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WORLD MARITIME UNIVERSITY
MALMO-SWEDEN

MARINE AUTOMATION AND IMPACT ON SHIPBOARD MACHINERY

BY
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NIGERIA

A dissertation submitted to the World Maritime University
in partial fulfilment of the requirements for the award of
the degree of

Master of Science
Maritime Education and Training
(Marine Engineering)

Year of Graduation

1992

(Declaration)

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

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

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ABSTRACT

Today, the world is experiencing high energy cost and energy conservation and these have prompted the ship operators to use automation in order to save energy. Also high operational and labour costs have accelerated the pace for automation application on board ships as mini-and microcomputer based controllers have become relatively cheap and yet, robust and flexible to perform the require functions. Automation therefore is now expanding in the maritime industry as benefit to its adoption is being widely accepted and acknowledged.

Nigeria, plagued by scare financial resources, lack of technical know-how and logistics with inadequate training facilities, has always hastened to adopt new technology without proper evaluation of technical and socio-economical factors for effective operation, management and maintenance of such systems.

In this dissertation, a comparative analysis of practical shipboard automation as applied by developed maritime nations has been looked at with a view to giving the shipowners and operators in Nigeria the tool to selecting a better level of automation for present and future vessels in their fleet so as to maximize efficiency and safety in shipping operations. However, in dealing with a subject as wide as this, it was very necessary to project the views and opinions of successful users and to highlight futuristic trend in shipboard machinery automation; with a view to making ships less costly to operate with high degree of reliability and safety to navigation.

ACKNOWLEDGEMENT

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INTRODUCTION

Man has transformed his world by his ability to control other occupants of this planet. Progress was slow at first, but was accelerated in the 18th century by a series of stupendous discoveries and inventions. During this period of the first industrial revolution, substituting machine for man's muscle was introduced. Today substituting machine for both human muscle and brain has become the required objective as equipments and materials became more sophisticated and complicated.

Recent technological development in marine automation have created some difficulties with profound consequences. As automatic control systems are more sensitive and accurate, they can maintain or exceed the efficiency, reliability and safety of manual systems. This would improve working conditions and thereby reduce manpower requirement.

Most countries have recently developed varieties of systems to modernize their merchant fleets so that they can reduce crew sizes, and ensure economical maintenance cost with diagnostic expert system. This has been accelerated by the availability of cheap, compact, yet powerful, mini-computers and the increasing availability of micro-processor based controllers which have a substantial influence on ship operations.

These devices are used on the ships to perform such functions as watchkeeping, navigational manoeuvrings, berthing, collision avoidance, material handling and cargo control. The use of this equipment occurs where monitoring, controlling and information processes are involved. Trends towards the greater modernization of shipboard installations and equipments, with reduced manning obviously point towards the ultimate goal of one-man control from the bridge.

In assessing the circumstances surrounding the shipping business today, the importance of promoting modernization by grasping the need to control ship installation and information should be recognized. This is so as shipboard environment also served as a living environment for ship's operators from the stand point of an integrated man-machine system. Thus conducting sufficient assessment on such a system through an ergonomic approach as well is desirable.

In this dissertation, several issues related to social, economics and safety operation of ships in respect to the reliability of automated marine machinery will be discussed.

Developed countries, having substantial resources and less manpower, can justify a reduction in manning levels on ships. Developing countries with a surplus of cheap labour, but a lack of logistics to cater for spare parts availability, shore base repair facilities, or highly trained personnel, may not justify such a high capital intensive venture without careful evaluation and analysis as financial resources are scarce. It should therefore not to be forgotten that the developing nations ships

cannot operate in isolation because shipping is an international industry. Also it should be noted that automation can conceivably reduce energy costs, improve reliability, and above all, enhance safety of the ship operation. It is also a known fact that most shipowners from developing countries are acquiring second hand ships from the industrialized nations due to limited resources, these ships are in most cases fully automated and require competent engineers with the grasp of the technology to operate such ships. With this in mind, the developing countries would have to train new technologists having a broad knowledge of the fundamentals and understanding of automation to a wide variety of problems. This would accelerate technological development in the developing nations for the future.

Therefore for developing countries to remain competitive in the shipping trade, application of automation to their ships should be critically examined and implemented at a point best suited for their prevalent situation.

The subject of my dissertation therefore is to discuss the application of automation to marine machinery with respect to propulsion, power generation, integrated bridge system and unmanned machinery space operation with computer utilization. It will attempt also to assess the impact on the Nigerian shipping industry and the benefit to be derived from such innovation.

1.1 INTRODUCTION:

Mechatronics is the ability to integrate electronic and computer technologies into a wide range of primary products and processes.

