in this pump workshop. Filters with different cartilages and cleaning arrangements should be stocked here as well.

**REFRIGERATION**

Perishable cargo, crew and passenger nourishment and air conditioning for comfort in hot geographical zones have made refrigeration part of marine science. Fish and petroleum (the very light products) transportation has refrigeration or variations of it as a determining factor in the success of a voyage. It is therefore incumbent on the marine training facility to train personnel to handle the refrigeration requirements of the marine industry both afloat and ashore. Some personnel are trained as refrigeration engineers and others add refrigeration training to one or the other of the marine specialties. Whatever the product after training, equipment in the workshop should be provided for refrigeration (and air conditioning) training.

The refrigeration plants in the marine industry are more often than not the vapour compression type. The freons (mostly 12, 22 and 501) and ammonia are the most
popular refrigerants. At times the cargo itself is employed as the refrigerant e.g. propane. In the maritime training facility refrigeration workshop, the freon and ammonia plants should both be represented as they will give the trainee a good basis to work with any of the other refrigerants.

In a lecture room adjoining the refrigeration workshop, a working model mounted on a board of about two metres by one point five metres (2 x 1.5m) will demonstrate the working principles and basic components of compressor, condenser, expansion valve and evaporator. Some refinements like driers and liquid receivers may be added. For classes of more than ten students, two or three of such models should be provided. The whole model assembly should be on wheels. In addition, mimic board display units of each system represented in the workshop should also be installed in the lecture room.

In the workshop proper, a two- or most likely a three-room cold store with refrigeration machinery should be installed. They may be a one-ton capacity room at zero degrees, a three-ton at negative fifteen degrees and a six-ton at negative forty degrees centigrade. These rooms should be properly insulated. The equipment should comprise two compressors each with a capacity of at least eleven tons, two condensers, a liquid receiver, dryers, expansion valves to match each room load, evaporators in rooms and the requisite instrumentation. If these cold rooms are to be used for the training facility's food refrigeration needs (which is advisable for economic reasons), then the capacity should be increased to allow for student errors. Piping for hot gas defrosting should be arranged.

There should be one or two other plants (smaller than the one above) for demonstrations, measurements and workshops.
practice of adjustments. Each unit may have for example a half a ton capacity where water is arranged to be cooled. The water in turn may cool air by means of a radiator. The flooded and the dry expansion types of evaporators should be represented here together with unloading facility on the compressor(s).

Another refrigeration demonstration unit should have the brine system arranged to be cooled by the evaporator. This will highlight materials for brine piping, temperature regulation for different chambers, the brine density control and the forms of defrosting that can be employed. An ice making machine with a per day capacity of one ton of ice will help students understand the principles involved in ice production.

In another part of the workshop some air-conditioning systems should be arranged. This set-up should take heating and cooling into its design. Electric heating may be substituted for steam where the latter is not available but humidity must not be left out of the design. Water spraying may suffice. A closed circuit air trunking with the possibility of outside air changes should be embodied in this setup. The size of air spaces will determine heating and cooling loads to be installed. This should be advisably small (for example a quarter of a ton cooling load) for low power consumption.

As outlined earlier, one or two different kinds of freon and ammonia should be employed in different plants in the refrigeration workshop. Charging arrangements should be made on each plant which will imply charging equipment. Charging hoses, nipples, gauges, weighing scales and vacuum and air pumps should be stocked. Testers for leaks for all refrigerants used in the workshop should be provided together with appropriate tools for overhauls, repairs and adjustments. Spanners,
extractors, flaring tools, pipe wrenches and ratchets for special valves are some of the tools to be arranged in the refrigeration workshop store.

On work benches, expansion devices (valves and piping) can be compared by mounting them in student made circuits. Manually operated, automatic, thermostatic, floats and capillary expansion (control) units must be represented. Hermatic compressors should also be dealt with in this workshop.

Repairs on refrigeration plants of the training facility should give trainees a fair amount of practice if national rules are not against such scheduling.

SEAMANSHIP

Modern technology has introduced a great deal of equipment that saves the mariner a lot of manual work. Yet there is still a lot more to be done by the seaman physically, and also to run this equipment in the right fashion. Accidents leading to fatalities have occurred due to improper use of equipment which stems from improper training in seamanship. The maritime training facility will have to provide training in this respect.

In the seamanship workshop, miniatures of underwater forms of ships with particular reference to appendages should be displayed. The effects of these appendages when stationary or in motion should imbue into students the dangers that can result. Examples are propellers, bulbous bows and under water thrusters. Fishing nets and similar equipment in between vessels must also be demonstrated in the workshop. Identification of these by markings and navigational lighting must be seriously stressed in the workshop practices.

Buoyage should be similarly dealt with. In addition to their navigational effectiveness, their anchoring and
buoying devices should all be miniaturized if the anchoring chains of markers are not to be tampered with during navigation.

On the vessel itself, the various forms of climbing arrangements should be seen in this workshop. Gangways, portable, pilot and monkey ladders should be provided in the seamanship workshop. Securing these climbing devices together with their practical usage will be taught in the workshop. The other forms of moving around the vessel should also be represented. Fore-aft life lines with rings for hooking safety belts, the rigging of stages and boatswain’s chair, working on ship’s side by work rafts etc should all have their various rigs placed in the seamanship workshop.

Rope work is very basic in seamanship. The different materials for manufacturing (natural, synthetic and metallic) should have samples and equipment for splicing them. This will mean spikes, fids and cutters to match the rope material and sizes. Yarn, strands and the lay should all be identified by samples including those ropes with core material. Provision should also be made to train the students in knot tying together with their applications in relationship to the marine environment. Rope protection is a must and this depends on material, the lay and application of the rope.

With the rope comes the pulley (sheave and tackle), shackle and hooking arrangements. As many forms of these should be represented in the workshop as possible. Bottle screws, grips, opened and closed sockets and such like will aid students in having a good introduction to the profession. Sewing palms and needles will be needed in canvas work. At times the needle may be used in rope work as well.

