1988

High tech ships; the status of safety after reduced manning and the possibilities of transferring this technology to developing countries

Abdel Azim H. Elrasoul
World Maritime University

WORLD MARITIME UNIVERSITY

MALMÖ, SWEDEN

"HIGH-TECH" SHIPS; THE STATUS OF SAFETY AFTER REDUCED MANNING AND THE POSSIBILITIES OF TRANSFERRING THIS TECHNOLOGY TO DEVELOPING COUNTRIES

BY

ABDEL AZIM H. ELRASOUL

SUDAN

A paper submitted to the Faculty of the World Maritime University in partial satisfaction of the requirements for the award of a

MASTER OF SCIENCE DEGREE

in

MARITIME SAFETY ADMINISTRATION

(MARINE ENGINEERING)

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

Signature:

Date: 21 October 1988

Supervised and assessed by:
Ernst Hansen-Tangen
Professor
World Maritime University

Co-assessed by:
Mr. Ragnar Kr. Knudsen
Principal Surveyor
Det Norske Veritas

TO THE SPIRIT OF MY FATHER

PREFACE

This thesis, having taken considerable time and effort was of a great interest to me and my aspirations towards shipping as a whole and my country in particular. It was a problem that confused me for a long time; how to combine between the two issues. With the assistance of my Professor, Mr. Hansen-Tangen we set up a good compromise, that is to split the thesis in two parts, one part for each issue.

Part A to be devoted to the effects of the application of reduced manning on safety onboard and Part B is to handle the, interesting question, of technology transfer.

Each chapter will be furnished with a separate introduction and a separate conclusion. Therefore, you will find a brief introduction to Part A and Part B and no overall conclusion. On the other hand you will find two sets of recommendations, one set for each part of the thesis.

I hope that, I had made something which is useful and would contribute to improve safety onboard reduced manning ships and, as in Part B, to encourage and enhance the transfer of technology embodied in the "high-tech" ships from the developed to the developing world.

I, hereby, forward my thanks and appreciations to my professor, Mr. Hansen-Tangen, the co-assessor, Mr. Ragnar Kr. Kindsen and the lecturer Mr. Stefan Fagerström for the assisstance and encouragement that they offered me all through this work.

ABSTRACT

The international maritime conventions and regulations and the national legislation concerning safety at sea almost were preceeded by catastrophies before they came into existence. Therefore, the emergence of the reduced manning ships was countered by a lot of noise and obstacles created by the safety people all around. This thesis in Part A, is not to hinder or slow down the process, it is a rational study to the phenomenon, evaluation of the pros and cons, removing the obstacles to consildate safety on board. It is actually an initiative to harness, think over and an attempt to regulate and control the safety requirements, once, before a catastrophy will take place.

The International Conference on Marine Engineering systems (ICMES) was held in Malmö in 1987 and was addressed by Mr. C.P. Srivastava, Secretary General of IMO. He requested the presence to work and convince the others to work on the issue of transferring the marine technology to the developing countries. Since that moment I decided to do something about it.

Part "B" of this thesis is an attempt for studying and analysing all the factors surrounding the transfer of marine technology from the developed to the developing countries. A considerable stress is made on the application of the "hihg-tech" ships, discussed in Part "A", in the developing countries and Sudan in particular.

TABLE OF CONTENTS

Page No.

Page No.

Page No.

Page No.

INTRODUCTION TO PART "A"

Part A, the effects of reduced manning scales on safety onboard, will be discussed through three chapters. The first chapter will focus on the applications of automation onboard, this together with the equiment reliability have led to the situation of the reduced manning are to be studied and their yields on safety are to be clarified.

The second chapter will, however, be considered as an excursion in the international conventions and instruments to see their views and responsibilities on the matter.

Chapter three will show in more detail the real applications of reduced manning onboard the "high-tech" ships with the safety measures being considered in every part of application.

CHAPTER ONE

AUTOMATION, RELIABILITY AND SAFETY

CHAPTER ONE

AUTOMATION, RELIABILITY AND SAFETY

INTRODUCTION:

A reduction in manning can only be realized by a compensating reduction in the manual tasks of ship operations. This will require not only a further automation of ship's machinery and equipment, but new concepts and standards of automation. Fortunately the technology is there and, equally important, it is also generally acceptable by users. Considerable advances have been made and will continue to be made in the field of marine automation, particularly computer based automation. With these advances will come radical changes to the way that ships are managed and operated.

1.1 WHAT IS AUTOMATION?

Automation systems have two main elements. The monitoring element which compares the required and achieved values and produces an error signal. The other element is, in off line systems, the display informing the operator of the error, and, in the fully automated or on line systems, the additional feature of an actuator capable of correcting the error.

The monitoring element in many present day control systems is electronic, and many of these are now computer based. The computer has brought a new dimension of intelligence to these systems. It is probably the main reason for the advances now being made and for the potential these systems have. For as the amount of electronic equipment in ships increases, so the use of computers to store and process the outputs from these equipments becomes both possible and advantageous. With more computers comes the possibility of data links between activities providing a completely new aspect to ship management and operation.

1.2 HISTORICAL BACKGROUND:

The control of ships, their plant and processes has progressed steadily since about of 1960 when automation was first applied to them. Prior to 1960, apart from a number of self-regulating systems (e.g. governor control of engine speed, mechanized lubrication systems, boiler combustion control and control of steam pressure, etc.) machinery and ship control was largely manual. About 1960 the first control rooms were fitted in machinery spaces. This took the marine engineer into an environment which was less noisy and of more moderate temperature. This requires the application of remote control to the main engines and it was quite quickly followed by extension of machinery control to the bridge. Though it was still necessary for the engineer to tour the machinery space periodically, to check the machinery and record the values of vital parameters for log records, it was not long before the dials and recorders of many of the instruments were brought into the control room to enable more continuous monitoring to be carried out. It was about this time, in attempt to reduce the operational aspects of the duty engineer's workload still further, that attempts were made to automate the logging function by the introduction of the "data logger". Later these were discovered to be unreliable because they were mainly designed for land-based use without attention given to onboard conditions. After this stage, quite soon, the term "unattended machinery space" (UMS) was introduced. This required that a ship was fitted with alarm, fire detection system, engine safety systems, plus automatic starting of stand-by equipment. From about 1965 the number of new ships constructed to operate in this way increased rapidly as the reliability of electronic equipment improved. It was not an easy step to apply computers in ship operations after it was used in the design in 1960, the reasons were:

i. The marine industries had not progressed to a point where the technology could be readily adopted.

ii. The early equipment proved unsuitable, in many cases, for use onboard ships due mainly to a lack of appreciation of the marine environment.

iii. The mini-computer was relatively expensive, compared to conventional electronic equipment.

iv. Shipboard personnel were not able to repair or maintain the computer and its peripheral equipment.

v. The cost effectiveness of the mini-computer was always marginal and because the merchant marine does not represent a large market sector, equipment manufacturing companies were reluctant to invest with so uncertain a return.

The early 1970's represented a period of consolidation. As the reliability of electronic equipment increased ships began to operate with engine rooms unattended for up to 16 hours a day. The engineering department became more and more concerned with maintenance as more and more engine room operations were automated.

Automation also began to impact on bridge activities. Navigational aids such as the transit satellite position fixing became widely available and the application of mini-computers to radar data processing heralded the introduction of today's collision avoidance radars.

The late 1970's saw the emergence of the microprocessor, or the computer on a chip. This technology resulted from development in aerospace, specially the American Space Programme. Electronic technology enabled logic devices to be produced at ever-decreasing cost.

1.3 AUTOMATION APPLICATIONS ONBOARD

Application for automation falls into main five areas:

i. Navigation
ii. Machinery
iii. Deck/Cargo
iv. Communication
v. Management and Administration

The last of these, Management and Administration, is in every sense a control system in that the user will want to compare his required result with the achieved result and do something about any difference or error. It is certainly an area in which automation to replace or assist manual operations is necessary.

1.4 AUTOMATION, INPUTS AND OUTPUTS:

The inputs to automation are in general:

i. Skilled Crew
ii. Planned Maintenance
iii. Spare Parts

The outputs could be:

a. Reduced Manning
b. U.M.S.
c. Safety
d. Optimized Process Utilization
e. Optimized Operation Programme Sequences

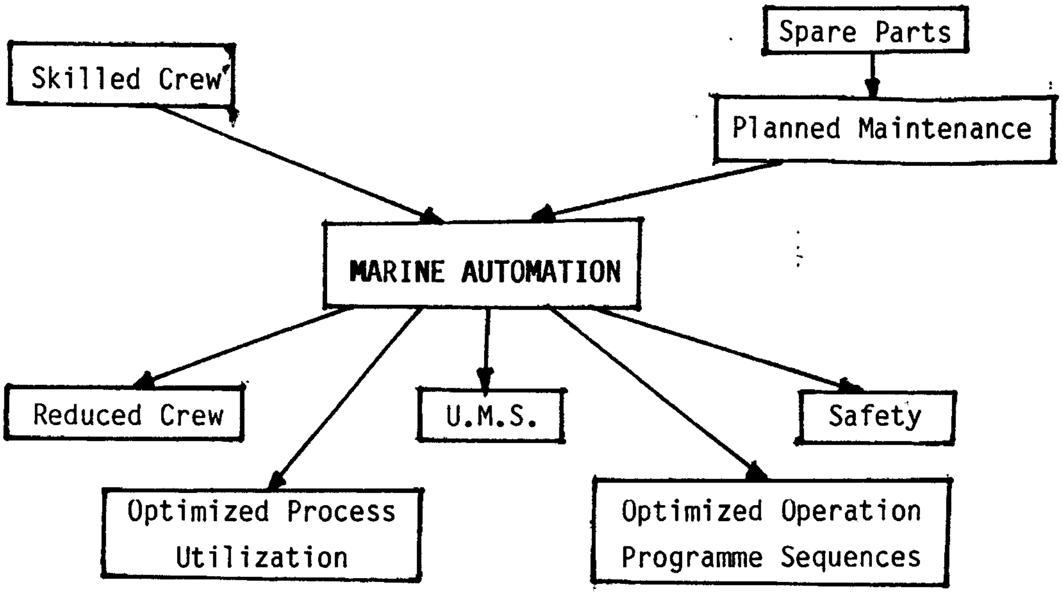


FIGURE (1.1): AUTOMATION INPUTS AND OUTPUTS

Survival in the business of marine transport by being more efficient and equally if not more competitive is the goal of every shipowner. Automation of ship's activities and machinery is one way by which this can be achieved.

Automation, properly applied, designed and installed, can give also:

a. Safer, more consistent management and opeation of ship's plant than is possible by manual control.

b. The present fragmented approach to and application of automation must give way to integrated systems.

c. Standardization of equipment and their interface must be the objective of those national and international bodies working on behalf of the industry.

1.5 TOWARDS AUTOMATED SHIPS:

In each country there are usually triangular contests, with shipping companies wishing to reduce costs, trade unions wishing to maintain or improve the income and conditions for members (or simply preserve jobs) and governments taking more (or less) interest in national revenues vis-a-vis minimum safety standards.

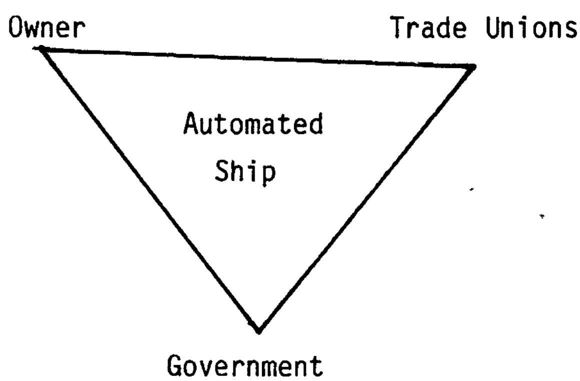


FIGURE (1.2) :TRIANGULAR NEGOTIATIONS

The two corners of the hotest negotiations are clearly those of the owner and trade unions in case of private companies in the west. The case, however, is different in the east and most of the developing countries where the government and the owner are at one corner, i.e. the government is the owner of the fleet. In the first case crew reduction comes through negotiations and may be strikes, like what happened in Sweden and at last it was settled for the benefit of both sides. The second case is not yet to face such a situation particularly when it comes to developing countries. However, part two of this thesis will consider the case in detail.

1.6 RELIABILITY:

Is a probabilistic notion, permitting to quote a component or an equipment in terms of changes of success in its mission for a given period of time, or more simply "is the ability of an item to perform its required function at stated conditions for a specified period of time". Estimated reliability is obtained from calculation while observed reliability is noted from real experience in true conditions. Reliability applies easily to discrete components or to printed circuit boards or to stand alone equipment. It is more difficult to apply it to large systems. In addition, some important data are missing in the calculations; such as possible faults in connections, in wiring, in terminals or in the software. It offers a relative value which is of interest when comparing or when evaluating the equipment. Nevertheless, it remains a theoretical and incomplete notion which is not enough to estimate the dependability of a system or the ship safety level.

Experience in dealing with marine equipment has shown that the simple concept of a component either being failed or operating is inadequate. The same goes for repair. A common denominator for most mechanical components is often large number of different failure modes which can be observed by any one item. The main problem with such a situation is that the different failure modes most likely arise through different failure mechanisms and may exhibit highly different characteristics and requirements as to repair actions.

The major hazards to be considered and evaluated for each mode are:

a. Loss of propulsion, manoeuvrability, steering,
b. Fire and explosions,
c. Flooding.

In order to access the level of safety, it is therefore essential to know the different parameters and the state of the system for every possible failure.

Besides the technical faults, the human factor is a vital part in this respect. Any assistance should be given to the operator to enable him to make correct decisions, during normal operation and emergency cases. The use of reliability engineering will provide assistance. It is evident that reliability and availability of the propulsion and navigation units are of vital importance for the economical results when operating large, modern ships. Operational break-downs and system failures mean not only loss of time and money. They also involve possible spill of high-risk cargo and pose danger of collision or grounding in areas of heavy traffic or in congested waters. The increasing size of ships, more complex and advanced systems for propulsion, navigation and cargo handling have developed the need for application of reliability engineering in order to assess the utility of the new technology, and level of safety.

Reliability engineering is a discipline providing tools for the evaluation of all kinds of failures and their consequences. It is, however, important to note that reliability engineering does not imply improving reliability but quantifying reliability. It presents a systematic approach to solving design problems, evaluating existing design and estimate future system performance.

1.7 RELATED FUNCTIONS:

Reliability could not be discussed apart from other related functions of direct dependence. These functions are:

a. Dependability
b. Failure mode, and
c. Redundancy

1.7.1 Dependability:

Is the confidence one can place in a system to assume the function for which it is designed or programmed. That function may be the main engine bridge control of a ship or her dynamic positioning for instance.

Where a function is carried out by a single equipment, its dependability is a direct funciton of this equipment reliability. Where many equipments are used, then the functional dependability gets an improved value, related to:

- The reliability of each equipment.
- The equipment failure mode.
- The nature of their redundancy according to whether they are identical or different (heterogeneous redundancy).
- The architecture of their interconnections.
- The strategy in case of failure.

It appears that good functional dependability can be obtained from modest reliability equipments and inversely, the first case being for economical reasons, the preferred in marine or offshore applications.

1.7.2 Failure Mode:

Is the behaviour of a component or of an equipment in the case of an internal fault.

Failure mode is not considered when evaluating a reliability level, since reliability does not distinguish between catastrophic failures and minor ones. Nevertheless failure mode is essential as far as the functional dependability is considered. Designers are to pay much attention to failure modes, with a view to selecting the most appropriate computer architecture and redundancy.

One of the most important reliability analysis is "Failure Mode and Effect Analysis" (FMEA). It represents a simple, but effective design tool. It can be applied almost without any particular trainng and consists of systematic and formalized evaluation of failure information. FMEA is a mental exercise, performed on a piece of paper, and the end result may provide important input to maintenance planning, spare provision planning as well as quantitative reliability analysis. An FMEA will assist to provide a high degree of achieved reliability or availability by identifying the failure modes, then effects and evaluate corrective actions that will eliminate or reduce the effects of the failure modes.

1.7.3 Redundancy:

Is the ability of a system or component to maintain or restore its functions when a failure has occurred, or in other words, if a given component fails its function is taken over by another component. The installation of a stand-by pump is a typical example.

The general requirement is that all active components such as pumps, engines, alternators, etc. are to be arranged with redundancy. Heat exchangers are, however, not considered as active components in this context. Important exceptions from this as regarding some Classification Rules are the following components:

- main engine,
- propeller and shafting,

- main boiler,
- anchor windlass,
- machinery for emergency power supply, and
- thruster

It does seem unlogical not to require redundancy in a number of the most important components on board, but such requirement would be impossible for economic reasons. By installing two pumps in parallel a great extra safety is obtained at a nominal cost, the cost of installing an extra main engine and propeller shaft would, however, be substantial. The safety requirement will always have to be weighed against the economy.

A further question is how redundant components should be arranged, and the most important factor here is the time needed for the stand-by unit to be in operation. Again the Rules of some classification society define three types of redundancy as follows:

Redundancy Type	Time Lag in Re-establishing Function
R1	0 - 30 seconds
R2	up to 10 minutes
R3	up to 3 hours

The consequence of the first type is normally that automatic change-over is necessary, while the second type allows for opening of valves, mannual start up and the like. The stand-by component must, however, be permenantly installed. The third type can be met by keeping a complete spare unit in the spare parts stock.

1.8 RELIABILITY PROMOTION:

From the previous discussion we can extract that reliability and then availability of a function may be promoted in many ways, this is for instance by:

- Stand-by arrangements (Redundancy).
- Designing each component for high reliability.
- Provision of spare parts, tools, instructions and availability of skilled personnel.
- Installation measures facilitating repair work.
- Arrangement of control systems.
- Limiting of failure consequences.

1.9 RELIABILITY APPROVAL:

How can an equipment be approved as reliable before it is put into service? Reliability approval is of utmost importance in the field of automated ships and technology as a whole. It is an area which is still occupying a wide range of discussion and many laboratories are still busy finding a better solution for this question. Up to now redundancy is contributing greatly to the reliability level to be raised. However, higher redundancy is not an indication of high reliability as the two components in parallel may be both of poor reliability.

Organizations taking care of reliability approval in the maritime field are mainly the classification societies and the maritime administrations. The latter being mainly depending on the former in many countries. Between establishment of standard and certification process execution there are four alternatives to be exchanged between the two organizations.