The good performance record of modern diesel engines for main propulsion is due to the ability of engine makers to exploit developments in technology. This is introduced at the design stage in both products and manufacturing processes. The result has been a system which is cheaper, simpler, more reliable and has greater flexibility of operation than their predecessors. In this highly competitive situation, the old division between electronics and mechanical engineering are being replaced by the integrated and inter-disciplinary approach to engineering design referred to as Mechatronics.

In this highly competitive environment, therefore, only those new products and processes in which an effective combination of electronics and mechanical engineering has been achieved are likely to be successful. In most innovative products and processes the mechanical hardware best utilized is realized by a consideration of necessary electronics, control engineering and computing from the earliest stages of the design process. The integration across traditional boundaries that this requires, lies at the heart of understanding the developments that are taking place. Thus the mechatronic approach to engineering design is

the only way to achieve high reliability of marine products and services.

The introduction of new technologies to the marine machinery therefore, is to follow the established and operational rules and regulations mainly for the safety of ships and human lives at sea.

Marine machinery mechatronics is concerned with bringing together and integrating key areas of technology, particularly;

- sensors and instrumentation systems.
- embedded microprocessor systems.
- drives and actuators.
- engineering design.

In the case of sensors, instrumentation, drives and actuators, the incorporation of dedicated data processing units will allow independent operation of the main controller thereby providing increased system flexibility. Such smart sensors and intelligent actuators that incorporate embedded microprocessors as part of the distributed system play a significant role in the design and development of a large scale mechatronic systems in marine machinery.

1.2 SYSTEM DESIGN CRITERIA AND OBJECTIVES:

The three main points to be considered in evaluating mechatronics from the view point of safety and reliability of ships are as follows:

- Design to minimize the potential system failure
- Quick trouble shooting and response in case of failure.
- Alternative means to continue navigation in an emergency.

In order to meet these requirements, the following points must be considered in designing the system.

- Redundancy.
- Fail-safe features.
- Monitoring operating conditions.
- Minimizing functional loss of a system.
- Possibility of manual operation
- Environmental considerations

Explanation is given below to each of the points mentioned above.

REDUNDANCY:

For redundancy, it is of utmost important to consider the safety of the whole ship in preference to a single item of equipment or machinery. The degree of redundancy to be provided for each sub-system, should be determined in relation to the importance of the sub-system within the whole system of the ship, the probability of its failure, availability of alternative means etc.

For a ship to continue navigation without disturbance to its propelling and steering equipment or machinery, designs providing redundancy such as parallel or standby equipment must be provided. Means of ensuring

continued navigation at a temporary reduced speed or sufficient supplies of spare parts to enable repair must be of paramount consideration and be taken selectively according to their importance. Furthermore coordinating the system with fail-safe or monitoring functions is essential.

FAIL-SAFE FEATURES:

These are functions designed in case of any failure of power, control circuits, structural members, or other components resulting in system abnormality to some extent. They will ensure safety of the entire ship. For instance, main propulsion engine tripping due to abnormal functioning parameters provides safety in the sense of protecting the main engine, but it signifies the loss of propelling power for the entire ship. It would be safer to continue operation of the main engine as long as is possible to avoid endangering the whole ship. This is therefore necessary to bear in mind during the design of the control systems or protection systems.

Mechatronics is attracting the attention of diesel engine manufacturers. In so doing, however, consideration should be given so that continuation of the unchanged state of operation can be maintained as long as possible by blocking control circuits and power circuits should they fail.

1.2.1 MONITORING THE OPERATING CONDITIONS:

To maintain the safety of the plant itself or the entire system of the ship through early detection of abnormalities, constant monitoring of operating condition is indispensable.

The operating conditions should be monitored not only to indicate the occurrence of abnormalities to the engineers, but also to coordinate the function to prevent an unexpected control action in the plant or the entire ship system and switch to backup system as result of abnormalities. Furthermore, it is an important function to be capable of identifying trouble for early restoration of the plant.

In mechatronics system designs, sensors and actuators are the hard working slaves. Even though the electronic unit serving as a brain of the system is normal, the function of the entire system cannot be expected to be normal if abnormalities develop in sensors or actuators. As sensors and actuators are generally mounted at different locations, there is the concern that a failure may occur in cable ways. It is therefore necessary to detect faults in units and cable ways at an early stage in order to cope with them properly. A good degree of consideration must be given to the safety of the entire ship; in accordance with the principle of fail-safe operation so as to assist the engineer's decision to either continue operation by maintaining the present state, run at reduced speed or stop operation.

1.3.2 MINIMIZING FUNCTIONAL LOSS OF THE SYSTEM:

With the recent increased capability of computers, the range of functions to be imposed on a single computer unit is tending to expand. A failure developing in a central processing unit (CPU) or similar unit with an extensive range of functions, means that all relevant functions could be lost, eventually creating difficulties in the operation of the ship itself. To avoid such a serious situation, there is the need to have a proper distribution of functions to enhance the safety of the entire plant. This is done by securing the independence of the control system, the alarm system, and the safety system representing the basic functions of an automated system.