Line throwing devices should be acquired or made for
the seamanship workshop. The mechanical line throwing gun with over one hundred meters of rope should be trained with. The manual rope throwing guns can be made in the training facility. Cleats, bollards and bull rails will then help students in the rudiments of ship tying.

Windlasses, anchor chains, riding chocks, stoppers, dogs, capstans and different types of anchors should be housed in the workshop. Relative positions of operators with respect to these equipment is important if injuries are to be averted when ropes and linkages are in use or snap. This is an area the seamanship workshop will train students in.

Different miniature models of hatch covers can be arranged in the workshop. Wooden boards with tent and buttoning down devices, single pull pontoon steel covers and hydraulic articulated pontoons with cleats and eccentric rollers can all be represented. Their security in stowage is important and this should be built into the systems in the workshop.

Hull maintenance can be highlighted in the workshop. Scrappers, chipping hammers (and some electrical or pneumatic chipping tools), wire brushes, paint brushes and rollers can initiate the trainees. Jobs in the workshop cluster may be used for this training if national laws do not see it as student labour use.

Sounding leads with a couple of sounding pipes with different bends can be arranged to give trainees a feel of sounding and some of the anomalies to expect while in the marine environment.

MAINTENANCE

The workshop cluster is going to house a set of "maintenance" rooms if the repairs of the buildings and fittings are to be done in-house. There should be a room
for carpentry with powered wood saw, plane, drills, sander and any other carpentry tools that will be required. Plumbing, painting, gardening etc should all be allocated places in this workshop cluster or near-by. All the maintenance rooms should be equipped with the necessary tools and storage spaces for stores.
The learning in these workshops will be psychomotor and mostly in the open air. Of course parts of the learning will take place in enclosed areas. In some cases the learning environment is far removed from any of the other workshops and learning facilities for various reasons as will be shown progressively.

FIRE CENTRE

The marine environment is the most dangerous arena for a fire. More often than not external help for such fires is difficult if not impossible to get. The normal mode of fighting fire ashore does not apply easily to the marine fire. This is because of stability problems that arise due to water accumulation (free surface). Add to this the unique accessibility problems found aboard and the difficulty encountered when retreating to a safe haven. Due to self sufficiency in power supply and at times the cargo being carried, liquid fuels are in abundance aboard, increasing the fire risk and making water which is in abundance in the marine field unusable for the fighting of this kind of fire.

Special training is therefore required to equip the mariner to deal with fires without external help. He must also be trained not to compound a fire problem with a stability one. This training can be effectively undertaken in a well set-out fire training centre in the maritime training facility. One should not rule out the possibility of utilizing the national or local fire training facility if it is in close proximity to the maritime training facility. Modification (mostly additions) will of course be needed to make the

outside workshops
alternative meet the maritime's special needs.

In the maritime training facility, the fire centre should be situated where there are no restrictions on emissions (especially of smoke and gases). A minimum of two hundred metres is recommended to separate this cluster from any of the other clusters. The wind direction should be given due consideration to prevent carrying the combustion products to other parts of this learning institution. The fire centre cluster will preferably be near the water, sea, lake, river or lagoon to enable the centre to have access to a copious supply of water. In places where water supply is no problem, the cluster can be sited otherwise. Fresh water supply is rather advisable unless special care will be taken of the steel equipment to prevent rusting and salt water corrosion.

The fire cluster should consist of two blocks. The first is the main block containing the lecture room, office and equipment cluster. The second block is the "ship" which would be used for most of the smoke and fire exercises. Thirty to forty metres should separate these two blocks. In-between and around these two blocks, some of the fire training equipment which need not be indoors may be sited (as shown further on in this paper).

The main block will house a classroom which should seat at least the largest class in the institution (say twenty-five). Student stations should have chairs and tables as in the normal lecture rooms in the lecture room cluster. Overhead, slide and movie projectors should also be provided together with video recorder/player and a television set. The instructor's table must have at least two square metres of top area to accommodate realia which is being shown or demonstrated with. Samples of devices should be on display in the lecture room. These samples will preferably be sectioned, and include sensors.

outside workshops
sprinkler heads, international shore connection, portable extinguishers, gas detection metres and a demonstration set for low and high explosive limits.

A changing room with lockers is essential. The changing room should be about two-thirds the size of the classroom and have a low table of about a third of a metre high and large enough to seat the class. A shower room should adjoin the changing room. There should be one shower per six students in a class i.e. four showers for a class of twenty-five and one for the instructors. Where arrangements are such that trainees can go for showers in their hostel without inconvenience, the showers may be dispensed with. For toilet facilities, three sets of w.c. bowls should be installed.

The main block may also house a demonstration room. This demonstration room should contain the "ship" model to a twentieth scale. It should be sectioned and have the possibility for removing stacks deck by deck. This will aid briefing, planning and debriefing of an exercise in the "ship". Different gases and liquids with their matching measuring instruments should be stored here and used for calibration exercises. A zero point nine metre (0.9m) high table should be provided for this. The table should have enough top space for half of the class at zero point five square metres (0.5m) per student. Extinguishing chemical mixing, testing and reactions could be demonstrated here. A sink with taps should be installed.

Carbon dioxide engine room flooding systems are scarcely operated on board except during the two yearly inspections or when there is a fire. When it comes to operating them in an emergency (when there is a big fire, which in itself is rare), problems arise despite the detailed posted instructions. A one metre by one metre
and zero point seven metre high (1m x 1m x 0.7m) engine room model with doors and sky lights, carbon dioxide piping and bottles can be arranged in this room to give students a miniature hands on experience. This engine room flooding system will contain pilot and main cylinders, isolating valves with all the accompanying wires and pulleys as found on board. All equipment in this model should be sized to match and real fires (not simulated) can be set in it just as real fires will be used in all exercises in the fire centre.

The various detection systems should have working models in the centre. Thermal, smoke (optical and ionization), flame and fragile bulbs should all be installed. Fire fighting media such as the halons, foam and dry powder should also have samples here. This room can also be used for re-charging exercises of the foam, dry powder and water portable extinguishers. Measuring jars, weighing scales and sinks should then be installed.