It is necessary for this matter as to be more tangible to take some society's Rules as an example:

a. For Redundant Components:

In this case it is considered that the single component's reliability is poor and therefore an additional requirement states that the combined availability of redundant components or systems shall exceed 0.9995 over the survey period. Considering a sea-water system fitted with double pumps having a normal service time of 6000 hours per year this requirement means that a maximum of 15 hours out-of-service time during 5 years of both pumps can be accepted.

$$\frac{\text{Actual time in service}}{\text{Desired time in service}} = \frac{x}{6000} = 0.9995$$

i.e. $x = 5997$

b. For Non-Redundant Components:

Here the Rules have requirements to critical reliability, e.g. "machinery with an output of 400 KW or more is to have a reliability over a period of 5 years of not less than 0.95" that is about 1% probability per year that a critical failure would occur. However, for machinery of less than 400 KW the critical reliability is to be not less than 0.9. In this case higher rate of failures are accepted as the consequences will be less serious.

To go back for the answer of the question at the beginning of this discussion I find it of a value to point to a procedure followed by NASAN (The National Administration for Shipping and Navigation in Sweden). To approve reliability of certain equipment on board a reduced manning vessel they put an officer from the Administration on board that ship for a period up to six months or over to report on the spot about the actual performance and reliability of these equipments. After the end of this period the officer will submit the report to the Administration to evaluate it and issues the appropriate decision about that particular equipment as to be approved or not. This is as for Administrations, but the matter is different when regarding the field of research. As an example we take Det Norske Veritas as a classification society worried about reliability levels. They also send an officer on board but using the radio communication he regularly sends the failure data through a certain code (coded) which will be fed to the computer in the head office to be processed. The computer will then decode the necessary recommendations on one hand and Rule adjustment on the other hand. Also at the end of a period a detailed report about failures and performance will be submitted to the head office.

1.10 SAFETY AFTERALL:

As regards safety, it concerns the crew, the ship and its cargoes and private property. Safety is the final result of the various dependability levels of those functions and systems which are involved in the ship or human safety. Therefore the main components of the global safety are the individual reliability levels of each equipment and of each software programme, added to the component failure modes and to the system architecture (in normal conditions and in emergency degraded conditions).

No doubt the new techniques are introducing some risks of new type such as: increased electromagnetic and electrostatic susceptibility, complicated failure modes and human factor in software. However, computers now are an absolute need for achieving an increasing lot of high level tasks which were impossible up to now. They are progress factor. If they are well applied, they can even bring in addition more reliability.

Nevertheless, it is also true that evaluating the systems quality and dependability is a difficult enterprise. It requires both minimum computer knowledge and good experience in the process matters. A good compromise in the selection of the tools of safety is difficult to achieve for the manufacturer and hard to evaluate for the classification society. Nevertheless, the catalogue of these tools is enhanced day by day and the means and methods of increasing safety are continuously progressing. This constant progress induces more and more the designers to spontaneously propose reliability and safety provisions much more developed than during the previous decade.

The need for improving the reliability of shipboard machinery and equipment has been stressed for many years. And for reduced crew ship, reliable shipboard machinery would be a prerequisite condition. In fact it would not be an exaggeration to say that if the reliability of shipboard machinery on the currently operating ships were adequate, it would be possible to man them with smaller complements without changing the specifications of the ships.

However, in reality no rapid and phenomenal improvements can be expected in shipboard machinery and equipment in spite of the incessant efforts being made by shipbuilders and ship machinery makers.

With the above in view, studies were carried out based on the accumulated data obtained from records of various shipboards machinery and equipment troubles that have occurred on many ships in the past to pin-point the weak points of each machinery and equipment. These studies resulted in the formulations of recommended measure for improving the reliability of such machinery and equipment, rough explanations of which are:

a. Outboard air intake system of main and generator engine.
b. Central fresh water cooling system.

c. Electric motor driven suction and discharge pump for the purifier.
d. Three stage air compressor.
e. Stainless impeller for sea-water pump.
f. Sea water pump bronze casing with tar epoxy coating.
g. Canned type circulating pump for boiler water.
h. Ferrous ion generating device and antifouling device for the pipes for heat exchangers.
i. Wall thickness of the pipes.
j. grade up of sea-water pipes.
k. Fuel and lub. oil pipes with tar epoxy outside coating to prevent corrosion.
l. Grade up of sea-water valves and strainers.
m. Oil separating device for control air line.

1.11 THE FUTURE:

During recent years, certain factors have had a considerable impact on operational costs of merchant ships. Some of these when it can be seen that the field of automation will be of importance in the near future, are:

- Oil prices and inferior bunker qualities.
- Short sailing contract periods for the crew; and organizational change.
- Increased ship specialization.
- International requirements for safety of ship and environment.

It has been said that a weakness of the previous generation is that although advanced and efficient equipment is used the results are still too traditional, i.e. the new equipment is not doing much more than the conventional equipment did. We are now beginning to see the contours of a "third ship automation generation"; where the automation systems will become an integrated part of the ship's operational functions. The development of maritime satellite communication systems, also enabling data transmissions between ship and shore, will be of great importance in this picture, enabling operational decisions to be made and transferred with a high degree of effectiveness.

In the third autómation generation one can see the outline of a system which is influencing the total decision-making for operation of the ship, this taking place on board as well as in the owner´s office, according to the operational strategy of the ship. Technically such a system might consist of a number of small self-contained computers, each with a dedicated function such as process supervision, ship administration computations, navigational functions, communication administration and so on.

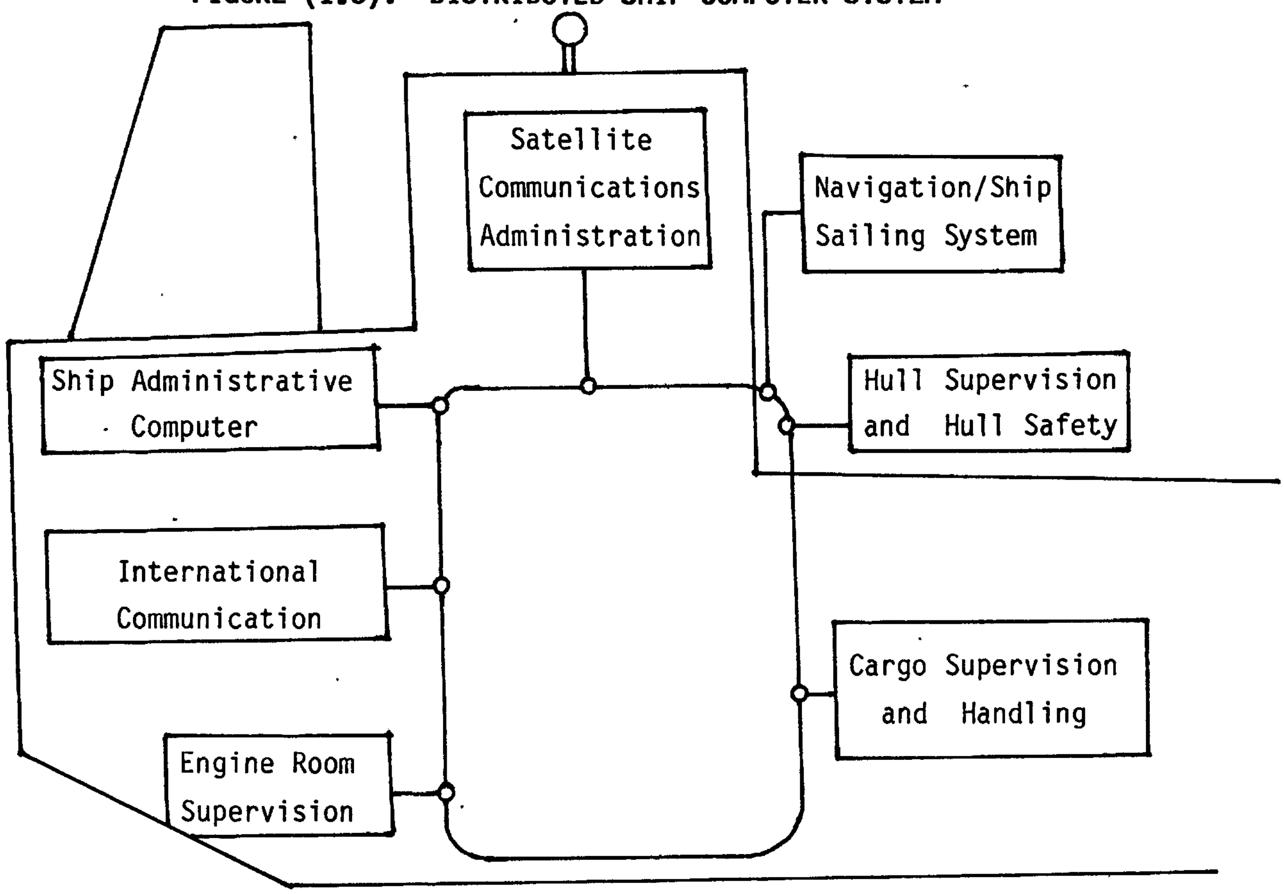
All these systems are made to communicate with each other as well as being able to communicate with external land-based stations, such as the owner´s company, agent, commercial data bases, service centres, etc. by means of data transmission by satellite.

In addtition to the more traditional automation tasks, such system will have a strong influence on cost reducing measures such as:

a. Optimizations of route (speed/rate);
b. Navigational improvements (routing, steering control, (etc.);
c. Optimization of trim and propulsion factors (g/ihp, t/n.m);
d. Supervision of hull roughness;
e. Optimization of docking and related procedures;
f. Bunkers and bunkering procedures (purchase, quality, storage, treatment);
g. Optimized cargo treatment;
h. Improved equipment for condition supervision;
i. Improved routine for maintenance and spare parts.

The introduction of such system is now beginning, with several ship owners now including these methods for new contracts. Figure (1.3) indicates the layout of an advanced automation plant based upon a distributed ship computer system. If we take the liberty of describing the technological development within shipping as the complexity of automation; we see that from the mid-1960s to the mid 1970s we automated the new buildings gradually. There were obviously variations within the individual vessels but the majority of new-buildings was rationalized and automated. It also seems clear that in the future we will see vessels with a considerably higher degree of automation, which will represent a more advanced operating pattern, defined here as "advanced ship operation".

FIGURE (1.3): DISTRIBUTED SHIP COMPUTER SYSTEM



In the future there will be two separate groups of ships:

a. An increasing number of ships with high cost, high efficiency, low energy consumption and with an extremely effective form of operation - advanced ship operation.

b. A decreasing number of traditional vessels with traditional operating and management patterns.

CONCLUSION:

Like any other field, automation also has its own drawbacks. This of course will be determined through the system design and its reliability level. Applications onboard ships will add some complications which are not encountered with land-based automation systems.

I can conclude, therefore, this discussion in three points:

i. Despite the considerable impact of automation technology onboard ships and until reliability is to approach unity and after, the ultimate criteria determining manning levels onboard will be safety.

ii. Technical feasibility is important, but the measure of the effectiveness of automation must be in the improvement in the "overall performance of the **MAN** aided by the **EQUIPMENT"**.

iii. The priority should not be for a "high-tech" design conceived with the objective of enabling a small crew to be carried, but with structures and systems that are robust and reliable, wherein attention to be focused on fuel economy, maintenance and equipment/component reliability and wherein the ship is manned in such a way that overall safety can be maintained".

The following points may support my conclusion points:

a. The periodically unmanned machinery space UMS lent itself much more easily to that approach because of the closed environment, the bridge and cargo areas are more complex because they react with the outside world which is often difficult to rationalize.

b. The enormous development of microprocessors sometimes leads to overenthusiastic expectations about the fully automated ship. The development of automation in ship's system is to follow a gradual process.

c. The sensors, whether radars or temperature sensors, are still sources of enormous information despite their experienced drawbacks and faults.

d. The working of systems, cooling water or cargo discharge systems, are not fully known or described in mathematical models.

e. The reliability of components in systems is not really specified.

f. The conditions of a ship at sea are unpredictable and therefore can only be described in a statistical manner. In any cybernetical system acting in an unpredictable set of circumstances, distrotions from sources outside the system could be expected. This will call for a control system with high corrective capabilities, mainly because a second distortion could follow any time after the first. If the time between distortion is shorter than the correction time of the control unit, the entire system will take unpredictable courses. On such occasions the crew has the capability of choosing alternatives. A ship´s officer on duty is monitoring and controlling, and when necessary he is also a fixer. A processor with sensors could do the monitoring and controlling even better but it is not a fixer.

CHAPTER TWO

"MANNING" IN INTERNATIONAL INSTRUMENTS

Introduction

2.1 Reduced Crew, Increased Responsibility

2.2 Development of Safety Standards

2.3 IMO Requirements

- 2.3.1 SOLAS Convention
- 2.3.2 COLLREG
- 2.3.3 STCW Convention

2.4 ILO Convention No. 147

2.5 Principles of Safe Manning

2.6 A Proposal Towards Unification

2.7 For the Sake of Safety

Conclusion

CHAPTER TWO

"MANNING" IN INTERNATIONAL INSTRUMENTS

INTRODUCTION:

There are two vague ideas which are said to be supporting the trend towards reduced crew ships or even totally unmanned ships, these being:

a. According to historical statistics it was found that more than 80% of marine casualties were due to human error. In this context also machine error was classified as human error due to bad design or improper maintenance. Consequently reducing the crew onboard will reduce the number of casualties.

b. Reducing the crew will eventually contribute substantially to the concept of safety in that the number of lives in question will be much smaller.

It is obvious that these concepts are general and will not justify the whole situation particularly when it comes to details. One can response immediately as follows:-

a. Concerning point (a), also generally, we can say "He who makes no mistakes, makes nothing". Human mistakes are existing everywhere and the shipping industry, like other industries, was to begin manually intensive and with technology outputs, man will be supplied with equipment towards a higher efficiency.

b. For point (b) one can simply say that the job itself has the priority then the safety follows i.e. the safety is a function of the job. The man is there onboard to carry out a certain career and he is not there for his safety. But if his job is of no meaning or could be replaced in one way or another then it should be well considered.

In this chapter one will look deeply into the international instruments whether in force or as proposals. This will include international conventions, particularly from IMO and ILO, Resolutions and Recommendations. The discussion will extend to include other parties in the maritime community and their views regarding this subject. This will apply to shipowners, Administrations, Classification Societies and some relevant organizations and unions. Through the discussion various concepts will be shown, both supporting or opposing the concept of reduced manning.

Prior to all, the increased responsibility of the crew on a reduced manning ship is viewed from different points. This is being followed by the development of safety standards since a long time ago.

2.1 REDUCED CREW, INCREASED RESPONSIBILITY:

Mechanization and automation have produced basic changes in the work and life style of seaman. It is not necessary to go back to the days of the sailing ship to make comparison. Even a comparison with ships dating from the first half of this century will make obvious the advances that have taken place in the design of the ships, their navigational equipment, the engine room automation, the increased comfort of the crew accommodation, the equipment for sporting and cultural recreation and many other matters.

Despite this, man is still playing the main role onboard and will continue to do so. In fact the responsibility of the captain and his crew has increased and will continue to increase as the value of the ships and their cargoes will rise. At the beginning of the 1950's there were hardly any cargo ships that cost more than 2 or 3 million dollars. Now on the other hand the captain and his crew are entrusted with ships valued up to 50 million dollars, or in extreme cases even up to 150 million dollars.

"Now fully automated ships become a posibility and perhaps a probability, but in reality to have valuable cargoes shipped around the world in almost as valuable hulls, unguarded and unattended would seems to stretch the imagination to the limits in this rather embattled world. Such an event could become a terrorist's or a pirate's paradise and to the author's mind is unlikely to occur in the forseeable future." (1)

If the crew is to accept more responsibility it must be more highly qualified. In the case of modern shipping it is not therefore always a case of making more intensive use of scientific and technological progress. It is equally necessary to ensure that the all-round qualification of the seaman to master the modern technology is fostered soundly and with an eye to the future.

There are two terms which arise with the existance of reduced crew ships, these being the "dual licensed officer" and "the general purpose crew" or GP. These two terms will reflect how much the responsibility of the crew is increased.

We can conclude that, with crew manning levels on ships dropping lower every year, and shipping companies expecting greater productivity from those remaining, it is essential to identify the duties and areas of higher workload. That can be rationally and safely achieved. The responsibility has increased due to a more sophisticated ship, irrespective of its training, and the same, or may be more, efficient operation is expected as was previously achieved with many more personnel.

2.2 DEVELOPMENT OF SAFETY STANDARDS:

In any industry, disaster has been the traditional stimulus

---

(1) Professor R.V. Thomson, Dean of Engineering, New Castle University, ICMES Conference 1987 "Marine Technology, A Time for Change".

necessary for the introduction of safety measures and the marine industry has been no exception. The names, TITANIC, ANDREA DORIA/STOCKHOLM and TORREY CANYON are all associated in safety circles not only with the disasters themselves but also with revisions and improvements which ensured in international safety measures. However, it should not be assumed that progress in international safety regulations is only made as a result of disaster. Far from that being the case, the work of IMO progresses on a broad front with ten specialized subcommittees reporting to the Maritime Safety Committee which co-ordinates activities in each particular field of research and development that is carried out by the member governments, bodies of the United Nations specialized agencies, classification societies, other learned bodies and the industry itself which makes a considerable contribution in these regards. This is all done without IMO itself spending any money on actual research.

Those who criticize this process of responding to marine casualties should bear in mind that the shipping industyr by its nature is properly resistent to being regulated, since its freedom to pursue its objectives by the most efficient and effective means possible is essential to its success and survival. The need for internal regulation must therefore be proved by experience before its acceptance can be assured. Also practical experience gained when established safety systems and procedures fail cannot be ignored. There are also those who characterize regulations made in respnse to casualties which happen to be classed as maritime disasters as regulatory over-reactions on the part of governmental authorities, hastily taken; the principal motivation being to assuage public opinion. The international consultative machinery established through IMO involves wide ranging discussions in which industry participates at both the international and national level. While there have been minor exceptions where an internatinal regulatory response has been made to an accident within six months it has otherwise taken one or two years to introduce even minor modifications and much longer to introduce major changes. The occasions on which haste can be attributed to this process are very rare indeed. As to the claim of regulatory over-reactions, this is always a matter of one's point of view and every safety authority finds itself accused from time to time, very often simultaneously, of over-reacting by those who have to comply with the regulation and of under-reacting by those seeking improved protection of life or property. On more than one occasion, subsequent experience has shown IMO corrective actions to have been, if anything, too conservative.

This discussion is vital when considering reduced crew ships as a new era of ships operation will begin accompanied by its expected and unexpected results, specially those regarding safety. One feels that, according to history of safety regulations, the same procedure to be repeated that it is not possible to devise some safe procedures for manning before accidents occur and people die.

The effectiveness of safety measures depends entirely on the adequacy of their implementation, application and enforcement. The role of IMO is to establish standards in the form of conventions, protocols and recommendations; and only governments can implement, apply and enforce such measures. To achieve full efectiveness, a measure has to be implemented by all governments through legislative or other means and applied through an inspection, certification or control process to all appropriate sectors of the industry. Sanctions of some sort have also to be imposed in some cases to enforce compliance.

With the need for global acceptance in view, the standards adopted by IMO do not generally represent the highest attainable standard in the field concerned. Even the fleets of developed countries reflect differing standards caused by variations in the degree of sophistication of the ships composing their fleets and in the quality of the management, maintenance and operation. There is a need also to ensure that equipment and procedures to be required by international regulations are sufficiently well proved and, further, that the equipment required will be commerjcially available at a cost-effective price. The standards adopted by the organization therefore generally reflect the highest practicable standards appropriate to the state of the art current at the time of their adoption.

2.3 IMO REQUIREMENTS:

Provisions affecting the manning of ships are contained in various instruments adopted by the internatinal organizatins such as the International Telecommunication union, the International Labour Organization and the World Health Organization. But in this context we are much interested in the provisions we find in the International Maritime Organization (IMO) Publications. Although many conventions, recommendations and resolutions were issued from IMO but still the questions of manning onboard ships is not well answered in particular. One, hereby, will try to tour among the SOLAS, STCW and COLREG Conventions and the principles of safe manning resolution.

2.3.1 SOLAS Convention:

Successive SOLAS Convention have included the requirement that all ships shall be sufficiently and efficiently manned but they never came to numbers specification. In SOLAS 1974 with its Protocol 1978 and 1981 and 1983 amendments we find the following regulations which in particular were appointed and designed for the question of manning in my point of view.

Chapter V Safety of Navigation
Regulation 13
Manning

The contracting governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.

The same chapter
Regulation 19
Use of the Automatic Pilot

a. In areas of high traffic density, in conditions of restricted visibility and in all hazardous navigational situations where the automatic pilot is used, it should be possible to establish human control of the ship's steering immediately.

b. In circumstances as above, it shall be posible for the officer of the watch to have available without delay the services of a qualified helmsman who shall be ready at all times to take over steering control.

Chapter II-1 Construction - Subdivision and Stability, Machnery and Electrical Installations.
Regulation 46
(For Cargo Ships)

i. The arrangements provided shall be such as to ensure that the safety of the ship in all sailing conditions, including manoeuvring, is equivalent to that of ship having the machinery spaces manned.

ii. Measures shall be taken to the satisfaction of the Administration to ensure that the equipment is functioning in reliable manner and that satisfactory arrangements are made for regular inspection and routine tests to ensure continuous reliable operation.

iii. Every ship shall be provided with documentary evidence to the satisfaction of the Administration, of its fitness to operate with periodically unattended machinery spaces.

The Same Chapter

Regulation 54

Special Consideration in Respect of Passenger Ships.

Passenger ships shall be specially considered by the Administration as to whether or not their machinery spaces may be periodically unattended and if so whether additional requirements to those stipulated in these regulations are necessary to achieve equivalent safety to that of normally attended machinery spaces.

Chapter IV - Radiotelegraphy and Radiotelephony

Part B - Watches

Regulation 6

Watches - Radiotelegraph

a. Each ship which in accordance with regulation 3 or regulation 4 of this chapter is fitted with a radiotelegraph station shall, while at sea, carry at least one radio officer, etc.

b. (ii) For Passenger Ships: if carrying or certified to carry more than 250 pasengers and engaged on a voyage exceeding 16 hours' duration between two consecutive ports, at least 16 hours' listening a day in the aggregate. In this case the ship shall carry at least two radio officers.

The Same Chapter
Regulation 7
Watches - Radiotelephone

b. Each ship referred to in paragraph (a) shall carry qualified radiotelephone operators (who may be the master, an officer or a member of the crew) as follows:

(i) If of 300 tons gross tonnage and upwards but less than 500 tons gross tonnage, at least one operator.

(ii) If of 500 tons gross tonnage and upwards but less than 1,600 tons gross tonnage, at least two operators. If such a ship carries one radio telephone operator exclusively employed for duties related to radiotelephony, a second operator is not obligatory.

2.3.2 <u>COLREG:</u>

The only regulation in the convention on the International Regulations for Preventing Collisions at Sea, 1972 that mentions something clear about manning as mandatory is regulation (5) on lookout.

Regulation (5)
Look-out

Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

2.3.3 STCW Convention:

It is one of the most important conventions adopted by IMO because it really added much to the pool of safety at sea. Nevertheless the question of manning levels is not addressed by the convention, since it was considered desirable to keep separate the question of manning levels and the quality of manning to be provided. So STCW concentrates on the quality of manning by spelling out the mandatory qualifications to be carried by crew members. When providing regulations concerning the crew certification STCW does not nominate more than:

- The Master
- The Chief Mate
- The Officers in charge of Navigational Watch
- The Ratings forming a part of a Navigational Watch in the deck department, and
- The Chief Engineer
- The Second Engineer Officer
- The Enginer Officers in charge of a Watch
- The Ratings forming a part of an Engine Room Watch in the engine department, and
- The Radio Officers
- The Radiotelephone Operators for radiotelegraphy and radiotelephony department.

This does not mean that these regulations mandate the existence of those crew members onboard and should not be understood even implicitly. What should be understood is that if those crew members are to be onboard they should carry the mandatory qualifications provided for. Also we do not find any nomination for second or third officers or any other jobs in an intentional way to keep aside the manning levels for other instruments.

But Regulations II/1 and III/1 are being the most important regulations contributing to manning levels. They are providing the basic principles on which the navigational and engineering watches should be properly kept. This is achieved through spelling out the duties to be carried out by the officer on the bridge and the engineer in the engine room for a safe watch. These stipulated duties must be undertaken either manually or automatically through equipments, the choice being up to the shipowner. In this way a concrete basis for manning level is founded. This basis being, for each individual ship, a comparison between duties stipulated on one hand and the manning or equipment on the other hand. This basis was actually utilized in adopting the principles of safe manning issued by IMO in Resolution A 481 which will be discussed later in this chapter.

2.4 ILO CONVENTION NO. 147:

It is of great importance to have a look over ILO Convention Concerning Minimum Standards in Merchant Ships as an international tool aiming for more safety onboard merchant vessels. The Convention was adopted in 1976 and came into force 28 Nov. 1981. The Convention was pointed at as a pertinent instrument to the matter of safe manning when IMO issued its resolution No. A 481 on principles of safe manning. The Convention is designed especially for substandard vessels particularly those registerd under flags of conveniece as clearly stated at the beginning. It consists of twelve (12) articles and only article (2) is containing the whole concept of the minimum standards concerned, the remaining articles being devoted for implementation and ratification procedures. In Article (2) (a) we find the main three points of the Convention as follows:

Article 2:
Each member which ratifies this Convention undertakes:

(a) To have laws or regulations laying down, for ships registered in the territory.

  i. Safety standards, including standards of competency, hours of work and manning, so as to ensure the safety of life onboard ships;

  ii. Appropriate social security measures; and

  iii. Shipboard conditions of employment and shipboard living arrangements in so far as these, in the opinion of the Member, are not covered by collective agreements or laid down by competent courts in a manner equally binding on the shipowners and seafarers concerned;

  and to satisfy itself that the provision of such laws and regulations are substantially equivalent to the Conventions or Articles of Conventions referred to in the Appendix to this Convention, in so far as the member is not otherwise bound to give effect to the Conventions in question.

(b) The Article goes on to ensure effective exercise of jurisdiction or control over ships in respect of the forementioned three points.

The ILO Convention No. 147 is called the Umbrella

Convention because its Appendix referred to earlier is containing all other conventions relating to safety at sea. This emphasized by Article 5 of the Convention which opens ratification to members which are party to SOLAS 1960 or 1974, Load Line Convention and COLREG Convention. The Appendix contains:

- Minimum Age Convention, 1973 (No. 138), or
- Minimum Age (Sea) Convention (Revised), 1936 (No. 58), or
- Minimum Age (Sea) Convention, 1920 (No. 7)
- Shipowners' Liability (Sick & Injured Seamen) Covention, 1936 (No. 55), or
- Sickness Insurance (Sea) Convention, 1936 (No. 56), or
- Medical Care and Sickness Benefits Convention, 1969 (No. 130);
- Medical Examination (Seafarers) Convention, 1946 (No. 73);
- Prevention of Accidents (Seafarers) Convention, 1970 (No. 134) Articles 4 and 7.
- Accommodation of Crews Convention (Revised), 1949 (No. 92);
- Food and Catering (Ship's Crews) Convention, 1946 (No. 68) (Article 5);
- Officers' Competency Certificates Convention, 1936 (No. 53) (Articles 3 and 4);
- Seamen's Articles of Agreement Convention; 1926 (No. 22);
- Repatriation of Seamen Convention, 1926 (No. 23);
- Freedom of Association and Protection of the Right to Organize Convention 1948 (No. 87);
- Right to Organize and Collective Bargaining Convention, 1949 (No. 98).

To discuss the pertinence of this convention to safe manning principles adopted by IMO, one can say that it handles the safety of life on board by setting standards of competency, hours of work and MANNING. As the safe manning term does not only mean the number, the convention stressed on employment conditions and shipboard living arrangement which to my opinion is the greatest safety element than any large crew number could be carried. One significant point to add is that the extra ordinary importance of this Convention lies in the fact that it encompasses all ships - no matter whether they fly the flag of a state party or non-party to the Convention.

2.5 PRINCIPLES OF SAFE MANNING:

In November 1981 IMO adopted the Resolution A 481 which covers the principles for safe manning. This resolution is considered as a pragmatic approach to the problem and we hope it is followed in the near future by some development in details to qualify it to be attached to a relevant Convention as an amendment or protocol.

Under the umbrella of IMO, ILO, ITU and WHO Conventions these principles were issued. The resolution urges member governments to take the necessary steps to ensure that every seagoing ship to which the International Convention STCW 1978, applies carries onboard at all times a document issued by the Administration specifying the minimum safe manning required for such a ship and containing the information given in the resolution. It urges also that member government should excercise port state control to get sure of compliance with such a document.

In establishing the minimum safe manning for each ship Administrations observe the following broad principles and provide to:

a. Maintain a safe navigational watch in accordance with Regulation 11/1 of the 1978 STCW Convention and also maintain general surveillance of the ship;

b. Moor and unmoor the ship effectively and safely;

c. Operate all watertight closing arrangements and maintain them in effective condition and also deploy a competent damage control party;

d. Operate all on-board fire equipment and life-saving appliances, carry out such maintenance of this equipment as is required to be done at sea, and muster and disembark passengers, non-essential personnel and other crew members;

e. Manage the safety function of the ship when employed in a stationary or near-stationary mode at sea.

f. Maintain a safe engineering watch at sea in accordance with Regulation 111/1 of the 1978 STCW Convention and also maintain general surveillance of spaces containing main propulsion or auxiliary machinery.

g. Operate and maintain in a safe condition the main propulsion and auxiliary machinery to enable the ship to overcome the foreseeable perils of the voyage.

h. Maintain the safety arangements and the cleanliness of all accessible spaces to minimize the risk of fire.

i. Provide for medical care on board ships.

For each of the principles mentioned above there is a guideline for application included in the same Resolution. A slight remark to be noted is that while the principles incorporated in the Resolutin apply in respect of the Master and the entire crew, the guidelines only apply in respect of the Master and the officers and ratings performing deck or machinery space functions. The Resolution is not mandatory but it urges the member governments to include these principles in necessary steps for the purpose of control of manning levels. The Resolution was really a necessary step taken by the Organization and was also on the spot and on time. This assures that the Organization is updating its conventions regularly and also updating itself by keeping strict surveillance and open eye on the changes in the maritime activities and needs. The Resolution has achieved an international success when many countries responded by issuing the document of "Minimum Safe Manning".

2.6 A PROPOSAL TOWARDS UNIFICATION:

The International Federation of Shipmaster's Associations (IFSMA), has responded to the questions of manning levels and submitted their veiws on the proposed minimum manning of ships of 1600 GRT and above to IMO. The proposed scales depend on each vessel having the following additional equipment:

a. An automatic pilot (double equipment) which will steer the ship under most conditions and speeds.

b. A call system (telephone or equipment) to all rooms, independent of ship's current (own batteries).

c. An automated engine room to be unmanned 24 hours a day.

d. An automated, centralized fire-detecting and fire-fighting system.

e. An automatic bilge alarm.

f. An adequate electronic position-fixing system.

g. Automatic mooring winches; centralized control system forward and aft, port and starboard.

The Master is in all cases to be excluded from watchkeeping.

Ships of 1600 gross tons (open measurement) to 4000 gross tons:

1 Master (duly licensed)
3 Mates (duly lincensed)
1 Radio Officer (duly licensed)
2 Engineers (duly licensed)
4 Multi-purpose Seamen (fully qualified and experienced)
1 Cook/Steward
1 Assistant Steward

Ships of 4000 to 9000 gross tons:

1 Master (duly licensed)
3 Mates (duly licensed)
1 Radio Officer (duly licensed)
2 Engineers (duly licensed)
1 Boatswain/Foreman (fully qualified deck and engine)
5 Multi-purpose Seaman (fully qualified and experienced)
1 Cook/Steward
1 Assistant Steward

Ships of more than 9000 gross tons:

1 Master (duly licensed)
3 Mates (duly licensed)
1 Radio Officer (duly licensed)
3 Engineers (duly licensed)
1 Boatswain/Foreman (fully qualified deck and engine)
6 Multi-purpose Seamen (fully qualified and experienced)
1 Cook/Steward

1 Assistant Cook/Baker
2 Assistant Stewards

This minimum complement could be approved only if composed of experienced seamen capable of carrying out their duties under all circumstances. The complement could be supplemented by trainees, but an apprentice or trainee may not be a member of the proposed minimum.

If a ship does not comply with the requirements (a) to (g) the crew must be increased in order that these functions are carried out. One of the engineers must also have qualifications as an electrician.

Furthermore, there are recommendations including, standardized bridge layout; manoeuvring control facilities on each bridge wing; standardized instrument handling and display; data logging on bridge and engine room.

2.7 FOR THE SAKE OF SAFETY:

Nothing can stop technological changes if they are to be for the benefit of the whole mankind. But hot competition for survival, as the case with shipping today, could take us away from other important measures. Safety measures should be The deciding factor in passing any technological change regarding ship industry. Manning reductions came out for a better competitive situation, but how could this "better competitive situation" be weighed against "the reduction of the pool of safety" on board? And is an equipment really capable of replacing a man in this aspect? I always expect a strict answer for one against the other when it comes to safety because safety will not accept any compromise.

Now let us see the frequent causes of most accidents:

1. Insufficient bridge manning and watchkeeping procedures.
2. Negligence in navigation, improper use of radar.
3. Use of automatic pilot under conditions or in situation in which a helmsman should have been placed, even on rivers under pilot assistance.
4. Disregard of collision regulations.
5. Insufficient cargo stowage.
6. Non-observance of stability data.
7. In a few cases alcohol has played its part.

Manning influences all those points either by reduction or by qualification and human factors. To have a close detailed picture about manning level and its direct influence on causes of accidents the following statistics is necessary:

Casual Factors	Total	Collisions	Rammings	Groundings	Strandings
Master not on bridge (in addition to watchkeeping officer)	46	9	-	29	8
Watchkeeping officer absent	213	43	2	80	88
Helmsman not on bridge	71	22	-	32	17
Look out not on bridge	173	39	2	52	80
Unsatisfactory relation with pilot	20	5	4	9	4
Navigator has just taken over watch	29	4	-	21	4
Helmsman had just taken over wheel	2	-	-	1	1
Navigator was at the wheel	194	39	1	118	36
Conditions related to watch arrangement	3	2	-	1	-
Others	1	-	-	-	1
	752	163	9	343	273
NUMBER OF CASUALTIES	**2709**	**891**	**192**	**1199**	**427**

FIGURE (2.1): CASUALTY FACTORS RELATED TO MANNING

The figures are always self-explanatory and no comment is actually needed.

To get into the heart of the problem let us see what shipowners say. They have internationally opposed the establishment of mandatory international safe manning scales, this is because:

a. International scales would necessitate a crude assessment of ship types and machinery/equipment carried on board and therefore the flexibility essential for ship operation.

b. The requirement of specific numbers could inhibit developments that evolve in the light of technological and other changes.

c. International regulations do not define the status or qualifications of all ranks of seafarers. There would be, therefore, problems of definitions.

They focus the solution in countries to institute systems under which the Administration fixes the safe manning level for individual ships or groups of ships. This determination at national level, in consultation with all relevant parties, will enable the essential flexibiity to be maintained. This view could be translated in the document of "minimum safe manning" under port state control.

Nevertheless, this should not be the whole story and for the sake of safety at the end there must be inspectors to ensure that these standards are being met. There should be also an independent "panel" of experts available to review manning levels on the request of an owner or state. And the most important, they are to investigate all incidents where manning levels contributed to an incident.

CONCLUSION:

i. The international conventions did not touch the subject of manning directly, may be due to lack of necessity at the time of their adoption. They left the questions to the satisfaction of the administrations, but they require the existance of some personnel. On the other hand, the incentive being the high safety incorporated in their jobs.

ii. STCW concentrates on the quality of manning by spelling out the mandatory qualifications to be carried by crew members in order to correspond to those duties and safe watch requirements spelled out in the same Convention.

iii. ILO Convention No. 147 being the most important maritime convention adopted by ILO has laid down solid grounds and bases, with STCW and others, for the emergence of Resolution A 481 (XII) on the principles of safe manning.

iv. The principles of safe manning was a necessary successful step taken by IMO just in time to meet the needs of a changing maritime field.

v. All the past points resulted in the birth of the important "Minimum Safe Manning" document.

vi. A great sign of development in our maritime world is that the traditional approach to manning questions, that of prescribing certain numbers of personnel holding designated qualifications to ships according to their tonnage or other criteria, has in recent years being replaced by a more flexible approach based on individual review of a ship's needs. This has resulted from the growing:

a. Difference in the design and layout of ships;
b. Difference in the amount and sophistication of their equipment;

c. Wide difference in the nature of their employment;

d. Variations in crew tasking; and

e. Differences in voyages or areas of operation.

CHAPTER THREE

SHIPS OF THE FUTURE

CHAPTER THREE

SHIPS OF THE FUTURE

INTRODUCTION:

Although the term "ships of the future" will remain valid as long as modernization and progress of ship remain, in this chapter the term is designated for types of ships which tend to be "existing ships" and many of them are sailing now. But, in my opinion, they are still under the term "ships of the future" because their operational impacts are not yet mature to assess them as "existing". As it was always the experience with the development of safety standards in shipping, that is to say, rules and regulations to follow a disaster occurrance, these ships have not yet yielded what is expected in the safety realm. Reduced manning on board ships sailing high tough seas, despite technology, is a daring practice which will result in serious impacts on the safety pool.