Another room of special interest is the equipment room. This will be a sort of store house. Lockers should be provided for cotton gloves, gauntlets, firemen's coats, helmets, oil skins, hoods and boots. Complete sets of breathing apparatus (at least each of one thousand two hundred litre capacity free air or the most widely used capacity in the local maritime field) and low air level alarms should also be stored here. An oil-free air compressor for refilling air bottles is a must. The location of this compressor must take air purity into consideration together with filtering devices. There should be enough breathing apparatus sets with at least twenty-five percent spare. Air bottles should have over fifty percent spare in addition to the air compressor to enable changing bottles while exercises are in progress.

Fire proof life lines (at least thirty-six metres outside workshops
each). Safety harnesses, axes and safety flash lights should all be stored here. This equipment room should be at least twice the size of a lecture room but it must have a very high ceiling (at least five metres inside height) for air circulation.

Spaces for storing portable extinguishers should also be provided here. Nine litre water and foam extinguishers, five kilogramme carbon dioxide, two to three kilogramme halon 1211, ten kilogramme dry powder extinguishers, smoke generators, seventy and forty-five millimetre diameter hoses and their nozzles may all be stored here for the various exercises.

The "ship" block will very likely be constructed of steel. Where steel is too expensive, fire resistant bricks may be used. There should be enough doors on this block to allow immediate evacuation of all persons in an emergency. These emergency doors should not be more than five metres apart on each floor. Windows should also abound so that smoke can also be evacuated in the shortest possible time if and when the need arises. For training, some doors and windows will be designated "unmovable" parts of the bulkheads.

There should be a minimum of five decks in the "ship" structure. The first deck (ground floor) should have a total floor area not less than twenty metres by thirteen metres. This deck will comprise an engine room with a workshop area containing engine dummies, a dummy tunnel with shaft and a door with closing possibility. A manhole in an engine room bulkhead should lead into the 'tween deck of a hatch. A fuel tank also with a manhole should be located here. Portable extinguishers befitting the fire expected in the locality should be sited all over the engine room or as an exercise might demand.

On the second deck, the engine room trunking should
house a dummy electrical switch board, a dummy boiler and some gratings in the deck. Two sets of stairs should lead from the engine room first deck to this second deck. Tanks and trays for setting fires should be provided. A door from the engine trunking should lead to eight or so cabins also on this deck. Half of the cabins in this ship structure should have a bed, settee and wardrobe each. The others should be equipped with a table and a chair each. A bathroom and lavatory should also be provided on this deck.

The third deck should still have an engine trunking, office, dining saloon, pantry, galley and three or four more cabins. Each space must be furnished (in steel) as appropriate e.g. range in galley, tables and chairs in dining saloon.

The fourth deck is going to have the hatch covers, limiting the enclosed structure to about twelve by ten metres. In the open air on this deck may be mounted dummy winches and windlasses. On the engine room casing may be sited a fan room. On the fore end of this deck should be the wheel house and chart room where wheel and telegraph, chart table and possibly air sampling (with carbon dioxide flooding) dummies will all be found. A radio room should adjoin the wheel house by a communicating door.

The fifth deck should just be about six metres by seven metres (on top of the wheel house) with a funnel sticking out.

All decks should be connected with two sets of stairs on the outside. These are to be staggered just as found on board ship. There should also be an internal flight of stairs. The shaft tunnel should have a vertical escape tunnel and ladder which may terminate on the third deck. The whole ship structure should not be less than ten

outside workshops
metres high. Apart from the first deck, all decks should have scuppers equipped with plugs. A ten centimetre high coaming should then be provided on these decks to draw trainees' attention to the fact that water should be drained off during fire fighting to prevent instability.

The accommodation in the "ship" should be fitted with a working sprinkler system with different temperature bulbs for demonstration. No electrical wiring should be installed in the "ship" for safety reasons. If any are fitted, there should be no means for making them live. This will safeguard against electrocution. There should be at least two fire hydrants on each of the first three decks and one each on the other decks. They will be advantageously located at the entrances to the spaces which they are to protect. Each hydrant should have a valve for turning on and off the water, a hose and a nozzle. It will be advantageous to have nozzles that can give a spray of up to four and a half metre diameter at a distance of two metres from the nozzle end to form a shield. They should also embody regulating/shutoff valves and be capable of throwing a jet of twelve metres minimum when the flow rate is twenty-six tonnes of water per hour. A pump (or water main) capable of delivering at least three and a half kilogramme per centimetre squared pressure at two hydrants (fitted with nineteen millimetre bore nozzles) should be installed. Isolation valves and an international shore connection may be fitted for practice. Where a pump is installed in addition to the water supply mains from outside the fire centre, the pump facility may be used as the emergency fire pump. Each hose should be at least sixteen metres in length which will give trainees the feel of real sizes and orientation.

Breathing apparatus exercises will be needed by the trainees to give them the feel of climbing from the lowest
hold or engine room deck to the bridge of a modern vessel or offshore structure. A hill of at least thirty metre height nearby should be adequate for this breathing apparatus exercises. In lieu of this, a flight of stairs with landing every three metres height should be constructed to about thirty metres high. Where intensive exercises are being undertaken (which is not very likely), a belt of lead weights may be provided to be worn on the waist to simulate tiredness or a load being carried.

At least six dummies (of human beings) will be needed for smoke rescue exercises. These should have weights commensurate with humans - forty to eighty kilogrammes each will do. Two stretchers, a first aid kit (including burns treatment materials) and a resuscitation kit with oxygen/suction unit should be provided for the first aid post in the fire centre.

In the open air, outside the two blocks mentioned above, should be provided a gas network of twenty-five millimetre diameter pipes in two branches, each having a length of three metres. The pipes should be perforated in different places and at angles to give a blaze of gas fire for practicing gas fire fighting. A nine metre diameter concrete platform with a maximum holding depth of ten centimeters will allow students to practice with the high expansion foam set. This will mean a high expansion foam generator, two mechanical foam branches and foam compound.