This Chapter, is an excursion with open eyes and conscious feelings onboard those ships considering the major aspects affecting the safety standard. If everything to be found as required or satisfactory, the human element is the one to be found the most retarding. Regardless of the incorporated safety in the ship's systems, separate independent safety systems are to be considered on board these ships.

3.1 COMMON FEATURES:

As I mentioned in the introduction to this chapter, the "future ships", as a project started some time ago, becomes now a reality. A lot has been written and every detail of construction was faithfully fulfilled. Under this heading I will introduce the most common and important features of this ship in order to have a basis for the next dialogue about her.

Let's define the term "ship of the future" first, it is a ship

a. built in the future, not contracted at the start of the research and development (R & D) programme,

b. in which the results of present-day technological developments are applied,

c. that meets future requirements for safe and economic employment, and finally,

d. with reduced crew.

It was stated earlier that the industrialized countries must rely on more capital-intensive shipping in the world freight markets. The conclusion to be drawn from this is that they must choose the types of vessels according to the market demand, and they must operate the vessels more effectively. They must compensate their higher salaries with other competitive factors, such as: greater operating efficiency; improved safety and reliability; less energy consumption; improved marketing and improved service. These can be achieved through additional capital investment in design and outfitting of ships in order to make them more productive labour saving and operationally reliable by the following means:

i. Use of materials with increased functional or maintenance-reducing effect.

ii. Increased use of instrumentation and automatation which improves monitoring and thereby increases operational reliability and safety.

iii. Greater efficiency in cargo handling and storage.

iv. Investment in design, equipment and operational systems that optimize fuel economy.

v. Ergonomical considerations incorporated in the design of the ship.

vi. Investment in labour-saving aids and that reduce or lighten the need for manual operation.

vii. Introduction of efficient and more human-oriented methods in organization of work and job satisfaction.

viii. Increased operation and information processing by investment in communication equipment.

ix. Upgrading the management funcitons at the shipping office through increased use of system analysis and modern planning techniques, use of electronic data processing (EDP) as a management tool, etc.

x. In the vessel, the bridge is the operations centre of the ship. Alarm monitoring and control of all ship systems and ship processes are performed from there. For this reason the bridge may be referred to as the Ship Operation Centre (SOC).

xi. The number of crew is small.

Optimization of ship operation is made possible by the application of results of the developments in:

a. electronics and microprocessors;
b. control engineering;
c. self-regulating systems;
d. fail-to-safe principle;
e. alarm, condition and performance monitoring systems;
f. reliability engineering;
g. simplification of mechanical systems and standardization;
h. maintenance management and design for one-man maintenance;
i. expert systems.

3.2 STARTING FROM THE DESIGN STAGE:

In all commercial shipping there is the need to be competitive and operating efficiency, derived in part from organizational functions and in part by technical solutions, becomes an imperative. The builder task, therefore, is to seek a conciliation between cost-demanding safety and cost-reducing efficiency.

Generally, the shipowner is more interested in a low-cost efficient ship without paying much attention or money to safety aspects. Therefore, it is the task of the Administration directly or through a recognized body, like a clasification society to:

a. Supervise and monitor the contract between the owner and builder through classifying rules.
b. Establish the optimum manning in relation to functions to be carried out on board.
c. Concentrate on safety requirements to be incorporated and built-in during this stage.

3.2.1 Between Owner and Builder:

This relation is not a direct one as it could be seen above, although there is a building contract between them, the main contract is between the builder and the classification society authorized by the owner as the case with developing countries. This contract will spell out that the ship is to be constructed according to the classification rules which are discussed between the owner and the class society. Accordingly the C.S. will supervise the whole construction stage, after necessary approval for the design work and drawings. The C.S. has its system for controlling and following these stages. It has a project manager situated in the shipyard. He sends the main drawings to the head office to be approved there and returned for him while some drawings could be sent to the concerned approving station in that district of the world, for approval also. There is also a surveyor belonging to the C.S. who is in charge of sub-contractors to approve every supplied equipment separately. The owner representative, on the other hand, has his contacts with the builder and the C.S. Through this system all safety measures in the construction or separate equipment could be well controlled in advance. The following figure is showing two kinds of relationships, one is assumed as healthy, securing safety and future relations, the other being short-sighted, making profits in the short-run, ignoring safety and loosing the future.

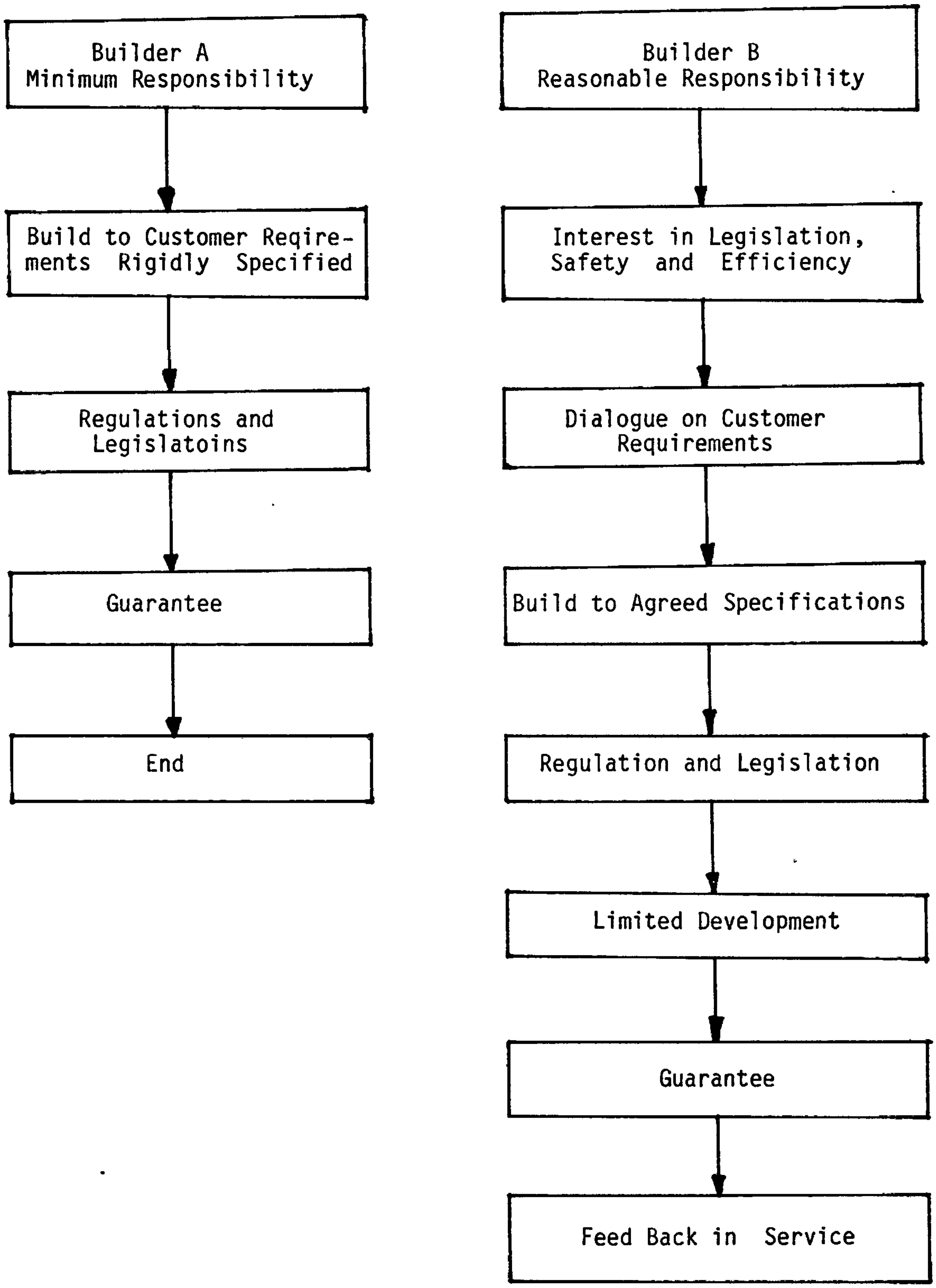


FIGURE (3.1): THE BUILDER/OWNER RELATIONSHIP

3.2.2 Optimum Manning:

An efficient ship built to meet functional requirements deduced from analysis of the functions to be carried out by the complement of the ship is the bases for safe and efficient ship operation and reduced operating cost. A work force tailored both in size and qualifications to all the functions and duties to be carried out on board is the basis for safe and efficient running of the ship.

If the building and outfitting of a ship is commenced without having established the optimum manning in relation to the function to be carried out on board, technical means to be installed and other operational conditions influencing workloads and performance of the tasks, then that is evidence of improper design work. How can we expect to design a ship for rational operation without knowing how it is to be operated, the number of persons to operate it and their qualifications? If manning levels are established without considering actual workloads, working routines, and operational procedures in relation to funcitons to be performed under normal and abnormal operating conditions as well as in emergency situations, we must question the relevance of the criteria which the manning level is based upon. Also, how can we arrive at optimum manning for safe and efficient ship operation without considering the conditions which influence the operation of the ship?

The points made should demonstrate that qualitative analysis of the functions to be carried out on board must be the basis, both for establishing design criteria and manpower requirements. Likewise, it is obvious that performance of such analysis and the ability to match functional requirements, technical relations and manning in order to optimize ship operation require a team of experts who master the various professions within ship operations, design, automation and human engineering.

The appropriate minimum safety manning is the responsibility of maritime authorities but the total manning of the ship is certainly the concern to everybody involved with safe and efficient ship operation. This could be listed as follows:

<u>Maritime Authorities:</u>

* Seaworthiness
- Crew Size

<u>Owners:</u>

* Competitiveness
- Optimum Manning

<u>Ship Management:</u>

* Operational Safety and Efficiency
- Sufficient Manning

<u>Classification Societies:</u>

* Total System Reliability (technical system and human operator is the total system)
- Competent Operation

The shown figure details the analytic approach and methodical evaluation of manpower requirements.

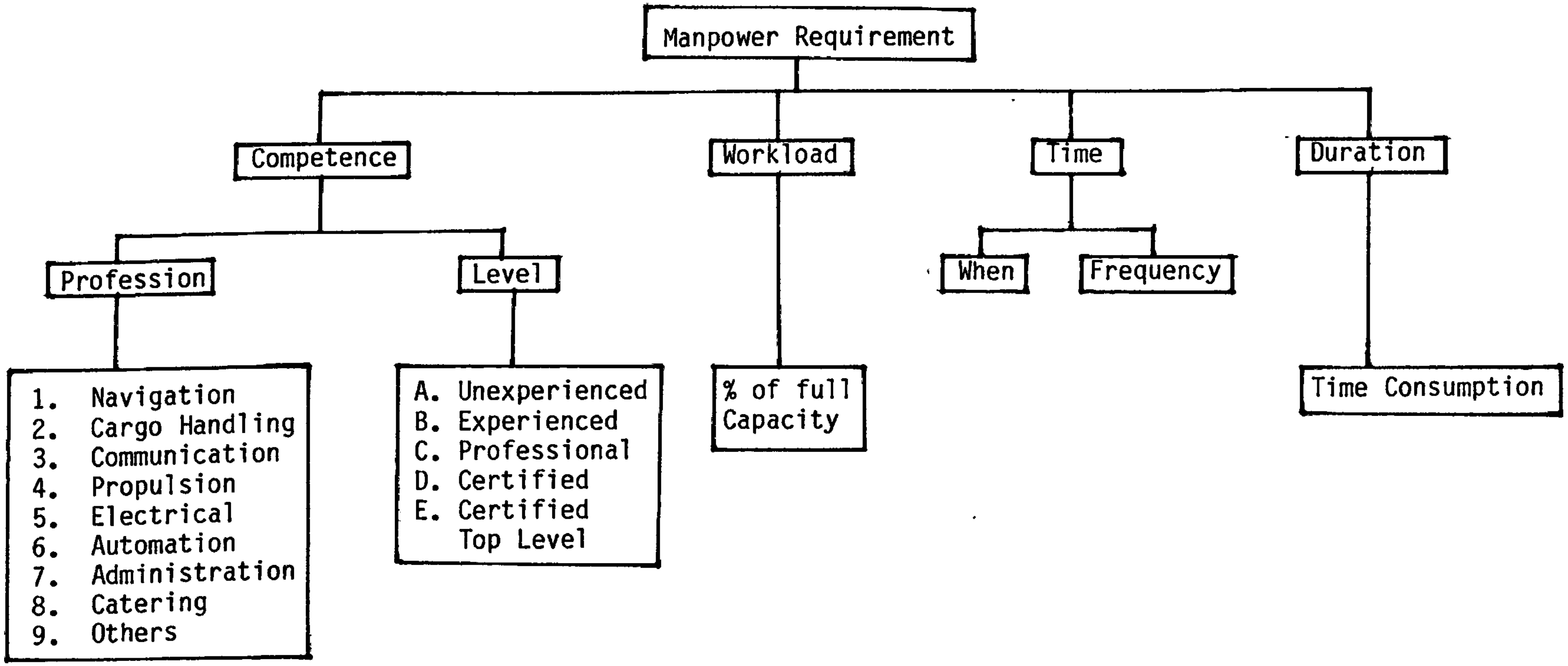


FIGURE (3.2): METHODICAL EVALUATIONS OF MANPOWER REQUIREMENT

3.2.3 Built-in Safety:

The manning level on a ship is the main basis for determining the amount of safety to be built-in or incorporated in the construction of the ship. The smaller the complement the higher the amount of built-in safety. When the crew numbers were normal, i.e. before rationalization, the safety was mainly fulfilled exter- nal to the construction, i.e. by separate equipments. These equipments are also needed today and even more advanced and safe beside the most important, the incorporated safety. The same analytic approach and methodical evaluation used for determining manning level is needed here for evaluation of safety on such reduced crew vessels. It is the question of the accessibility to operate a safety system or equipment, a question to compromise between the small complements, their positions at any time and the distribution of such systems and euqipment around the decks, accommodation and engine room. The idea of concentration of the safety operating items was introduced in such type of ships. This is what is so-called "safety centre" situated in a certain position. It will be discussed later in this chapter. However, the choice between extensive distribution and concentration will also be handled. But, what so ever the case might be, the built-in safety is to consider, inter alia, the type of the ship, the crew number, nature of operation and the environment in which it operates. Any defects or flaws in the safety plan during this stage could be of a catastrophic result in the future and will be also expensive to rectify. However, the whole plan should aim and concentrate on how a limited number of crew could successfully handle, operate and control all safety systems and equipment on board. This is to be done irrespective of their positions, the emergency situation at any time and any place. Before this, the built-in safety is to offer a natural protection, behind our senses, to minimize the expected and unexpected impacts of sea perils. The ship stability in this context, being out of the scope of classification rules, is to be well considered by the maritime authorities.

3.3 THE WORKLOAD AND MAINTENANCE:

It was necessary to analyse the workload on board traditional ships as a step towards reducing the crew on board the "future ship", through automizing the job or using dually licensed or integrated crews. The result was to introduce intensive technological applications to reduce the workload, nevertheless, some weak areas are still there. These are concentrated workload in coastal navigation and the maintenance question. Before suggesting any solution, I would like to point out the technological developments introduced in each area of the ship.

3.3.1 The Engine Room:

The past few years have seen the computerization of engine automation systems. This does not influence the manning so much, because the manning level for normal operating conditions already is zero if the requirements for unattended machinery space are complied with (UMS). In this area, reduciton in alarm conditions and the need to attend the engine room under various operating conditions as well as reduction in maintenance can reduce the workload and affect manpowr requirements. Reliable computerized alarm, monitoring and control systems are some of the means to achieve this.

3.3.2 Bridge and Cargo Area:

The use of automation and remote control systems has been extended to new areas on board. Examples are automation of navigation functions and transfer of engine room, mooring and cargo control functions to the bridge. This development has been made possible by the introduction of computer-based systems for collecting, processing and presenting information needed for deciding on actions to be taken and enabling the operator to execute his decisions from the place he receives the information.

This development has great impact on the manpower required to perform the various funcitons. Computerized information systems, automation and remote control systems are the basis for developing one-man bridge concepts and for extending the number functions to be monitored and controlled by the watch officer.

Furthermore, it has been demonstrated that computer-based monitoring and control systems allow ballast, cargo, stripping, tank sounding and inert gas systems to be safely and efficiently operated by one-man from the cargo control room. Thus one-man cargo operation is achieved, except in cases when an additional deck hand is required at the cargo manifold.

Satellite systems are utilized for position-fixing of the ship. Computerized route planning combined with more accurate and continuous position-fixing systems and auto- matic track keeping reduced the workload in carrying out traditional navigational tasks.

3.3.3 Radiotelegraphy and Radiotelephony:

The use of satellite systems are playing an important role in the development of more rational ship operation and reduction in the manning. They are used in instant two-way communication between ship and shore. Furthermore, satellites are making more reliable weather forecasts available and a new satellite-based maritime distress system which will eliminate the need for telegraphy communication is being developed.

Instant voice and data communication systems have simplified ratio communication at large and offer fast transfer of data between shore-based computers and ship-based ones. Again, workloads are reduced and new opportunities to increase operational efficiency are given.

3.3.4 Give Way to Technology:

A separate chapter in this paper is devoted for international instruments and regulations regarding manning scales. In the following lines I want to show how national legislation, through maritime authorities, may play its role in removing the obstacles and giving way to technological innovations and novel equipment trial. This, of course, should be done without violating the international conventions and endangering safety of life at sea. For example, we can see some maritime authorities have made significant moves:

- One which grants exemption from manual radio listening watch on 500 Khz telegraphy which had to be attended by a professional radio operator.

- One to relax the requirement of having one person on the bridge in addition to the watch officer for visual lookout at night. (only approved by IMO as an experiment).

- Furthermore, the rules of Norwegian Maritime Authority which require the engine room to be manned during certain navigational conditions and during loading and discharging of certain cargoes may now be relaxed if the technical standard can justify this.

These possibilities to reduce watchkeeping duties release considerable manpower. Furthermore, dual or multi-purpose crew and the possibility to combine positions extend the flexibility to utilize available manpower and, of course, to reduce the manning.

3.3.5 The Maintenance Question:

Despite the efforts done to minimize the maintenance work by firstly using new minimum-maintenance materials on one hand and improved on board organization through work study on the other, and despite increasing the reliability level of equipment and redundancy, the maintenance work does not reduce. A fact, that I believe on and I experienced during my sea time, is that automation increases the possibilities of technical failures and it reduces possibilities to improvise in case of a breakdown. It frequently also increases maintenance efforts.

However, there are many ways in which maintenance work could be carried out. The choice between them being dependent on:

a. the type of the ship
b. crew qualifications
c. economy

The most familiar trends the shipowners are following in maintenance are:

i. shipboard crew
ii. "riding gangs" or even "flying gangs"
iii. shore-crew "belonging to the company"
iv. shore-crew "proposed as international system in major ports"
v. service agencies "with the company's superintendent"

However, for the "high-tech" ships we are considering, whatever higher the qualifications of the crew the on board equipment are too sophisticated for them to handle every aspect of its failures. In most cases both the preventive and corrective maintenance tasks are to be performed or supervised by experts or, as it is always the case, the manufacturer. Of course, some of the routine operational faults could be detected and rectified by the qualified crew.

I will briefly highlight one system proposed by the Japanese which gather many advantages. It is a shore-based crew responsible for the voyage repairs when the ship is berthing, to assist the ship's regular crew in harbour manoeuvring and coastal navigation as a "riding gang" while carrying out some maintenance work. The shore-based crew will leave the ship by a tender with the pilot.

This system and others could help very much in maintaining the ship to sail, may be, safely from a port to another but this type of maintenance, which is mainly corrective, will not maintain the ship as an "asset" in a good condi- tion in the long run. The quick turn-rounds of these modern ships, which are mainly containers, will not give adequate time for preventive maintenance, accordingly the maintenance cost will increase and the issue of the "high- tech" ships to minimize operational costs will be strongly violated.

3.4 TYPES OF CREW:

It is obvious now, as already practiced, that these types of "high-tech" ships are to be operated by crews with high and different qualifications from the traditional crews. As many careers disappeared, the jobs are left there to be carried out either by equipment or another crew member. The concept of dual-licensed officer and general-purpose crew was born with this type of a ship. The departmental thinking of the ship (deck, engine) is even viewed as obsolete and impractical. The ship is being viewed as one system and operated with integrated crew. Simulation and simulators are extensively used for the purpose of this special training. Simulators have the advantages of:

i. Allowing experience to be gained in those operational situations that are too dangerous, costly, time consuming or impractical to exercise on board ships.

ii. In a brief period simulator training provides an experience that would take years to gain on board ships.

iii. Simulator training is cheaper and gives better control of the training process.

In fact and with the introduction of centralized bridge monitoring and control systems, the tasks of the bridge officer change from navigator into a combination of navigator, engineer, radio officer, computer operator and manager. Essentially his tasks comprise:

a. Supervision of the automatic and self-regulating processes (which also includes navigation);
b. Optimization of ships operation (reduction of fuel consumption);
c. Preventive maintenance (if any), advised by the condition monitoring system;
d. Fault management;
e. Administration/documentation.

An equal amount of attention and training to be given to the ratings in order to achieve the concept of multi-purpose ratings and the integrated crew. The satisfaction attained would be marvellous if the following statement is always true. "In the Federal Republic of Germany we now have the situation that ratings intending to obtain a license do not understand why they have to decide between a deck and an engine license, because they only have experienced one overall department, the whole ship." (24)

For integrated crews there are good reasons:

i. Bridge watch on vessels with centralized systems´ surveillance on the bridge requires more profound technical knowledge.

ii. A deck officer´s job becomes more and more boring because of increasing restrictions to mere bridge watch. New tasks from the traditional engineer´s area could be challenging and provide increased job satisfaction. On the other hand no engineer would have to restrict himself to pure maintenance and repair work in future.

iii. If equally qualified officers have to share all tasks to be performed in the bridge watch, especially the boring night watch, could be distributed among more than the traditional three officers of the watch.

iv. Every officer would be able in future to act as superior to the already integrated ratings in all areas, which is not the case today.

v. Crew planning would be easier and the number of officers kept on stand by to replace others on holiday or when it could be reduced.

Finally, the function of an officer serving on board "ships of the future" can be compared to that of a control room operator in the process industry: he is a process operator. However, there is a fundamental difference between an operator in the land-based process industry and an operator on board ships. The land-based operator can always be assisted by specialists for repair jobs, etc. On board ships the operator will always have a lot of do-it-yourself maintenance and repair work. His job is more demanding. So should be the training more consistant and certifying institutions more competent.

Examining the international trend in crewing structure since a long time ago, now and some years to come will show how the technological advances affected and will further affect the crewing structure. More reductions in the crews should, logically, mean more qualified, trained and competent crews. However, some shipowners are utilizing both the commercial advantages of reduced crew and cheap crew by running away to open registeries. In this way they may achieve some profits in the short run, but by ignoring standards and consituents of safety they are loosing a lot in the long run, may be the ship itself and her cheap reduced crew.

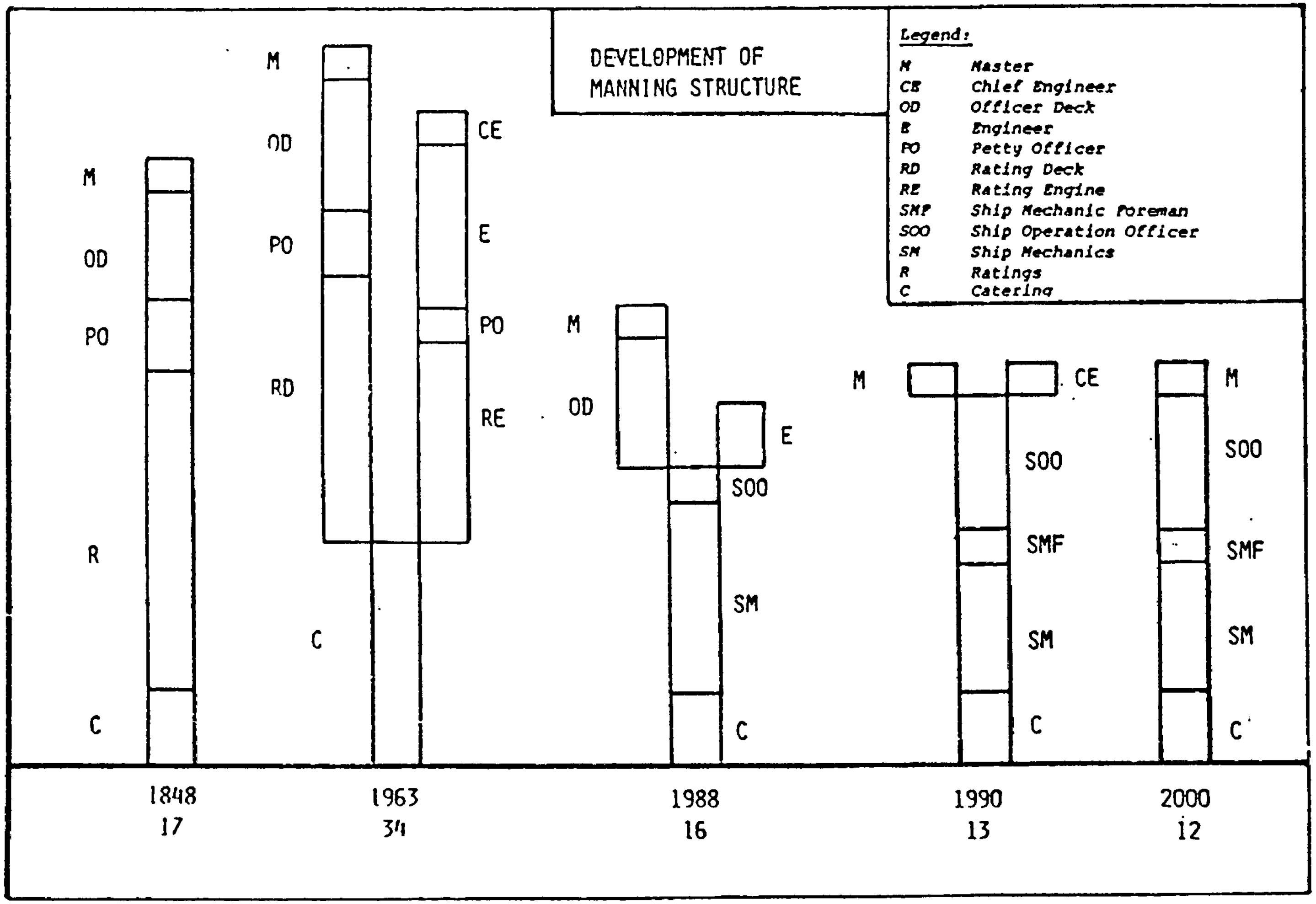


FIGURE (3.3): DEVELOPMENT OF MANNING STRUCTURE AND FUTURE AVERAGE CREW SIZE

3.5 HUMAN ELEMENTS:

To my experience as an ex-seafarer, seamen are suffering psychologically more than anything else. This is mainly due to the limited social life among a very small community they have to adapt themselves with whatever the attitudes and behaviours of the contacted persons. This problem is getting even more complicated when it comes to reduced manning ships. The community is getting much smaller and the automation has made jobs easier and workload smaller. The previous underload of communication with outside world is now combined with an inside one. Look, for example, at the jobs of the second officer before and after application of high technology on board. He was traditionally a watchkeeper and navigator, who also took morning sights and did the wages and paper work for the whole vessel. Today the satellite navigator has largely obviated the need for sight-taking, accounts are computerized ashore and an agent corrects the charts. Consequently his workload falls considerably which leads to boredom, lonliness and frustration. All these problems are added to the known ones of sea life, fears of danger, tensions and strains, sexual problems, families, viewed as abnormal in ports, alcohol and may be suicide.

3.5.1 Ergonomics:

Real application of ergonomics on board "high-tech" ships is an urgent requirement. It is a science aiming to achieve a good fit between people and the hardware and facilities they use in a certain environment, the fit between the user and machine or tool which cannot reliably be solved by recourse to common sense.

As the "high-tech" ships are concerned, the application of ergonomics should cover the following areas:

i. the design of displays

ii. the design of controls
iii. layout of pannels and machines
iv. anthropometry (data about body dimensions) and design of work place
v. the climatic factors of environment
vi. the noise and vibration of environment
vii. the vision and lighting of environment
viii. work organization

This is very important because the interaction between the system and the operator can lead to accidents even if the system is designed to take account of all ergonomic principles. The operator˝s problems and strains may introduce factors into a "safe" situation to change it into an "unsafe" one.

It is argued that an accident occurs as a result of the environment demanding more of the operator than is able to be given; when the environment demands more "spare-mental capacity" from the operator than there is available. To define an accident, there are three factors, the more of these which are present, the more likely the event will be called an "accident". An accident then, has a low degree of:

a. expectedness,
b. avoidability,
c. intention to cause the accident.

Thus, accidents are unfortunate, unpredictable, unavoidable and unintentional interaction with the environment.

I would like to brief on two essential ergonomical aspects which properly fit with the "high-tech" ships, those are the workload and adaptation.

the task being achieved but at the expense of stress and strain of the user. This may be manifested in physical harm, extreme frustration, number of errors made, feeling of dissatisfaction in an effort to compensate the poor design. Errors can have serious consequences leading to personal injury, casualties and death. Also, adaptation over longer periods of time, such as working in an environment that vibrates continually at a low level, may have long-term effects on the health of the individual. Therefore, ignorance of ergonomics by designers, planners and other decision makers can result in a poor fit between user, equipment and environment. The conse- quence of which could endanger safety very much.

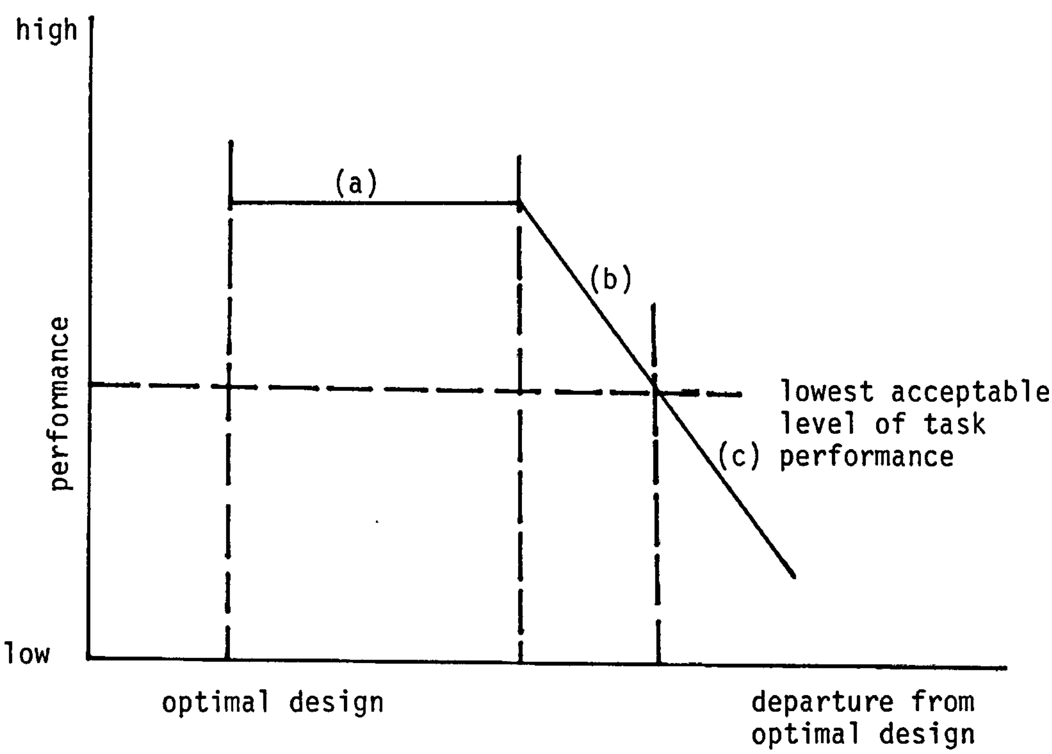


FIGURE (3.5): DESIGN AND ADAPTATION PERFORMANCE

3.5.1.1 Workload:

Both the high and low workloads have their harmful consequences on the operator. When this will be the case the performance, consequently, will be low. The figure shows that only when the task demands are within a narrow middle range will performance be highest.

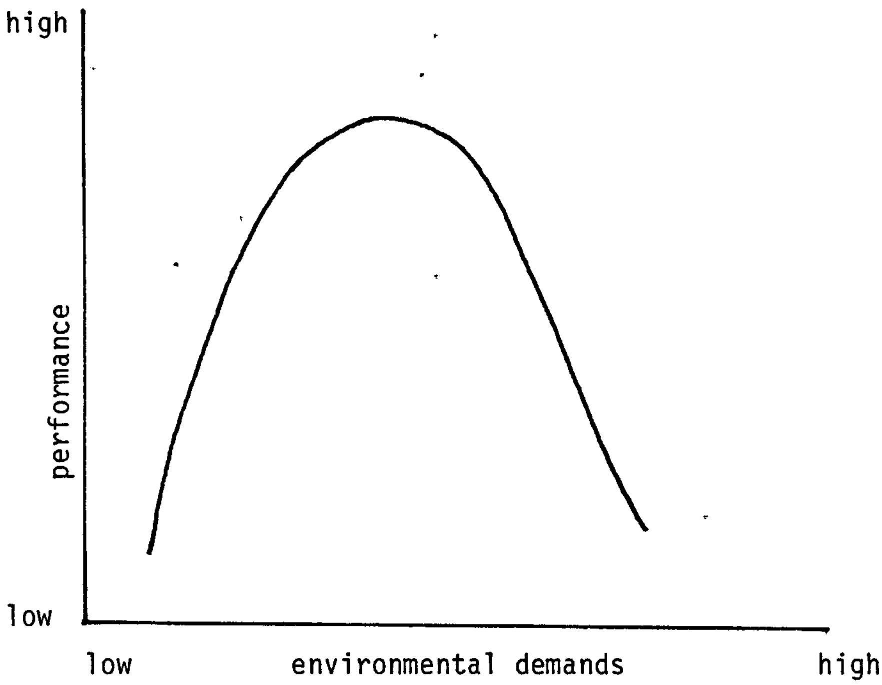


FIGURE (3.4): THE HYPOTHETICAL INVERTED - U RELATIONSHIP OF ENVIRONMENTAL DEMANDS VERSUS PERFORMANCE

3.5.1.2 Adaptation:

Regarding the sophisticated equipment on board the "high-tech" ships, adaptation is to be well considered. The important thing here is that people are adaptable, they can tolerate small departures from optimal designs of the equipment they use. Adaptation may result in

a. Maximum performance is maintained by means of successful adaptation.

b. Adaptation can not compensate for design deficiencies, and, although performance is acceptable, the task involves a degree of strain or discomfort.

c. The design is so unsuitable that the task is dangerous or impossible to perform to an acceptable level.

3.5.2 More Care:

Administration, shipowners and other concerned bodies must pay more attention to the problem. All what is written is just defining the problem without introducing solutions. In the "high-tech" ships, the high investments dedicated must contribute considerably to minimize the problems mentioned. I believe that, neither productivity nor safety will be obtained by means of technology alone. Technology and people are both necessary. Therefore, more investments should be directed to improve sea life in order to level it up, as far as possible, to normal human life. When discussing this problem of human element with "high-tech" ships, one hopes that technological innovations will continue steadily to replace people on board totally by equipment, totally unmanned ships will relieve people from sea life and its associated discussed problems.

3.6 MORE SAFETY SCHEMES:

Unless safety is considered in the design of the equipment or the project then one may say that technology issues are mainly economical and commercial. After fulfilling the commercial purpose then the side effects of technology application on safety are considered. The consideration itself is a compromise which frequently declines to benefit the commercial side on the safety account. For this reason, it is always said that pure technology and safety will never go together hand in hand. And for this reason, again, more safety schemes are to be considered separately from the project technological issue, in this case the "high-tech" ship.

3.6.1 Safety Centre:

It is a very practical and successful idea which is introduced on board ships of reduced manning. During my field and on-the-job training in European ports I had the chance to see and examine the efficiency of a safety centre. Due to limited number of crew on duty while the ship is sailing it is a difficulty for them to handle a dangerous situation, like fire, when the required equipment and apparatus are scattered around the ship sections. It may be also not easy for the whole crew, when the general alarm is triggered, to control the situation with the traditional safety plan designed for a normal number of crew. The safety centre is incorporating all the controls of the safety systems from which they could be operated and monitored. The size and contents of the centre will depend on the size and type of the ship. For passenger ships, it is well established and furnished. In all cases, the location of the centre is to be easily accessible by the top staff who are authorized to operate the centre. In many cases it is found to be located at the deck above the engine control room and close to the chief engineer's accommodation or office.

3.6.2 FGMDSS:

Future Global Maritime Distress and Safety System is being developed by co-operation of IMO with ITU and INMARSAT. It is expected that this system will enter into force in the 1990s. Draft amendments to Chapter IV of the SOLAS Convention will probably require introduction of new communication facilitites such as:

a. Very high frequency (VHF) transceiver suitable for digital selective calling (DSC) and radiotelephony.
b. NAVTEX receiver.
c. A float-free VHF EPIRB (Emergency Position-Indicating Radio Beacon).
d. MF, Medium Frequency transmitter and scanning receiver suitable for DSC and radiotelephone and direct printing.
e. An INMARSAT Ship Earth Station (SES).
f. VHF homing device (all VHF facilities could be incorporated in one set).