Steel trays, each fifty centimetres off the ground should be provided for halon, foam and carbon dioxide portable extinguisher training. Two of the trays may be two metre diameter each and the third a metre square. They should each have a zero point three metres of depth. Three sets of brick fire "trays" should also be built in the open air. They should be adjacent to each other and closed on three sides. These brick trays may be a metre

outside workshops
by two each with the walls rising a metre and a half high. These trays will be used for "metallic/electrical" fire practice.

Fire hydrants located near these out of doors equipment will help trainees combine water spray shielding with approaching conflagrations.

This setup should hopefully meet the marine fire training demand of the maritime training facility. It is of utmost importance to stress that the planning and the execution of the fire training programme should be meticulously undertaken if the full import of the training is to be gained.

SURVIVAL CENTRE

Marine structures, floating and fixed, are designed to survive the marine environment under normal conditions. At times, abnormal conditions prevail, forcing humans to evacuate the ship or marine structure they are inhabiting, to the water for some time.

Humans are not amphibious. Special adaptations will have to be made if one wants to "live" in the water for any length of time. This is the main objective of the survival centre. It should train mariners to use the meager supply of equipment and nourishment which is provided as a survival kit on board the ship or marine structure.

The maritime training facility will aspire to provide as many different kinds of survival equipment on its grounds as can be found aboard vessels. The facility will also endeavour to give each student adequate practice in the use of this equipment. This is clearly shown on the international level by the IMO's International Convention on the Standards of Training, Certification and Watchkeeping for Seafarers, 1978. Chapter VI of the
convention deals with survival craft proficiency and makes
it mandatory for certain ranks on a ship or marine
structure to have a survival certificate. Appendix to
Regulation VI/1 outlines the minimum knowledge required
before one can be issued this certificate. This will
hopefully increase the survival chances of people at sea
in an emergency situation.

The survival centre will preferably be near the sea
(river, lake or lagoon) near which the training facility
is situated. It is difficult to isolate this centre from
the boat centre (harbour of the training facility), though
they are treated in this paper separately. Some of the
exercises may be conducted in a swimming pool which can
double as a survival as well as a recreation facility.
Where climatic conditions are severe it is recommended
that the swimming pool be sheltered from the elements. A
three tier diving board can give practice in jumping into
water from a height with life jacket on. The height (to
water level) of jumping should never exceed six metres.
A four metre, a two metre and a thirty centimetre height
should provide substantial variety for practice jumps.
The minimum water depth in the jumping board area should
be four metres to prevent a trainee touching the bottom
and being injured. The pool may then be sloped up at the
bottom to give a one point two metre depth at the
shallowest part. This set up can then be used for
swimming lessons as well.

Investigations have shown that people slip out of
life jackets that are improperly donned while in the
water. Improper use of life jackets has broken necks of
would be survivors on contact with water when the heights
they jumped from were high. Practice is therefore well
justified.

A simple rigging to simulate helicopter rescue from

outside workshops
the water may be mounted a metre or two from the diving board along the edge of the pool. In a typical installation, the swivel rig's head will have a pulley over which a rope runs. The rope is then taken on a drum which may be manually or electrically operated through gearing. This will then teach trainees how to go into a sling, basket or a stretcher lowered from the "helicopter". Where the sea at the survival centre is sheltered and ambient conditions allow, the pool may be dispensed with and the sea used in its stead.

Life buoys (quoits) with life lines of thirty metres attached will help students learn to throw this floatation device to people who are "overboard". Some of these may be provided with water activated lights to indicate their positions. Both fixed volume and inflatable life jackets with whistles, reflectors and/or sea water activated lights should be practiced with. Modern technology has come out with immersion suits that can aid a survivor even in very cold water. Two complete sets of these survival suits maintained at the survival centre will allow students to practice donning them.

Ships are equipped with life boats and life rafts for survival purposes when the ship is abandoned. The maritime training facility must therefore give training on how to use these survival crafts in the best possible way. Though the boat centre should have a set of boats (as discussed later), for survival one motorized and another un-motorized, rigid life boats can be of great assistance. They may be open or semi-enclosed. Gravity davits should be provided for life boats for trainees to master launching and retrieving. It will also help trainees in knowing the care needed to keep the launching devices in permanent readiness. Where a free fall launching arrangement is installed, a self righting totally enclosed
life boat may have to be installed for the training. For the gravity type, a boarding stage may be provided.

Life rafts, rigid and inflatable, may also be installed for practice launching, boarding and use. Training in righting the non-self-righting life rafts is very important. The various devices for releasing life rafts from their stowed positions should be given some eminence as automatic release devices have been neglected and detrimental penalties have been paid in emergencies.

Covers or canopies for the survival craft are important. Statistics have shown that the cold has killed more shipwrecked mariners than drowning. Though people in survival craft are advised to stay near the location the vessel was abandoned, sails have helped survivors go to safety. Its use may therefore be encouraged in the survival centre of the maritime training facility.

Pyrotechnics in the form of rockets, flares and smoke floats for position identification is quite good and may be practiced with during survival training. Emergency position indicating radio beacons (EPIRB) by international regulation, GMDSS, are becoming a must in the marine field. Its activation therefore needs to be taught. The survival centre may be equipped with two of these floatable EPIRBs with at least five metres of rope attached to each one of them. Those operating on the four hundred and six cycles per second (406 Hz) frequency is recommended for world wide marine usage.

The boats and rafts in addition should be equipped with oars, buckets, bailers, sea anchors (and/or drogues), signalling mirror and liquid compass marked in points. Sewing palms needles and sail thread can initiate trainees into survival craftsmanship.

The use and preservation of rations on survival craft is very important. Samples stored in the boats in outside workshops
the survival centre will give trainees the sort that they
are which is basically water, carbohydrates and sugar.
Concentrated or tableted milk, biscuits, sweets and water
are the main. Their sealing and remaining sealed are to
be highlighted. Fishing hooks, lines and bait can help
students train in fishing though one must always remember
that lots of water is needed when digesting high protein
food, of course drinking sea water is prohibited.

Survivors have been known to stay on their own for
over a hundred days at sea. Passing the time without
becoming insane then becomes one of the priorities.
Portable radio sets, playing cards and other such things
have helped in this respect. The students will
advantageously be orientated in this direction also
during the survival course by providing them with some of
these amenities.

Shark repellents have been effectively used in shark
infested waters to increase survival. Not dumping bird
and fish remains into the water has also increased chances
of survival on such infested waters. Training in these
respects too can go a long way.

Stretchers, first aid kit and resuscitation kit may
be imported from the fire or first aid centre for training
in the survival centre if and when there are no overlaps
in schedules. On the other hand, the survival centre may
demand a set of this equipment of its own.

A sandy beach on the waters edge may give practice in
beaching life boats. The boat centre should provide the
rest of the needed spaces and equipment for survival
training.

Though most seafarers are never going to need the
training they acquire in the survival centre, it is far
better to have the training and not to use it than not to
have it when the need arises: the more so when one

outside workshops
realizes that nobody knows which mariner is going to have the need to use the training so acquired.

**BOAT CENTRE**

The boat centre will provide great assistance to the survival craft and also train the students in small craft handling. There is the bonus of this being a recreation facility with a training touch if navigational buoyage can be provided. For non-sea going craft, sheltered waters will be required. The selection of craft will therefore depend on the boating area available.

In any case, the boat centre should house a motorized speed boat for rescue operations. This may be up to five metres in length with the capability of housing first aid kit, resuscitation and suction equipment. The speed will be needed when survival courses are being run.

A work boat too will be an advantage. Towing rafts and other boats will be the main duties in addition to giving practice in boat handling. This is essential where the training facility uses the sea for boating practices. The work boat too should be motorized.

About ten other assorted boats may complete this centre with respect to boats. Some may be sail, others rowing and of course some may have either outboard or inboard engines to give all the various training the mariner must have.

The work boat is likely to be of steel construction and the small boats of wood, fiber glass or steel. The possibility of repairing these boats in-house may be considered when acquiring them. Though no one is going to advise students to mishandle the boats, incompetence may be expected from them.

A stores shed to house the accessories may be sited

outside workshops
at the water's edge. Storage shelves for sails, oars, outboard engines, ropes and all other boating equipment which has to be stowed away from the boat when not in use should be provided.

Another shed is going to be for repairs and maintenance of the crafts. The repair shed will need doors wide enough for the biggest boat which is to be serviced there. Powered and hand tools may be installed in the maintenance shed. Saws, grinders, chain blocks for lifting, drills and others may all be represented here. Cleaning and paint spraying facilities may also be provided. The engineering repairs and maintenance may be carried out in any of the appropriate workshops in the workshops cluster as seen fit, that is if such repairs cannot be performed in the boat repair shed.

A towing car (for example a jeep) and cradle arrangement may help haul the boats out of the water. A gentle slope should then be constructed into the berth facility. A twenty degree gradient will suffice.

Sheds constructed over part of the jetties may help suspend boats out of the water by means of tackles and ropes. Wooden or concrete platforms may also be arranged in these sheds and tackles on rails help drydock the boats. The very small boats that can be manhandled may not need these docking arrangements.

Finally, if the training facility acquires a training vessel (as discussed in the next chapter) and decides to berth it on the training facility site, then this port (boat centre) may have to provide the jetty for her. The berth may be dredged to the required depth for the maximum draft of the training vessel and bollards rooted on the key. Fending may also be allowed for. Due to its deep draft compared to the other boats harboured in the boat centre, a turning (or maneuvering) zone may be provided outside workshops
for the training vessel depending on the berthing and unberthing methods envisaged and the hydrographical contours of the boat centre.

General physical fitness is a prerequisite for trainees to undergo any of the exercises in these "Outside Workshops". This is due to the physical exertion and the hazards one is exposed to in these training phases. Though the institution should endeavour to give as good a prevailing condition in the "outside workshops" as possible, one must face the fact that fire, smoke or water does not tolerate weaklings. Equipment, for example breathing apparatus, may help but the elements will still take their toll. The only way to reduce this toll is for the trainee and trainer to be fully alert. This invariably includes physical health to the highest possible degree.

The mariner in most cases is isolated when he needs help. It therefore behooves him to prepare himself as fully as possible to be "self dependent". The maritime training facility's "Outside Workshops" hopefully will aid him in this preparation towards the unforeseen but constantly threatening emergencies.
Training of mariners has taken many forms over the centuries. One aspect which has stayed the same, at least in the last century, is the practical experience required at sea before one is given any responsibility aboard. The international convention on Standard of Training, Certification and Watchkeeping for Seafarers, 1978, with subsequent amendments, stipulates the minimum practical training required before the first and successive certificates of competency are issued. These rules and regulations highlight the necessity of proper practical training before one is allowed to take charge of machinery or navigation related to the marine environment. The aim is to prevent casualties which might yield social, environmental and/or economic losses. In this chapter, the practical experience required before the issuance of the first certificate is what will be focused on.

There are two main systems practiced worldwide in giving this requisite sea service. The first is for the trainee to be attached to a vessel operating commercially. The number of trainees in such a case will be limited to a maximum of four (generally two engine and two deck cadets), or thereabouts. The chief officer or second engineer (both senior officers) may be responsible for the trainees in addition to their normal ship operating duties. No special classrooms or teaching materials are provided. There might (at times) be no set programme for the trainees but to learn what the ship provides through the daily routines and what comes up by way of emergencies. The end product of such a training procedure is indeterminate due to lack of control of the programme.

The second is to have a vessel dedicated exclusively
to the training of cadets. This vessel may be commercially operated in addition to the training or limited to the training alone. In any case, special provisions are made for accommodation, lecture rooms and materials, a duplicate bridge for the cadets or provision for teaching on the bridge, engine room designed to facilitate learning and arrangements made for trainees to see as much as possible within the set time frame. Above all, officer(s) solely dedicated to instructing the cadets are included in the crew. This vessel if integrated into the training facility's programme will ensure continuity and wholeness of the training.