The high degree of automation incorporated in FGMDSS equipment will allow the required radio watches to be maintained by personnel holding only basic radio qualifications.

3.6.3 The Black Box:

Twenty years ago the aviation industry was required by law to fit "Black Box" recorders for investigation purposes after accidents. Maritime accidents and disasters have been in the limelight recently and many ways of reducing casualties have been proposed, but it is doubtful if they can be eliminated completely. However, the rate at which they occur can be reduced with improved technology. The principal way of minimizig the rate of accidents is to obtain feedback from those that have already occurred. Then the reasons for various incidents can be found and deficiencies in vessels, equipment and operational procedures can be rectified.

It was in the early 1980s that the idea of a shipborne recording system was first seriously considered at IMO. After initial interest it was dismissed as not technically feasible. However, after a detailed R & D programme, with UK DOT support, Lloyd's Register of Shipping claim to have overcome the technical problems. In October 1987, LRS launched their voyage data recorder system or marine "Black Box" oboard a 1600 GT container ship "City of Plymouth". The 70 cm high x 50 cm dia. unit consists of two recorders that sit in a watertight, steel protective case that is fire and shock proof, buoyant and fitted with a COSPAS/SARSAT emergency alerting and location system, on 409 MHz, for recovery. However, the Box will automatically be released from the vessel in three instances: if the recordings are in danger of damage by severe heat; the ship is sinking (3-5 m. submergence) and when the ship is capsizing, 85-90 deg. to vertical.

The Box can collect up to 60 separate sources of information from all quarters of the ship, including vessel motion and accellerations, hull stresses at selected points: draughts, environmental data; ship control settings i.e. wheel and rudder angles; time; navigational data (course, position and depth) and radar. There will be also data collected on alarms including main and auxiliary engines and steering gear; navigational lights; system operations i.e. bilge and cargo pumps, deck machinery and tank levels.

The fitting of such a Box is optional till now, LRS is to present its findings to the IMO and propose that fitting becomes mandatory by law. In the light of reduced manning vessels, these systems will lead to safer operations, safer vessels and reduced accidents at sea as more and more information on accidents becomes available. Crew and ship performance and efficiency could be monitored by shipowners regardless of accidents.

However, mandatory fitting on an international basis will be necesary if the marine "Black Box" is to achieve its full potential as a safety device. The obvious forum through which this can be achieved is the IMO.

CONCLUSIONS:

i. The "high-tech" ship is a capital-intensive ship introduced by industrialized countries to retain their competitiveness in the world freight markets by compensating the high crew costs through reduced manning.

ii. Safety is to be incorporated in the design when determining the number of complement. Built-in safety from the design stage is of utmost effectiveness other than any additional separate safety system.

iii. The workload is to be carefully calculated and distributed among the small complement, and more efforts to be exerted to overcome difficulties in standby periods and maintenance.

iv. Many equipments have been introduced in the various parts of the ship to replace manual tasks by automatic operation.

v. Special type of crews are required, the traditional divisions (deck, engine) are disappearing, therefore, dual licensed officers and general purpose crew or integrated crew are more efficient.

vi. Applied ergonomics aiming to achieve a good fit between people and hardware facilities they use in the ship environment is intensively used.

vii. More safety schemes should be considered irrespective of the built-in safety in the construction on board such ships to take care of the valuable ship, its valuable cargoes and the most valuable, the lifes on board.

PART "A" RECOMMENDATIONS:

1. In order to compensate the high salaries with other competitive factors other than reduced manning, shipping companies must rely on greater operating efficiency, improved safety and reliability, less energy consumption, condition monitoring systems, improved marketing and improved service.

2. If there are some drawbacks and weak points in the operation of these ships which need more care and field studies they are:

   i. The peak points of workload facing the small complement like those in the standby periods and manoeuvring in and out of harbours. Use of shore-based crews must be assessed and costs to be compared with those costs of a normal size of crews.

   ii. The ship as an asset may loose a great deal of its value if the planned maintenance between dry docks is not that proper with enough time and number of personnel.

   iii. The human factor on board these ships is much demanding and a lot is to be done to make sea-life bearable.

   iv. One of the most successful bridge automation devices has been the automatic pilot, but what about the effect of removing the helmsman's role and the lookout as a second pair of eyes to alert the officer to a developing collision situation.

3. There are more general side effects like:

   i. Marine personnel on shore will suffer shortage in the long run and the pool of experience in maritime administration will be greatly affected. Officers are of small numbers with high experience doing a comfortable job for longer periods and shipowners prefer not to replace them.

ii. The pool of experience on board the ship itself is affected by:

a. The small number of crew.
b. The diminishing role of the ship master which leads to job dissatisfaction.
c. The absence of cadets and trainees who can be more aware of the situation than to depend on simulation training only.

4. To control the situation and towards a more successful project, I suggest the following:

a. The criteria of "existing ship" and "new ship" in the safety conventions is not enough to counter the high jump and the great departure from the earlier safety measures created by the "high-tech" ships. A new criteria for safety should be developed for these ships. IMO has some basis like the length of the ship and the age of the ship, what about "the number of crew" as a new basis?

b. Special surveys to be developed and enforced for these ships which to be conducted by specially qualified surveyors. Port state control is to concentrate on the workloads and ILO Convention No. 147.

5. Open registry must phase out especially with these ships, shipowners must not combine between reduced crew and cheap disqualified crew. it's a dangerous situation for a reduced manning ship to be a substandard one.

6. Shipping is an international business, developing countries are to receive and deal with these ships in their ports for port state control. To maintain their role in participation to the safety of shipping they must keep in pace and be aware of the technology on board at least by training special surveyors if

not by transferring the technology as a whole.

7. As it is said, pure technology and pure safety will never go together hand in hand. National legislation is to give way to technology to proceed onboard but not on the expense of safety standards. Safety must benefit from and progress with technological applications.

P A R T "B"

INTRODUCTION TO PART "B"

Part B of this thesis will deal with the transfer of technology particularly in the ship industry. As shipping is an international industry, homogenity and uniformity of technology all over the world is for the benefit of the objectives and services rendered by the industry. To my experience and according to what I have noticed during the training in developed western countries, the technological gap between developed and developing countries is too big for the latter to attain the former's position in the foreseeable future. They have a lot to do, but logically they have not to start from the sailing wooden boats era. The west civilization of today is a human heritage. It comes as a result of cumulative efforts done by all people since a long time ago. I do not deny the role of the west, they have done a lot, they put the last rungs leading to today's technology. Similar to the situation now for developing countries, developed countries did not start from zero position, they benefited from a former built civilization. Accordingly today's technology must be accessible to all mankind, for the benefit of all, with reasonable rights for the donors and high competence from the recipients

The bigger the gap in technological facilities and services in shippig, the greater the seaborne trade and safety standards onboard will loose. Maintaining a safer shipping and cleaner oceans is a global mission, the diversification will be a great obstacle. The western "high-tech" ships need services in all the ports they call in the Thrid World or they are to restrict their trade activities in the developed ports. They are also to be controlled under port state control all over the world. Briefly, not unification or standardization of services, as it is not attainable in the short run, but accession and availability of technology to the developing countries will help very much:

a. Expansion of seaborne trade by founding necessary services and facilities for all ships in all ports.

b. Maintaining safer shipping and cleaner oceans when all equipment and technological applications are accessible to all.

c. Developing countries to build their shipping industry to contribute to their national economies and human civilization.

In the following two chapters, the technology transfer will be discussed on the global level in one chapter and on the state level, Sudan in this context, in the other chapter. Considerable stress will be applied on the transfer of "high-tech" ship technology to developing countries as Part A of this thesis examined these ships carefully and showed all their operational aspects.

CHAPTER FOUR

TRANSFER OF TECHNOLOGY ON THE GLOBAL LEVEL

Introduction

4.1 Obstacles to the Rooting of Science and Technology in Developing Countries (DCS)

4.2 Basic Elements of the Transfer of Technology Process

4.3 The Transfer Mechanisms

- 4.3.1 Turnkey Operations
- 4.3.2 The Technological Enclave
- 4.3.3 Licensing
- 4.3.4 Joint Ventures
- 4.3.5 Education and On-The-Job Training Abroad

4.4 Obstacles to Technology-Transfer

- 4.4.1 Attitudes of DCs and MNCs
- 4.4.2 Research and Development (R & D)
- 4.4.3 Codes of Conduct for Technology-Transfer
- 4.4.4 The UN Law of the Sea (UNCLOS)

4.5 Examples of Transfer in Shipbuilding and Repairs

- 4.5.1 South Korea
- 4.5.2 People's Republic of China
- 4.5.3 Taiwan

Conclusion

CHAPTER FOUR

TRANSFER OF TECHNOLOGY ON THE GLOBAL LEVEL

INTRODUCTION:

This chapter will be devoted to the technology-transfer on a global level with particular consideration to developing countries (DCs). The obstacles to rooting of science and technology in DCs and those to transfer of technology will be discussed. Then the necessary techniques and mechanisms to penetrate those obstacles will be shown. The codes of conduct for technology-transfer are a hot point showing the actual willingness of developed countries for transfer and the real efforts, faith and competence of the developing countries to attract technology owners. The UN Law of the Sea (UNCLOS) has a separate subchapter as seabed unaccessible resources remain as a dream of fortune for developing countries. The practical side of the convention (UNCLOS) in its International Seabed Authority (ISA) is viewed as a disappointment by the developing countries, as developed countries are trying to design the Authority operational rules according to their technological powers. At last some successful transfers will be shown.

4.1 OBSTACLES TO THE ROOTING OF SCIENCE AND TECHNOLOGY IN DEVELOPING COUNTRIES:

In general, most of the developing countries suffer from low per capita incomes, low educational levels, poor nutrition and health and very little industrial capacity. Perhaps one of the few features that distinguishes some of them from others is their potential for growth. As regarding the field of science and technology they, also in general, suffer low science and technology absorptive capacity, they are at a disadvantage when bargaining with multinational corporations (MNCs) owing to their lack of scientific and technological skills and knowledge; unless they are blessed with resource riches (e.g. petroleum), they lack purchasing clout; and their domestic markets are generally weak.

Of course, most of these problems which impede the progress and promotion of all aspects of life styles will, also, impede effectively and with strength the rooting of science and technology. However, it is more difficult for science to take root, in this atmosphere, than technology. Technology, as will be shown, can be bought, borrowed, stolen, transferred through many machanisms or developed indigenously.

It is my purpose here to mention without elaboration the most prominent obstacles to the rooting of scientific and technological capabilities in a developing country. These are:

a. Lack of resources (education systems, libraries, laboratories, R & D funds, training funds, etc.);

b. Isolation of scientists;

c. Institutional and bureaucratic obstacles;

d. Lack of domestic demand for science (the link between science and economy and local, national, and international needs is non-existent);

e. The vested interests of the elites (the ruling group);

f. Cultural and cognitive obstacles.

4.2 BASIC ELEMENTS OF THE TECHNOLOGY-TRANSFER PROCESS:

Although technology-transfer encompasses a great many different types of activities, the transfer process itself can be described in rather simple terms. Any technology transfer process can be examined according to six elements:

i. The transfer item:
What is being transferred? A tangible product (e.g. a heat sensor)? A process (e.g. a semiconductor doping process)? Know-how (e.g. information on proper use of equipment)? Some combination of these things?

ii. The technology donor:
Who possesses ownership rights to the transfer item? Is he willing to make the technology accessible to others?

iii. The technology recipient:
Who will receive the transfer item from the technology donor?

iv. The transfer mechanism:
Precisely how will the transfer item be delivered from the technology donor to the recipient? Through licensing? Direct purchase? Some other mechanism?

v. The rate of diffusion of technology:
There are two measures for these diffusions, the imitation lag and the demand lag. The imitation lag means how long does it take for a new good to be produced in a country other than the innovating one. And the demand lag means how long does it take for a new good to gain acceptance in foreign markets after it first hits the market in the innovating country.

vi. The absorptive capacity of the recipient:
How capable is the recipient in adopting the technology effectively?

4.3 THE TRANSFER MECHANISMS:

There are innumerable ways in which technology can be transferred from donor to recipient. I will select only those mechanisms which are likely can play their role in the shipbuilding and shipping industry as a whole.

4.3.1 Turnkey Operations:

In this kind of operation the donor constructs a fully functioning production facility for the recipient. Once it is completed, the recipient need merely turn a key to get the facility functioning.

This kind of operation can be directly applied to a newbuilding of a ship ordered by a developing country through a certain contract. Let us check the degree of technology transfer in this operation and other side effects. First the recipient can contract to have the officers, engineers and technicians thoroughly trained by the donor for the operation of the ship. Of course, I am talking here about a "high-tech" ship of acutely reduced manning. On the other hand, because of a low capacity to handle the technology embodied in the ship, the recipient may decide from the outset to depend heavily upon the donor to run and maintain the ship. Of course, in the latter case the degree of technology transfer is nearly nil. This was the case with some rich Arabic countries due to lack of expertise and necessary personnel to run the ships.

There is one advantage saying that if the recipient is careful in selecting who it will choose to produce the turnkey facility, it will be able to acquire tested competitive, high quality production facilities that may incorporate the most advanced state-of-the-art technology. In my opinion, if a country is to ask for such a high technology it must have the necessary absorptive capacity, if it has such a capacity then the technology it will acquire will depend upon how much it will pay and how faithful the donor will be in passing such a technology and the necessary associated training. In the case of turnkey operations, the lack of skilled labour in the recipient country need not prevent it from obtaining modern facilities, since much of the construction requiring skilled labour will be managed and performed by the donor's personnel.

However, the main disadvantage of the turnkey operation is the minimum acquisition of know-how. Since the recipient is buying a finished product i.e. a functioning production facility it may not acquire many of the engineering and management skills needed to construct the facility. In shipbuilding, however, some of the know-how could be acquired if a number of the ship's crew is to attend the whole construction and assembly. Stipulation of training will transfer a lot of know-how. South Korea and other Asian countries gained a lot from Japan, through this mechanism in their early stages of shipbuilding.

4.3.2 The Technological Enclave:

Developed countries companies would set up enclaves in developing countries for a number of reasons: to be closer to sources of raw material, to take advantage of cheap labour, to have production facilities nearer to foreign markets, or to take advantage of economic incentives offered by the host country e.g. tax holidays. At its worst, the enclave is a fully functioning production facility that is divorced from its surroundings. That was in the past, when, also, the management of the facility would be composed of the foreigners and very little know-how would be transmitted to the indigenous population. Now most of the corporations that owned the enclaves made conscious efforts to better integrate their overseas facilities into local economies. Skilled labour and management positions were now opened up to the indigenous population. In the 1970's a technological enclave developed with the active encouragement of certain host developing countries. Countries such as Malaysia, Singapore and Taiwan promoted the establishment of offshore production facilities, frequently in the electronics area. These facilities would be owned by multinational who wished to take advantage of cheap, reliable labour in the host countries. Unlike earlier technology enclaves, however, the host governments would establish ground rules that assured substantial technology - transfer to indigenous workers.

4.3.3 <u>Licensing:</u>

Is one of the chief mechanisms employed for transfer of technology. A license is an agreement that allows a technological recipient to employ a donor's technology, subject to certain conditions that are spelled out by the parties to the agreement. Usually it is agreed that the recipient will pay a fee or royalty payment to the donor for the use of technology. Often the royalty payment is a small percentage e.g. five percent of the recipient's sales that were made possible through use of the donor's technology.

This technology transfer mechanism is most useful in situations where the recipient has a high capacity to absorb the technology being transferred. The main advantages of licensing someone else's technology is that it reduces duplication of effort and can save considerably on the costs of in-house research and development. The main disadvantages being the licensee will be heavily dependent upon the licensor and often will not possess the advantages of initiating new products. The most dangerous one is that licensing may result in underdeveloped R & D capabilities.

Technology transfer may entail, when appropriate, the provision of blue prints and drawings, engineering data, information on production techniques, and a statement allowing the licensee to share the licensor's patent rights. Arrangements may also provide for training by the licensor of the licensee's personnel. Finally, provisions are often included requiring the licensor to update the licensed technology.

It is worthy to say that the skillful employment of licensing as a strategy for national development enabled Japan to build its economy to a great extent on technology that originated outside its borders. In view of the enormous earnings gained by the Japanese from this technology, its purchase has to rank high on the list of the great bargains of history.

4.3.4 Joint Ventures:

A joint venture occurs when two or more business entities get up a third entity that will enable them to produce a good or service jointly. Common motivations for undertaking a joint venture are to share costs and the desire to share technical, marketing, production and managerial skills. For example an American firm may have technical and marketing expertise, but may be weak in production, while a Korean firm may be strong in production (owing to its comparative advantage in labour costs), but weak in other areas. By working together the American and Korean firms can build upon each other's strengths. Generally joint ventures involve both cost-sharing and skill-sharing arrangements.

4.3.5 Education, Site Visits and On-The-Job Training Abroad:

Historically, education abroad has been a very important technology transfer mechanism. It was certainly important in the development of scientific and technological capabilities in the United States during the eighteenth and nineteenth centuries. Education abroad is no less important to developing countries today. The principal drawbacks with education abroad as a technology-transfer mechanism is its cost and long gestation period. Despite this limitation, a country wishing to develop adequate indigenous scientific and technological capabilities has no choice but to send students abroad for education.

Sending people abroad simply to observe how others operate a piece of machinary or manage a complex process or utilize resources can be a very cost-effective way of transferring technology. Of course, it is important that the individual on a site visit or participating in on-the-job training, have some prior idea of what it is that he is supposed to learn. The greater his competence in his specialty area, the greater the amount of technology that will be transferred to him.

No institution in the world is worthy of mentioning in this context other than the "WORLD MARITIME UNIVERSITY" in Malmö, Sweden being one of the unique technical assistance schemes of IMO. It provides the forementioned education and on-the-job training, probably, in more depth and scope. It is even free of all the limitations and disadvantages regarding the costs since all the expenses of living, travels and tuition are arranged through the international financing institutions.

However, there are many other technology-transfer mechanisms such as patents, in-house transfers of foreign subsidiaries, simple emulation of a product or process, direct purchase of naked or embodied technology, purchase of technological services, international cooperative research efforts and published literature. All of these mechanisms and other can play their role in transferring technology if a proper strategy is intended and competently traced.