Whether the training vessel is commercially operated or not will depend on the economics of the situation and who provides the vessel. If a company has the training vessel in the fleet it will have the commercial touch. On the other hand, the training facility may operate the vessel non-commercially. A commercial touch to the training facility's vessel should give a more all round experience to the trainees.

From the foregoing, the training vessel approach is far superior to the first (i.e. attaching a cadet or two to a commercially operated vessel without training instructors). If the superiority is not to be lost, then the close correlation between the maritime training facility and the training vessel should be maintained. The instructors on board should be part of the training facility staff. Possibly, commandant(s), lecturer(s) and educator(s) who in addition to the instruction aboard have duties to perform in the training facility should suffice. It is best for the training facility to own and operate the training vessel to reap this benefit of total correlation between shore and sea training to the fullest.

The training vessel should be berthed in the boat

training vessel(s)
centre on the training facility. The close proximity of
the ship to the campus will bring ease of reference and
encourage belonging and special care of the vessel. If
this berth cannot be on the training facility due to
physical reasons, then the nearest port may be used,
cognizance being taken of the fact that easy access to the
vessel is a must especially with respect to maintenance
for sea keeping.

The training facility may be obliged to own two
training vessels. Where fishing technology forms part of
the curriculum, a fishing vessel of about two hundred
gross tonnes and a deep sea going vessel of at least four
thousand gross tonnes should form the bases of the
practical sea training phase. There is the possibility of
combining the above two vessels into one. Unfortunately,
cramping can result in such an approach so two distinct
vessels are advisable.

FISHING TRAINING VESSEL

The training vessel for fishing will give experience
in routine work, non-mechanized and mechanized fishing
techniques. Seamanship and the use of navigational aids
in the real fishing environment is the aim. Catch
handling with safety measures in all aspects should be
embodied in the design and build of the vessel.

The tonnage of the vessel (200 grt) will be the
average commercial fishing vessel size in the locality of
the training facility. The engine power, about one
hundred and forty kilowatt (140kW), should match the size
of the vessel. She should be fitted out with the
prevailing industrial fishing gear with provision for
adapting techniques that are most likely to be introduced
into the local fishing trade in the foreseeable future.
It is unadvisable to fit multipurpose, unconventional
fishing gear as this will obviate the aims of the training experience. The general fitout should be representative of the order of the day in the vessels of the same size in the locality.

The engine should have the capability of bilge pumping and delivering water on deck. An attached generator may produce the power required for deck equipment and fishing gear handling. This should be in addition to an auxiliary engine of about thirty kilowatts (30kW). The deck powered equipment may have the possibility of using lower powers than required so that mistakes made by trainees will not be disastrous. The vessel should be designed and have among others, stern, bottom and mid-water trawling. Purse seining, longlining, pole-and-line fishing and gillnetting may all be catered for, where such harvesting methods are applicable. Sonar facility for locating schools of fish will also enhance the trainees' knowledge in this sphere.

As a training vessel, the full capacity for fish catches in commercial quantities need not be utilized. The spare space may therefore be used as accommodation for the trainees. A vessel of this size may accommodate twenty-five trainees in addition to the normal crew who should all be part of the maritime training facility.

The wheel house which will contain all the equipment as on a commercial fishing vessel of the same size should have an all round view. Though space is at a premium, the wheel house may have sufficient space to allow a small group (eight trainees and two instructors) to gather for explanations and instruction. This may also be applied to the engine room.

Safety is a premium especially where trainees are involved. Enough life jackets and lifeboats (and of course liferafts) must be provided on board. The fire
fishing capacity of the training fishing vessel must be adequate.

**MERCHANT TRAINING VESSEL**

To meet the highest propulsion power stipulated in the STCW convention for the highest certificate of competency, a three thousand kilo-watt engine must be installed in the training vessel. The vessel should be in the region of four thousand gross registered tonnage or sized to match the engine depending on the design. Though for first certificate of competency, less tonnage and power is required, a training vessel of the stipulated size should give the trainees a fair size to train with.

The vessel may be fitted out like a normal commercial trading vessel of its size, with modifications (mostly additions) as outlined in this paper.

**BRIDGE FOR TRAINING**

In addition to the normal navigational bridge, there may be a second bridge atop of the first. The second should be the training bridge equipped with a wheel and steering telemotor transmitter. A gyro-compass and a viewing for the magnetic compass should be provided with the possibility of auto-piloting. Two radar screens, satellite and decca navigators (multi-sensor receivers) and echo sounders may all be hooked to the ones on the main bridge. The main bridge will have the over-riding capability to enable corrective action to be taken when trainees make errors on the second bridge.

For communications, radio transmitter/receiver sets will be aboard together with two VHF sets with extensions to the training bridge. Two echo sounders may be fitted, one being the deep and the other the shallow type. A
barometer, anemometer and hygrometer will help in determining the prevailing weather conditions. Inclinometers will help to maintain the vessel upright for efficient propulsion and less stressing of the ship's structure.

The engine console in the training wheel house should have indication for speed from the doppler logs, engine revolutions, alarm and critical indications as well.

For internal communications, electronic telephones and public address systems may be installed. Sound powered telephones and sound pipes may link essential positions like bridge, engine room, emergency steering, forward and aft mooring stations for emergency actions and training.

The training bridge may also act as the second fire station as the fire detection panel on the main bridge will be duplicated here. An air sampling system may be used to monitor the spaces. The cargo and engine spaces shall be covered by a fixed fire fighting system.

Use of automation should be limited in the training bridge. A manual chartroom with manual position fixing instruments, such as sextant, is recommended.

ENGINE ROOM

The engine room controls should preferably be manual for trainees to have watch standing experience. Temperature, pressures and level regulation will then be manual. This would then give the needed practice when an automated control is to be over-ridden due to faulty operation. It also brings the trainees very close to the machinery and the various processes. Even if the engine room is fitted out for un-manned operation, for training purposes, the manual mode should be used most of the time.

Both steam and diesel engines may be represented in training vessel(s)
the engine room. This will allow the students a fair practice in each. Where the main engine(s) run on steam, i.e. turbines, at least one of the auxiliary engines should be diesel and vice versa. The training vessel's power plant should match her size to give a service speed anywhere between ten and seventeen knots (10 - 17 knots). There are instances where sail power has complemented main engine power on training vessels. Depending on the engine chosen, clutch and/or gears may be interposed between engines and propulsion shafting. A fixed blade propeller should suffice with an aft peak tank cooling the stern tube. There may be three auxiliary engines feeding the electrical bus-bars with 3-phase alternating current. Transformers and rectifiers will help bring to various equipment the required voltage. For a three thousand kilowatt main engine, each auxiliary generator should develop not less than one hundred and fifty kilowatts (about five percent). Because of the higher electrical load expected for the hotel services of the over fifty cadets that may be on board at a time, this auxiliary engine capacity may have to be doubled.

A shaft generator, also of the same size of one auxiliary generator, may be driven off the ship's propulsion line to give trainees the mode of operation of such a system.

The biological (or whatever system is chosen) sewage treatment plant should be sized to match the increased capacity expected for the increased number of personnel. The same applies to the refrigeration and air conditioning systems.

Some equipment may be provided in more than the duplication normally installed on commercial trading vessels. This will give instructors time to explain to trainees when the equipment (pumps, compressors, etc) is
opened up, rather than rushing to box them up for their stand-by duties.

LECTURE ROOM(S)

A space designated as a lecture room may be needed for large group instruction. Where the total number of trainees aboard are more than fifty, two rooms may be needed. Chairs with writing tablet arms should be provided for the students. Provision for securing in rough seas should be made. Each lecture room should seat at least twenty-five trainees. A writing board, projector, screen and a television set may be installed in the front of the lecture room. An overhead and a sixteen millimeter projector should be sited to give a good image on the screen.

Another room (or cupboards against the bulkheads of the lecture room) should house books, manuals, blueprints and other learning materials to cover academic, professional, extracurricular and particularly the training vessel itself.

DINING SALOON AND RECREATION FACILITIES

A dining saloon and a duty mess should be provided for the trainees. These facilities may adjoin that of the officers'. The tables in the saloon may double up for desks when cadets need large table top working space. These tables may therefore be sized to seat at least six cadets apiece during meal times. With some sofa and settee arrangements in a space adjacent to the dining saloon, this dining area may be turned into a recreation lounge in between meal times.

Almost all young people are hyperactive. Spaces may therefore be needed for sports and games. Table tennis, deck polo, sea billiards and such like should be catered...
for in addition to table top games such as cards, chess, draught, etc. Hobbies like photography, bird watching, gymnastics and darts can help fill the off-duty and learning hours which is in abundance at sea.

ACCOMMODATION

Where the normal accommodation on such a vessel is not enough to house a large number of trainees, cargo spaces may give way to cadet cabins. Such cabins may be designed to berth more than a cadet in a cabin. Bunks, lockers, drawers and writing table and chair should be provided for each cadet on board. Each cabin may have a day room next to it where seating in comfort can be easily achieved and "visitors" can be entertained.

Washing and toilet facilities may be the communal type where space is at a premium. In any case, at the most four cadets should have a water closet and a shower between them. Due care should be exercised when designing these cabins where female trainees are included in the training programme.

EMERGENCY SYSTEMS

Above all, with so many people aboard her, it is recommended that passenger ship safety regulations be applied to this training vessel. This is in respect of water tight divisions and fire separation zones. The national (adopted from international) regulations may have to be applied.

The ship's fire fighting capability will always be kept in readiness and top shape as this impression is what the trainees are likely to carry with them the whole of their marine careers apart from saving the vessel and their lives when needed. This applies also to the life saving appliances. Lifeboat capacity should be adequate.
Coupled to life rafts, there should be more than enough for everybody on board on port side or starboard side alone (100% per side). If the national passenger vessel rule is more stringent than this, then the national regulation should prevail as these cadets are more or less "learning passengers".

Emergency power should be given priority in maintenance. An emergency diesel generator feeding an emergency board may be needed in addition to a battery backup to ensure no total blackout situation arising.

A well planned training programme should be drawn to match the training vessel's equipment. Without this, the purpose of this most expensive and essential training aid will be lost.
Humans cannot leave the marine environment alone. Separating land masses, the water masses have to be traversed in one form or another for people to relate to each other. Holding an unlimited quantity of resources and covering over two-thirds the earth's total surface area, the marine environment has to be penetrated to reap the benefits available.

Shipping (international and domestic), defense and sovereignty, fish, minerals, energy, sand and stone harvesting necessitate humans venturing into the untameable marine environment. Cutting down losses as near to zero as possible in this unforgiving environment while harvesting marine resources is every nation's objective.

To do this effectively, man has to know the prevailing conditions in the environment and to apply the available tools efficiently. Both require the proper training of all maritime personnel to fulfill their job demands. It is then that the best of equipment will be produced and each managed and applied as designed. In effect, the maritime casualties will be reduced appreciably to safeguard man and the environment and put the limitless marine resources at man's disposal.

Training of personnel should be performed in a conducive atmosphere. The equipment one may be using in the field should be introduced before one enters the field if user acquaintance and friendliness is to be achieved.

Where the training facility is sited is important. Gains can be made if located near the marine industry. Visits by trainees to various sectors of the maritime industry will aid them to know what their chosen
profession entails and to gain experience while still in training. Knowledgeable visiting lecturers can be drawn from the industry in addition to part time release for up-grading workers.

Being near a water mass will afford the training facility the opportunity to practice seamanship.

Geological considerations will off-set expensive losses accruing from earth quakes, landslides, erosion, etc. Health hazards also impose limitations on the geographical location if epidemic out-breaks are to be prevented. Electricity, water and sewage systems are amenities one should not lose sight of as big bills and inconvenience can result if not given due thought in the siting stage. The environmental status has to be contended with. Examples of these are noise, pollution by factories and high tension cables.