4.4 OBSTACLES TO TECHNOLOGY - TRANSFER:

4.4.1 Attitudes of DCs and MNCs:

Developing countries attitudes toward MNCs are highly ambiguous. On the one hand, MNC investments are welcome because they bring with them much needed capital, create jobs and income, introduce technology into the economic system, train people in useful skills and contribute to industrialization. On the other hand, MNCs are viewed with great suspicions and distrust. There are a number of reasons for this. First a developing country may fear the great economic power of an MNC, whose global assets may be substantially greater than the country's GNP (Gross National Product). Second, DCs are reluctant to surrender some of their national autonomy to an outsider. To many inhabitants of DCs, the differences between the old colonial relationships and the new ties with MNCs are very small. In a related vein, a significant number of people in DCs see the MNCs as agents of foreign governments who act to further the foreign policy objectives of these governments. Finally DCs recognize that MNCs' interests differ from their own national interests. While the DC may want an MNC to lay an important role in its development plan, the MNC itself is operating according to corporate objectives that may or may not correspond to the DC's development aims.

Because so many DCs occupy a weak position in their demands for technology, transfers to them are apt to be more superficial. This is possibly best illustrated by reference to off-shore sourcing. Firms in advanced countries set up production facilities in DCs, where labour is cheap for production and assembly tasks. The manufactured and assembled products are then sent back to the home country, where they are marketed for domestic consumption, or else they may be sent directly to foreign markets. The best known example is the case of US electronics firms having their products manufactured in several Asian countries. Additional obtained benefits in off-shore sourcing here include little labour-unrest and high worker-discipline. Furthermore, these firms can use their overseas operations in ways that would be untenable at home. For example, the overseas facilities may be employed to meet orders in boom times. Once the boom is over, plants may be closed and indignous workers laid off until the arrival of the next boom.

Off-shore sourcing generally involves low level of technology transfers. Most tasks performed in the off-shore manufacture of a product are highly automated. The tasks that require human intervention are generally trivial assembly operations that employ unskilled labour, so that the typical worker picks up few useful skills in the plant. To the extent that local management is used to run the plant, they will gain useful exposure to modern production techniques. These production techniques and the advanced technology that goes into making the product are developed in the home country. Despite the obvious short-comings of off-shore sourcing agreements to the host DC, they are fairly attractive to countries that are not preoccupied with the issue of dependencia. Once interesting appeal of the off-shore sourcing arrangements to the host DC is the fact that products being manufactured are designed for export. Consequently, these products will not compete with local manufacturers in domestic markets. Other advantages include employment and income generation, and government revenues from operations. and government revenues from operations.

4.4.2 Research and Development (R & D):

Traditionally, foreign direct investment in DC yield little high level technology transfer. An important reason for this is that virtually all the R & D for an MNC is done in the home country. There is little incentive to set up R & D facilities in the host DC. For one thing the MNC is concerned that ultimately such facilities will work to the firm's disadvantage, since they may improve the host DC's bargaining position on technological matters, may improve the DC's ability to imitate the MNC's technology. Beyond this, the MNC is protective of the technology it has developed at great expense, technology which may be vital to the firm's international competitive position. To the extent that DCs do establish local R & D operations, these must focus on quality control tasks and adaptation of MNC technology to local conditions.

In the abasence of MNC R & D facilities in the host country, how can technology get transferred from MNC to the DC via the MNC's subsidiary? There are four ways:

i. By training indigenous personnel to perform their required funcitons in the local MNC facility.

ii. By having the MNC contract out research to local R & D facilities in both the public and private sector. In practice, this rarely happens. Local R & D facilities typically have little or no contract with the MNCs.

iii. Through MNC arrangements with local suppliers. Rather than purchase suplies that have been engineered by firms in the advanced countries, MNCs could show local suppliers how to produce what they require in their local manufacturing efforts. Again, this occurs only infrequently.

iv. By the sale in the host country of locally manufactured products that embody technology. Technology transfer will be effected if the MNC educates local users in the use of the product. Or else, the product may stimulate local users to identify novel uses for it, and this may lead to local innovative R & D efforts.

4.4.3 Codes of Conduct for Technology Transfer:

a. MNC's Codes:

Interestingly, earlier codes of conduct were designed to protect international business enterprises from the arbitrary actions of states, while the codes formulated two and three decades later were, in contrast, concerned with protecting states from the arbitrary actions of large internatinal corporations. In 1970's, codes of conduct emerged from various quarters. A number of the most prominent MNCs put together short statements of business principles, which described their ethical responsibilities: There were two motivating forces behind the behaviour of these MNCs. One was the perceived need to answer criticisms by DCs that they use technology transfer to exploit the third world. The other was the recognition that a series of scandals involving pay-offs and other forms of corruption among a number of prominent American MNCs in the early 1970s required a major public relations effort to assure the American public of the good intentions of the MNCs.

The central focus of corporate codes of conduct was on such things as pricing, competitive behaviour, payment of commissions and standards of product quality. To the extent that the codes dealt with issue of technology transfer, corporations would typically state that their technology was used to benefit people throughout the world in a number of ways:

a. The products produced by MNCs improved living conditions;
b. People abroad received technical training for using and/or manufacturing the products; and
c. Licenses were available on reasonable terms for production of goods by enterprises abroad.

However, western governments also assumed some initiative in issuing a code of conduct for international business behaviour. This was done under the auspices of the Organization of Economic Cooperation and Development (OECD) and ultimately was embodied in a document called "Guidelines for Multinational Enterprises". In section entitled "science and technology" the guidelines identify three areas of responsibility to be asumed by multinatinal enterprises. That is, they should:

i. Attempt to see to it that their activities contribute to the building of national scientific and technological capabilities in the host country;

ii. Adopt to as great an extent as possible practices that will increase the diffusion of technology; and

iii. Grant licenses on reasonable terms and conditions.

We note that, they are really and precisely guidelines since they only suggest behaviours and since they are not compulsory.

b. UNCTAD's Code of Conduct:

UNCTAD has also its attempt to develop a code of conduct for technology transfer. Because the draft focused entirely on the responsibilities and obligations of MNCs, and avoided dealing with those of host governments, it clearly would appeal to DCs and be viewed with doubt by MNCs. However, the gap between the DCs and market econmies was reflected in many points one of which is that Third World government represent domestic purchasers of technology and negotiate on Their behalf while market economies do not. At the end Third World was accusing market economies of ploy to avoid reaching an agreement while the latter saw the positions taken by the former as unrealistic and unreasonable.

The single greatest unsolved issue between the North and south in the negotiations is the matter of legal character and effect of the code. Group 77 wants the code to be compulsory. For their part, negotiators from the market economies want the code to assume the character of a guideline. They are not ideologically willing to overseeing and imposing technology transfer regulations on private enterprises. Furthermore, there is some questions as to whether such a regulation is compatible with domestic law.

4.4.4 UN Law of the Sea (UNCLOS)

The third UN Conference on the Law of the Sea (UNCLOS III), which began delibrations in 1973 and concluded them nine years later, strove to develop a treaty pertaining to the Law of the Sea, its most important points being:

a. A redefinition of waters over which coastal states have jurisdiction and a classification of navigation rights in these waters; and

b. The establishment of a regime for the exploitation of resources from the deep seabed in international waters.

The second point is my concern since its achievement entails exploitations of high technology the DCs do not possess. The Group of 77, looking for a solution, required the establishment of an all-powerful Internatinal Seabed Authority (ISA) which would have control over the mining operations of companies. This was based on the concept that "the resources of the deep seabed are common heritage of mankind". An enterprise would serve as the operating arm of the Authority in mining the seabed. It was to be understood that the

DCs would receive special consideration in all aspects of the undertaking. There were other suggestions from the super powers e.g. Soviet Union emphasized the role of states in the regime i.e. the mining activities would be conducted both by state parties and the Authority, leaving for the Authority to determine the operation site. The U.S., in my opinion, aimed to paralyse the Authority through its suggestion. It suggested the establishment of a parallel, or dual access, system. The Authority's Enterprise would stand on equal footing with other applicants for contracts to engage in mining operations. Contracts would be entered into if the applicants were qualified by virtue of their financial standing and technological capability. The facts that, this Authority is to be financed internationally and only a handful of companies from the United States, Europe and Japan had the technology and financial resources to recover the resources from seabed and ocean floor would show how critical situation the Authority is pushed into. The suggestion adopted at the end required that the applicant should submit to the Authority descriptions of two sites of equal value, one site to be accepted by the Authority for exploitation by the Enterprise and the second to be assigned to the applicant.

An especially controversial provision in the draft treaty was one that requires contractors to transfer mining technology to the enterprise if it is not available in the open market on reasonable terms. It is difficult to see how private companies, which developed their proprietary technology at great expense, would be willing to part with it so readily. It is equally difficult, on the other hand, to envision the enterprise operating successfully with the needed technology. Again, with parallel equal applicants to the Authority, which possess the technology and would not part with it so readily, the Authority is completely paralysed.

4.5 EXAMPLES OF TRANSFER IN SHIPBUILDING AND REPAIRS:

No doubt, some Asian developing countries due to national efforts and local expertise accumulated over the years besides the comparative advantages they have in cheap labour and strong markets, have developed their shipbuilding industries very remarkably. Some of them are considered in a world leading position. No doubt, also they have benefited very much from the transfer of technology process. Most of this transfer being from the biggest shipbuilder and technology leader in the world, Japan. One important fact to know is that this industry is well planned and supported by the governments in these countries. I will, in the following, highlight some aspects of this industry in some of the Asian counties.

4.5.1 South Korea:

Since 1982, South Korea's shipbuilding industry has been the second biggest producer of merchant newbuilding tonnage in the world and in the last two years it has taken over the role of price-setter from Japan for a large part of the newbuilding markets. With heavy promotion from the government, the industry expanded from a minute world market share in 1972 to 19.2% share of the world orderbook in 1983. Korea's shpbuilding industry has modern production facilities, many of which were supplied by Europe. Official capacity is approximately 4.5 million grt. This corresponds to an available capacity of approximately 1.7 million cgrt. 89% of this capacity is accounted for by the four big Korean shipyards led by Hyundai H.I. in Ulsan and Daewoo in Okpo which are also the biggest producers of offshore drilling rigs in the world (13 rigs on the orderbooks in March 1986).

Hyundai is the biggest shipyard in the world. Including a further eight medium-sized yards and seventy small others, the Korean shipbuilding industry directly employs some 65000 people, 58000 of them in the four big ones. The industry constitutes a major sector in the country's economy and in view of this industry's importance for training and industrialisation, and despite big losses and subsidies, it will continue to enjoy state aid measures in the medium term. The diversified production programme including products and chemicals tankers, reefer vessels, modern container ships and offshore modules beside large bulk carriers. Wherever more exacting demands in respect of technology and quality for specialised ship types play a less important role than the price, the Korean ship-building industry is a serious competitor for the West European shipbuilding nations.

4.5.2 People's Republic of China:

Since 1979/80, the People's Republic of China has been making a great effort to gain a foothold in the international shipbuilding market. They have done this not only to earn foreign exchange from ship exports, but also to gain technical knowledge. The first ship export orders came between 1979 and 1982 from Hong Kong shipowners; these were followed by orders form the Federal Republic of Germany, Norway, the USA, Italy, Poland, Romania and Malaysia. Since 1982, the major proportion of the Chinese shipyards have been gathered under one roof, the "CSSC" (China State Shipbuilding Corporation) comprising 26 shipyards, 66 mechanical engineering companies and 61 engineering design and research institutions with a work force of approximately 300,000.

In 1985, the Chinese shipyards built a total of 1.44 million dwt of shipping tonnage. Until now, 20-30% of the utilized capacity has been used for export orders. Newbuildings capacity is expected to be expanded to 4 million dwt by the year 2000. So far the impetus for expanding capacities has come from domestic demand. Productivity is still very low by international standards and foreign knowledge and foreign licenses are in great demand. Although foreign purchasers are being offered financing on world market terms, export orders are initially only being accepted at the low current price levels (and below) if the deal also entails the acquisition of technical knowledge. The huge domestic demand and the lower-than-cost prices on the world market will not allow China's shipyards to be pushed onto the export market in direct competition with South Korea and Japan.

4.5.3 Taiwan:

There are over 500 shipyards in Taiwan but only five have a shipbuilding capacity of more than 500 grt and only two yards, the Kaohsiung Shipyard (CSC) and the Keelong Shipyard (CSC), with a joint newbuilding capacity of 1.6 million dwt p.a. (repairs capacity 4 million dwt p.a.) and a work force of some 6800 at the end of 1985. These two yards are of international significance. The other three larger shipyards are the Shipbuilding Work Taiwan Machinery Corporation, The Fair Wind Shipbuilding Co. Ltd. and the Fung Kao Shipbuilding Co. Ltd., all in Kaohsiung. The overall employment figure of some 10,000 in the shipbuilding industry has remained relatively stable since 1980.

Taiwan's big shipyards, once designed for the series production of oil tankers and bulk carriers, have for some years been mainly concerned with building containerships and multi-purpose freighters, 50% of these being for the domestic market. Generous programmes launched by the government to expand the Taiwanese fleet formed, and will in future continue to form, the basis for the Taiwanese shipbuilding industry. Despite the present critical overbook situation, in February 1986 the government decided, within the framework of a six-year plan, to increase the shipyard capacities in the newbuilding sector to 4.8 million dwt by 1991 and to step up repair work activities to 18 million dwt. If these targets are realized, this would mean a strong advance of the Taiwanese shipbuilding industry into the world market.

CONCLUSION:

The previous discussion was aiming to point out the original problems of DCs in receiving technology and the obstacles to transfer. Although the transfer is not the final solution but can offer a good basis, the most viable methods for transfer, particularly in shipping were discussed. In shipping, however, experience proved that joint ventures and training are the most fruitful mechanisms. The role of international organizations to organize and enhance the transfer is vital assuming the utmost good faith from both sides, the MNCs and DCs. The Asian progressing shipbuilding and repairs were quoted as examples of transfer from the Japanese technology and experience.

CHAPTER 5

TRANSFER OF TECHNOLOGY ON THE NATIONAL LEVEL

CHAPTER 5

TRANSFER OF TECHNOLOGY ON THE NATIONAL LEVEL

INTRODUCTION:

"Where technological change is concerned the search of profits by some will certainly impose problems on others, but the solution is not to try and stop progress: The only viable solution is to accept progress and, at the same time, try to harness it so that no group of countries or interests is hurt." (1)

Technical change in shipping is currently a process of using capital to introduce high productivity ships and to reduce crew requirements but at the expense of increasing the technical competence needed. Both of these developments spell difficulties for application for the shipping policies of developing countries. On the other hand, the shipping policy of developing countries in respect of liner services is not simply to carry 40% of their cargoes. Fleet expansion is a means for the realisation of fundamental objectives in the wider economic and social field, not an end in itself. Carrying 40% on own bills of lading in leased container slots will not serve any of these wider objectives.

Developing countries must expand their merchant fleets and in a competitive way. The competitiveness in shipping today depends upon many factors the most important being the types of ships, their operational efficiency and the associated services the shipping company can introduce through a competent management. Therefore, developing countries could not rely only on their cheap crews, if they are really so, to reduce operational costs as the only factor

---

(1) Workbook on the application of the UNCTAD Code
by: S.G. Sturmey

of competitiveness. In fact, they can sacrifice the factor of employment to gain many other factors which will consolidate their competitive situation more in the future, and moreover to build up their shipping industry as a whole. That is to say, by introducing technology in every aspect of shipping activity and onboard ships in particular. The "high-tech" ship will dominate the seaborne trade for many logical reasons. For developing countries, as a consequence, cheap crews on traditional antiquated ships of poor services is not an adequate weapon to remain compatetive in the shipping market of tomorrow.

This chapter will try to discuss all the pros and cons to the transfer of technology and acquisition of the "high-tech" ships by developing countries, and Sudan in particular. One important note is that the acquisition time is left for the best marketing, shipbuilding, economical situation periods and other factors which are out of the scope of this thesis. To reduce or at least arrest the technological gap and to grasp at the technological change is the real objective of this chapter.

5.1 GENERAL VIEW:

Before going deeply in discussion, it is better to have a general view of the "high-tech" ships operation, to figure out some important operational features and to highlight the areas which reflect concepts likely to motivate or to slow down the process.

Many of the operational advantages have been mentioned in Part A, but there are some more to point out:

i. They are specialized high capacity ships mainly of the fully cellular container type.

ii. They are embodying high technological features in their operation and handling.

iii. They are fast ships with much less time in ports and consequently fast turn rounds.

iv. Naturally, the manning cost is very low, and the other operational costs are also lower. Low maintenance cost due to new minimum maintenance materials used, lower fuel consumption and lower port charges due to quick turn rounds.

v. Greater productivity per ton and lower costs per ton-mile.

vi. High-tech ships are better protected against inflation than the low-tech ships. As long as inflation continues, the competitiveness of low-tech ships will be steadily and continuously ended in relating to the high-tech ships.

vii. For all those reasons and others, high-tech ships are providing better services and chances of access to new markets and customers.

Regarding, however, those obstacles to putting into effect the reduced manning scales, in general, and to acquisition of such ships by the developing countries, one can determine some important points to be discussed later in detail.

These points are:

i. The capital cost which is very high.
ii. Trade unions pressure to preserve jobs.
iii. The antiquated manning laws.
iv. Shortage of sufficiently highly trained personnel.
v. Due to their large capacities, developing countries may counter some trading problems as the whole annual trade of many of them could be put into one or two container ships.

Of course, there are other areas which were touched before. Here it is better to repeat those of the maintenance plans and more important the proper management and maintenance of the whole fleet.

5.2 THE CHEAP LABOUR ARGUMENT:

The most known argument against the application and the acquisition of the "high-tech" ships to developing countries is the argument of developing countries having cheap labour and consequently they must plan to build labour-intensive ships rather than capital-intensive ships, i.e. "high-tech", due to lack of capital. This argument is unfair and unrealistic. In many other industrial fields developing countries have introduced technological applications which cut down the labour force for better production procedures, the benefit being for all. Application of "appropriate technology" after economical and social impact assessment should go on every direction. In shipping itself, developing countries have been always reacting positively by absorping all the optimizations applied on the ship's operational costs. The technologies used in those optimizations were developed by the developed countries and our developing world is just buying this technology. When a new technology is again introduced by the West to cut manning levels, developing countries stand still and confused because they have to do something more this time, to face their antiquated manning laws and their rigid labour unions. The capital is not a new problem, although it is bigger this time, it has been a problem for a long time and they managed to solve it. These issues will be also discussed later. The cheap labour comparative advantage is not the only one developing countries has and they do not want to loose it even for many and better advantages. And even the cheap labour they will not loose. It is still there and will remain for a long time, the problem is actually the employment of more labour rather than loosing cheap labour. Therefore, it is a big advantage effectively added to developing countries rather than developed countries to combine between the two, reduced crew and cheap crew at a time. In fact, and to prove it is the right direction, the developed countries which introduced these ships to stay competetive by reducing the crew, used this concept of combination. The competition is even harder to gain by one factor. Many sophisticated ships are now working under flags of open registry, they are European runaway ships. During my training I have seen some Norwegian "high-tech" ships totally manned by Philippinians, another way of doing it. What a better chance developing countries have, they have the combination at home under their flags and their rules.