Student population and types of buildings to be constructed will determine the size of land. Vertically stacked corridor floor type buildings may dominate though they will be clustered onto the land to form a campus set-up. Of course climate and kind of learning process in the building will determine the final selection of type.

The planning is very important if repairs, maintenance and replacement costs are to be brought low. Educational and architectural consultants may be needed to execute the planning stage effectively.

The library which supports the learning process should be well stocked to meet its objectives. Serenity and good stock management can go a long way in easing learning and searches. Library stock protection should be given due attention if losses are to be reduced to the diminishing point.

Class size can shrink or increase so adaptability of the lecture rooms by movable walls will aid room size
adjustments at little or no cost. Basically, it is recommended that each lecture room provides enough seating spaces for trainees and mounting areas for teaching aids. Writing boards, projectors and other materials that will enhance the knowledge acquisition process should be catered for in the lecture rooms.

If teaching aids are to be effective, then their selection and/or production should be given time and thought. The aids production centre, well equipped, will make teaching aid production fun rather than a job to be done and finished with. Printed and duplicated material should be easily taken care of by computer(s) (with word processing capabilities) and a good photo-copier. Transparencies can also be easily made in-house and a 35mm camera will help with slides (developed and printed out of campus). Video camera(s) in conjunction with video players and display units can bring complex processes into the comfort of the lecture rooms.

Well equipped laboratories and workshops can initiate the marine students from basics through actual tasks they will perform in the field as professionals. The more so with the safety and survival procedures which can mean life or death in the unrelenting marine environment.

Though expensive, simulators will allow the learners to make mistakes without causing any harm nor expense. This is very important as ship owners always look for employees with experience but normally do not want trainees to learn with their equipment. This may be because a mistake in the real world can make or break the owner. A simulator obviously circumvents this ambiguity.

Computers, which have become part of science, should be introduced to the trainees as the maritime industry is now a science rather than an art. The computer laboratory will see to this in addition to speeding up accounting.
stock keeping and some management procedures of the training facility.

The training vessel(s) give the professional to be the experience that goes into making a mariner. The maritime world accepts this experience before being given responsibility and is clearly defined in the international regulations. It therefore behooves the maritime training facility to provide such experience before a trainee is deemed qualified.

This synopsis has dealt with some of the things pertaining to the training centre. It in no way attempts to belittle the administrative, board and lodge, recreational and physical fitness set up of such a facility. They all form essential parts to make the training facility worth its salt though they do not fall within the confines of this paper. They should all therefore be catered for. In the same way, the syllabi and other programmes (soft ware) should be given their due quota of attention.

STAFF

This paper is not dealing with staffing, anyhow it is worth mentioning that a good set of equipment without the proper usage, care and maintenance becomes a liability rather than an asset. Qualified hard working personnel, especially technicians who know the equipment inside-out, should be available. This underlines an axiom which should be added to this set of recommendations. "White elephants are created by man not by nature."

APPLICATION

Though this paper is primarily written for a maritime training institute, it has a wide field of application.
With modification of the geographical location, the chapter on land applies to any educational establishment. The buildings are about the same for a particular climate though the type of learning process can mean some alterations. For example, when considering a school for children under the age of ten, one only goes to (or just below) the lower side of the given range of 0.38 to 0.75 square metres per student station to meet the need. Of course workshops will not apply to such a primary school age.

Higher institutions of science can also modify the laboratories and workshops to suit their requirements. This may mean replacing the tools and machines specified in this paper with those in the field they are studying in. The machine tools, bench work tools, etc will fit almost all technical colleges.

Even the arts schools and colleges can draw on parts of the paper, for example, the aids production centre.

Discussing application, one must not lose sight of the fact that maritime training facilities that are to be set up will find an immense source of material to start with in this paper. The already established training facilities too can draw from these recommendations to improve upon what already exists. The entry requirements and graduating standards will determine how much must be subtracted from and/or added to these recommendations.

Financial limitations can make one divide the buildup into phases. For example, a training facility may install one personal computer per forty students initially. Then add on to it gradually till the stipulated number per students is reached. From there it can go on to main frame computers if the training facility so demands.

The maritime industry can also benefit from this set-up (apart from the training of personnel) by way of

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conclusion
research assistance. A typical example is a shipyard that utilizes the research facilities the training institute’s tow tank provides. Another is a government ministry (agriculture for example) commissioning the fishing training vessel to research into a new fishing net for the net’s local applicability.

Finally, it will be presumptuous to imagine that this paper’s humble recommendations are a panacea to maritime casualty. A lot of other ingredients must go into the prescription that may reduce marine accidents to the diminishing point. But these other ingredients, tangible and intangible, will be based on a sound Physical Set Up - A Maritime Training Facility.
Geographical distribution of Total losses during 1987  
(number of ships)

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*Source: "Lloyd's Register Casualty Return 1987".*
**APPENDIX 2**

Total losses during 1987

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<td>Greece</td>
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<td>Japan</td>
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*Source: "Lloyd's Register Casualty Return 1987".*
APPENDIX 3

CHEMISTRY LABORATORY APPARATUS SAMPLES

1. Beakers
2. Bunsen burners
3. Crucibles
4. Flasks
5. Graduated cylinders
6. Pippets
7. Sinks
8. Taps (for gas and water)
9. Titrating sets
10. Chemical weighing balances
EXAMPLES OF BENCH WORK TOOLS

1. Reamers
2. Hack-saws
3. Oilstones
4. Taps (in sets of 3) with holder
5. Dies (with stock)
6. Chisels in flat
   cape
   round nose
   & diamond point
7. Files in round
   square
   flat
   half round
   triangular
   & key
   of course they must be
   stocked in bastard
   medium
   & fine
8. Allen keys
9. Screw drivers in normal
   & off-set
10. Spanners in open flat
    ring
    combination
    box
    & adjustable
11. Hammers & mallets
12. Wire brushes
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