Finally, the cheap labour is an advantage which could be still used with the "high-tech" ships. The problem of the employment should not deprive us from and stand as an obstacle to the technological change. If the rule is so we are to do everything manually and labour-intensive. If it is a living rule we are to refuse technology and live in the middle era of the twentieth century.

5.3 THE ANTIQUATED MANNING LAWS:

As I mentioned before developing countries have utilized the technological facilities applied onboard to minimize operational costs without any difficulties. However, for absorping the new technology which resulted in reduced manning, they have a step to take forward in order to prepare themselves for application. Developing countries must get rid of the antiquated manning laws and replace them with new laws which give way for the "high-tech" ships for reduced manning to join their merchant fleets. Some countries, however, need to update only some of the regulations and rules regarding manning structures. The updating must put into consideration, always, the future possibilities and should cover all the other associated matters of this aspect. This is important because it is common practice in developing countries that amending a law takes a long time to be ratified. This amendment, in particular, will counter many political and economical pressures, beside the normal bureaucracy.

In Sudan, however, the problem looks to be much easier from one side and complicated from the other side. It is easier because there are no manning laws essentially. The Maritime Law and the Shipping Act are completely out of date and all agreed to replace them totally. So one expects, theoritically, that the new Shipping Act will contain very modern and updated manning laws. It is also complicated because of the lack of the awareness, a long discussion will take place before ratification. The role of the maritime administration officers is important. Probably these ships may be acquired by Sudan before manning laws come into existence, then the problem will be much easier. It is not a joke as we already had a similar situation. The last new ships we had in our fleet in the very late seventies were manned at the beginning with over fourty members. With the market pressures and in order to minimize crew costs the number was cut down to twenty six without any legal problems from any direction. The cut down was even done in two stages although the shipping company is suffering a huge overstaff at sea. So, in my opinion, it will be quite easy applicable if either of the situations is there. One fact that will facilitate passing these laws is that the number of experts in maritime affairs is very small and as far as I know the Ministry of Transport is heavily relying on them to prepare for the legislation. The technical assistance in IMO showed its readiness for help and it is really required as it will furnish the laws with more confidence.

5.4 THE LABOUR UNIONS:

The natural reaction of the labour unions towards reduced manning trend is to refuse it using legal or illegal ways as strikes. Even in Europe where the "high-tech" ship is born trade unions react violently and refused the trend, their issue always being to preserve jobs for their members. However, the conflict was easily solved in Europe and the example of the agreement between shipowners and trade unions in Sweden was shown in Part A of this thesis. Generally the problem could be solved if the shipowner can afford the same financial status for the spared seafarers at their new positions. This solution could be frequently found in Europe rather than in the Third World.

One important difference that complicate the situation in Europe and could not be found in developing countries should be notified. That is in Europe when a company acquires new ships it normally sells some of its old ships, European shipowners frequently change their ships after five to eight years. This situation means more job losses for trade unions particularly when the new coming ships are of reduced manning type. In developing countries, however, there is no market for their existing ships except at virtually scrap prices. There is also one common reason which could weaken the pressure of the trade unions, that is the difficulty in finding sufficient personnel able to put the new manning scales, with the high technology dispensation, into effect. And also if anyone is to be qualifield to the level he can operate, maintain and supervise these ships he will prefer to work at shore and he can definitely find a good job.

To focus this issue in Sudan a part of the story was told when I was discussing manning laws. One side of the problem could be solved by ratifying manning rules, while the other side, the practical one or the friction between the unions and the shipping company is supported by many features and practices. The most important practice was, which I mentioned earlier, the two cuts down made to reduce manning when proper job assessment was applied. The new ships received in 1979 were designed to be operated by maximum 26 complement or could be less, but without good assessment and according to the manning structure we had onboard the old ships, the new ships were manned. The financial status of the company was also encouraging at that time, but the situation changed later on and that reduction was made and was accepted by the unions after a short discussion. When new ships are to be added, even of the reduced crew type, more jobs will be available in case of keeping the older ones. This is the case I am basing my discussion on, as we will see later, these new ships will be in the form of a joint venture or shared ownership and we will have the chance of more jobs. Finally and according to my experience as a previous member of the officers and engineers union executive board, if Sudan is to own a complete fleet of "high-tech" ships, this will be rationally accepted by the unions if they are to participate from the beginning in the proceedings and discussions of expanding the national fleet and providing it with more advanced and "high-tech" ships. They are, all of them, people who faithfully appreciate and dream of a flourishing successful fleet. One more point of great importance is the management recruitment policy which should match properly the future needs so that the situation of the current overstaffing is never to recur.

5.5 THE TRAINING:

The special training required for the high-tech ships in the proper way was discussed in Part A. This could possibly be attained through enrolement in specialized maritime schools and institutes established for the purpose of graduating qualified personnel to work as dually-licensed officers and general-purpose crew. The traditional maritime academies can no longer serve this issue unless they are to be updated to keep in pace and to provide simulation training as a major part.

For developing countries, however, the situation can not be handled very much different from the original; because ship-owners everywhere, even government owned companies, will not get into the risk of employing disqualified crew on such high-capital ships. As a matter of fact, those personnel must be satisfactorily trained before the date of delivery of the ships to the concerned country. However, the way in which the crew is to be trained depends very much on the way the developing country will acquire such a ship. Choosing some traditional officers to attend the whole construction of a high-tech ship in the shipyard accompanied with short specialized courses in each area could put these officers in the right way. Delegation of direct responsibilities to them onboard should come gradually. Training of fresh students from the beginning in the specialized maritime schools is very expensive for developing countries to afford since these schools only exist in Europe. It is better, financially, to prepare the existing traditional officers for the new job so as not to loose their built-up experience particularly on safety. After many years to go when the high-tech ship will be a reality in our developing world, maritime institutes will also be at the required level as many of them today are, e.g. in Alexandria and Ivory Coast.

As I mentioned, the solution will depend on the form of acquisition. If it is a joint venture then a clause of training is essential to incorporate in the agreement. Mixed crews between the two parties, one which has the technology and the other which has the market for example, will help very much in the transfer of the know-how and training.

For our case in Sudan, all the forementioned is applicable. One important point of advantage to add here, that is the last ships we acquired in 1979 embody a relatively high technology especially in the engine-room. All engine parameters are monitored through extensive applications of control systems. A modern monitoring and supervision system on engine performance is fitted, DIFA 31, and the engine could be controlled effectively from the bridge during manoeuvring and sea passage either. Briefly I can say the engine is designed for UMS operations despite the overmanning practiced by the company. In fact, and in my opinion, this exercise of manning a UMS engine was very useful and advantageous practice of effective transfer of know-how to the operating personnel. It was a practical training while doing the job itself, a chance which is beyond simulation. Someone may think about dangers and damages which might result from such a situation, but there were not any, the top staff namely the chief engineer and the electronic engineer were having enough periods of training while the ships were under construction. This situation made people familiar with such advanced technology, and to my experience, as I worked onboard these ships and have seen many high-tech ships during my training here in Europe and USA, the technological gap or difference between the two is not too big. The great departure in technology, I noticed, was the extensive computerization and communications applications, a departure which could be attained by our people through some short simulation courses.

5.6 METHODS OF ACQUISITION:

In the following I will try to consider some of the most viable and popular methods for ships acquisition and select and add at the end those possible ways for developing countries and Sudan in particular. First I will cover some of the ships financial resources, concentrating on those methods which are suitable for financing the fleet expansion.

5.6.1 Sources of Finance:

i. Loans from national or international banks for a new building with their various types of securities and guarantees. Developing countries usually deal with international banks and mainly the World Bank. There have been many obstacles to finance from the have been many obstacles to finance from the International Financial Institutions (IFI) to developing countries, which were pointed out by UNCTAD, due to conditions stipulated by IFI which developing countries could not fulfil. However, financing new buildings, to some extent, is considered easier than that for second hand ships, the issue of maintaining shipyards and associated employment being behind facilitations.

ii. Within the shipping company, retaining a part of the earnings as a method of obtaining funds for expansion is another method. The acquisition of a new ship, however, may well require funds well beyond any retained earnings and other sources must be considered in addition. In this recession period where shipping companies in developing countries could hardly make any profits, this alternative seems as difficult. It could be beneficial if the company is to increase its investments by issuing more shares. This will be considered later when talking about Sudan.

iii. As a national policy, that savings could help as most governments allow accelerated depreciation on ships for tax purposes and as a result the acquisition of a new vessel may save the company substantial amounts of tax that would otherwise have to be paid on profits arising from the company's other vessels or activities. In fact this is only a postponement of a company tax liability and is therefore comparable to an interest free loan from the government.

iv. A popular method of financing expansion is by leasing rather than purchase of new vessels. By leasing a new vessel the shipowner has nearly all the advantages (and disadvantages) of ownership but without the need to provide the initial capital investment.

5.6.2 Alternatives for Sudan:

For Sudan, and for most of the developing countries where the largest companies are owned by the government as well, there are many alternatives for the "high-tech" ship acquisition. All the traditional methods developing countries have been using before could also be considered without mentioning them, if they will consider the "high-tech" and if those methods will be successful in financing the acquisition.

5.6.2.1 More Shares:

Sudan shipping line company, the national carrier, is owned by the government (500 shares, 499 shares for the Ministry of Finance and one share for the Central Bank of Sudan). As a matter of fact, the shipping business is more successful when it is owned by the private sector as it is the case in western Europe. I am not calling for selling the company to the private sector in the mean time because the circumstances are quite different, however, the policy of the Sudanese Government today is towards selling public corporations to the private sector, these including the main governmental banks and agricultural schemes. The alternative I suggest is to raise more capital for the company by issuance of more shares for sale. It is usual that the existing shareholders are given the right to purchase a number of shares they hold. I do not expect that the government will do it and I really hope that the private sector will contribute considerably and, as far as I know, they will welcome such a step. We have many businessmen who are involved in the business of shipping through small shipping companies, they have both the capital and the expertise. However, the government can stipulate or plan for possessing half or so of the shares to retain its rights for the time being. In the future, I only see that shipping business is to be run by the private sector. this alternative which will raise the capital and strengthen the financial status of the company to proceed on plans for fleet expansion is already adopted and implemented by Sudan Airways, the National Air Carrier, and was really successful.

5.6.2.2 Shared Ownership with Neighbours:

Sudan Shipping Line, again, being the largest company operating in Red Sea and the most successful one can well utilize this criteria for more success and expansion. As a mater of fact, more than 90% of the cargo carried on the vessels from the north is for Saudi Arabia and Yemen. Sudan imports being relatively smaller. The shipping business in Saudi Arabia is mainly a private business, the national carrier is just beginning suffering shortage of staff. The reputation of Sudan Line in the whole area is very good and cooperation with it will be welcome. The maritime expertise of Sudan is the biggest in the area and in the mean time Saudi Arabia is asking for Sudanese crews to run some of its ships. On the other hand, as I mentioned earlier, the new "high-tech" ships are mainly very large container ships, as it is the trend towards containerization, and the annual trade of the developing countries is rather small, the possibility of joint ownership of the "high-tech" large ships becomes a necessity. I see the possibility of such ownership between Sudan, Saudi Arabia and Yemen in the mean time. This concept could be also viewed under the umbrella and auspices of the Arab League where an operating small company was already established. However, in this context, both the Arab League and the African Unity Organization can play a regional role in the transfer of the shipping technology to their areas.

5.6.2.3 Joint Ventures:

In Chapter 4 I have talked about joint ventures in general. In my opinion, the most viable mechanism in transfer of technology in shipping is the joint venture. The most known motivations for a joint venture are:

i. Accommodation of foreign investment laws
ii. Resources sharing
iii. Skills sharing

iv. Use of expertise of locals
v. Risk reduction
vi. First step in a merger/acquisition
vii. Heavy dept financing

However, we have seen in Chapter 4 how much deeper the problem of transfer is when it comes to the code of conducts as every side is firmly sticking to its interests. Technology-transfer is one of the most complicated issues between the north and south and I am considering now a joint venture between a technology owner and Sudan, all the related discussion in the last chapter will be raised again. It is a fact that when the absorptive capacity of the technology recipient is low and his partner has strong technological capabilities, then a joint venture is perferrable. I think the position Sudan Shiping Line is occupying in the Red Sea will qualify it to a successful joint venture, that is the market. The second advantage Sudan is possessing is that of the cheap labour. As joint ventures, in general, are resources and skills sharing we hope by the resources we have to acquire the technological skills others have in order to, not to make profits only, but to get a basis for the maritime technological development. The details of running the joint venture and the contents of the agreement are matters which could be easily handled if the principles and objectives of the venture are clear.

The issue of distribution of ownership and control of the joint venture is of great importance. It is natural that if one party clearly has majority interest then he will have the control. If each party has 50% then each of them will be reluctant to give up controlling interest. In this case to avoid deadlocks in decision making one solution may be that the joint venture may be structured so that each partner has 49% interest, with 2% interest given to a third party, who would serve as a tie-breaker in the eventuality of deadlocks.

However, one can imagine a combined approach, that is Sudan with Saudi Arabia can form one side of the joint venture with the other partner which possesses the technology. Sudan and Saudi Arabia will possesses together the market, the cheap labour and a higher capital which will qualify them to the majority owner. After the joint venture is structured Sudan and Saudi Arabia can distribute their capabilities and advantages. Sudan can dominate the expertise side in manning and management while Saudi Arabia can look after the finance and marketing side. This situation can attract, with many benefits, techno- logy owners to set up a successful venture for both sides.

CONCLUSION:

Developing countries must not rely on the argument of cheap labour continuously as an adequate factor for competitiveness. It is not enough and will not last long. Instead they must sacrifice extensive employment to gain more competitive factors of improved services incorporated in the "high-tech" ships. Developing countries, also, must take a step forward to give way for technology to sign on board their fleets by updating their antiquated manning laws and by logical discussions and compromises with the labour unions rather than confrontation. Good assessment of labour future needs can make the problem to disappear completely.

Many methods of acquisitin of "high-tech" ships are available for developing countries, those which were discussed: raising the capital of the national companies by issuance of more shares to the private sector. This is a step for shipping to be totally owned and run by the private sector in the future. Shared ownership and joint ventures are also successful methods for acquisition.

RECOMMENDATIONS

PART "B"

1. ON THE GLOBAL LEVEL:

i. The code of conducts made by UNCTAD and multinational corporations for technology-transfer should be realistic, both sides must agree on responsibilities and obligations to put a common new code in effect for the benefit of all.

ii. UNCTAD is to concentrate on the issue of the technology-transfer by setting up a special internatinal financial institution to finance projects that embody true aspects and features of technology-transfer in shipping activity.

iii. Regional organizations like the Arab League and African Unity Organization must pay more attention to the maritime field and be aware of their responsibilities, obligations and benefits in shipping in order to enhance technological developments through regional and international cooperation.

iv. Developing countries must benefit from each other's expertise in the field of maritime technology. This is being easier for underdeveloped ones than to deal directly with the technology owners, the technological gap is much less, the cares are common and the agreement is easier to reach.

v. A special recommendation to WMU graduates to work hardly on the issues of:

a. Technology-transfer, by using the knowledge and training they acquire to develop their maritime sectors, being motivated and impressed by the technology applications they saw during their training.

b. International cooperation, by utilizing the uniqueness of WMU that gathers all these nationalities and creates a healthy atmosphere for cooperation. This criteria will help very much in implementing the previous item (iv) of these recommendations.

2. ON THE NATIONAL LEVEL:

i. Developing countries are to improve and strengthen their roots in maritime science and technology in order to increase their absorptive capacities for the transferred technology. Effective and updated maritime legislations, efficient administrations, proper ships register and appropriate inspection services are all in service of a good base for transfer of technology.

ii. If developing countries are to start by setting up minor works on ship repair and maintenance at home, this could be a nucleus for a future subsidized shipbuilding as it will encourage and build up the maritime expertise which will serve effectively the transfer of technology.

iii. Developing countries must not rely on the argument of cheap labour as a continuous adequate factor of competitiveness. It is not enough and will not last very long. Instead they must sacrifice extensive employment to gain more competitive factors of improved services which are incorporated in the "high-tech" ships.

iv. They must also take necessary steps forward to give way to technology to sign on onboard their fleets by updating their antiquated manning laws and by logical discussions and compromises with the labour unions rather than confrontation with them.

v. Developing countries are to explore, improve and maintain their comparative advantages in shipping to attract and dominate joint ventures with technology owners.

BIBLIOGRAPHY

01. Shipping and Developing Countries
By: J.J. Oyevaar

02. Ships and Shipping of Tomorrow
By: Rolf Schönknecht
Jürgen Lüsch
Manfred Schelzel
Hans Obenaus

03. Port Engineering and Operation
By: E.J. Harding

04. Shipboard Operations
By: H.I. Lavery

05. Safety at Sea, Proceedings of the Second West European Conference on Marine Technology

06. Lloyd˝s Shipmanager
Issues: February 1987, April 1987 and June 1987
By: Captain Jack Isbester

07. MER Magazine (Marine Engineering Review)
Issued by the Institute of Marine Engineers

08. Fairplay Magazine
Series of Essays Written By: Captain E.W.S. Gill

09. Euroship 84
"A collection of papers on the EEC˝s maritime requirements for the 1990˝s" by the Institute of Marine Engineers.

10. Applied Ergonoics
By: Ian Galer

11. Fitness for Sea, an International Conference on Seaworthiness, 9-10 September 1980, V.1 and V.2

12. Ship Manning, Present and Future, a seminar (9 Feb. 1983)

13. SOLAS Convention, Safety of Life at Sea

14. STCW Convention, Standards of Training, Certification and Watchkeeping

15. ILO Convention No. 147

16. IMO Resolution No. 481

17. Rational Bridges for Increased Safety and Efficiency
Rational Manning of Ships
By: Captain Per Larsen (DNV)

18. An Ergonomic Study on Regular Staff of Ocean-Going Vessels
By: S. Une and K. Nomoto

19. The Developing Countries and International Shipping, World Bank Staff Working Paper No. 502

20. International Business and Global Technology
By: J. Davidson Frame

21. Workbook on the Application of the UNCTAD Code
By: S.G. Sturmey

22. Shipping Finance (Fairplay Publications)
By: J.E. Sloggett

23. Handbook of International Joint Ventures
By: John Walmsley

24. Operating Modern Liner Vessels, Possibilities and Restrictions of On-Board Automation and Crew Reduction
By: Jens Froese
International Symposium on Liner Shipping IV
Hamburg, 01 - 03 June 1988