However, the advantage with computers is that many functions can be totally monitored and controlled, therefore the above consideration of independence may not be obtained. In such a case, consideration of equivalent safety is required by the installation of alternative systems, change-over functions to a stand-by computer, etc.

The area to which mechatronics is presently being applied is only a small part within the entire ship system. Though highly probable that it would be expanded extensively in the future. When this functional diversification is realized, basic functions will be imposed on respective distributed sub-systems, and the extra features such as functional optimization and system sophistication will be incorporated into the central processing unit that control the entire plant.

1.2.3 MANUAL OPERATION:

Automatic control of various plants on the ships is still undergoing further development. A plant utilizing automatic control systems must incorporate a manual control to enable the engineer to cope with the possibility of failure of the automatic control function. To be able to respond immediately to any contingencies in the automatic control system, consideration is given to means to take the necessary steps instantaneously to temporarily undertake the duties of the automatic controls and means to ensure emergency operation. Consequently, instrumentation to provide minimum levels of information to undertake such alternative means must be provided. Consideration also to ensure independent so that the ultimate protection system can be kept effective even during manual operation. Therefore, the basic control functions necessary for manual operation must be separately provided from the automatic system for normal use.

1.2.4 ENVIRONMENTAL CONSIDERATIONS:

The configuration of mechatronics systems could take the form of electronic signals from sensors being received by controllers to regulate actuators. In such a system, sensors and actuators are often fitted where environmental conditions are severe. Therefore consideration must be given to their resistance to such adverse environmental conditions. With electronic components, including controllers, there is the risk of malfunctioning due to high level electrical noise.

vibration and high temperature that normally exist in ship's machinery. Thus a careful assessment of the resistance of component parts to adverse environmental conditions is one of the highly important considerations for securing satisfactory levels of reliability for mechatronics.

A series of sensors for monitoring and alarm functions has shown a high statistical failure rate on ship installations, particularly those for exhaust gas temperature. These have been dominated by the parting of filaments caused by vibration. Thus sensors with high resistance particularly to temperature and vibration must be selected for those mounted directly on engines or in the vicinity exposed to excessive vibration and high temperature.

1.3.0 MECHATRONIC APPLICATIONS IN MARINE MACHINERY OPERATIONS

ELECTRONIC GOVERNOR:

Electronic governors are typical mechatronic application. The first practical application in ships was in 1987 and was approved by the classification society after several environmental tests were conducted. All the governors installed were on 2-stroke cycle diesel main engines. A better stable running condition was achieved with a bore/stroke ratio of greater than three. This proved that slow speed main diesel engines in their very low speed range performed better than conventional mechanical-hydraulic governors.

The basic system configuration includes the control unit, actuator, and revolution pickup as shown in figure 1. There is another model type in which the display panel and power unit are separated from each other.

Table 1 Measures for Ensuring the Reliability of an Electronic Governor

Redundancy	Fail-safe, monitoring and alarm functions				
	Contents of abnormality	State of Engine	Alarm display	External output	
<ul style="list-style-type: none"> • Duplication with a mechanical governor • Duplication of processor and memory of CPU • Duplication of rpm pickup • Duplication of actuator feedback sensor • Duplication of hydraulic oil pump for hydraulic actuator 	Abnormality in processor	Hold on	○	Batch output	
	rpm signal abnormality	1 pickup fails	Normal running		○
		2 pickups fail	Hold on		○
	rpm setting signal abnormality	Hold on	○		
	Scavenging air pressure signal abnormality	Hold on	○		
	Actuator abnormality	Hold on	○		
	Power supply abnormality	Hold on	○		

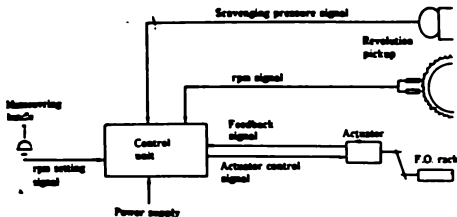


Fig. 1 Basic System Configuration of Electronic Governor

Source: NKK Technical Bulletin-1990

The electronic governors used in marine diesel engines are designed with the aforementioned design philosophy to ensure reliability and safety (see Table 1).

Redundancy is provided either by:

- Duplicating with a mechanical governor in case of electronic governor failure, or
- duplicating the processor and memory of the central processing unit for automatic change-over to the backup system.

Revolution pickup systems are duplicated in all models to prevent the engine speed even when there is a cable breakage. Thus normal operation is ensured by another rpm pickup system when one pickup system fails. Duplication is also provided for the feedback sensors and hydraulic oil pumps. Redundancy for fail-safe function and monitoring function is provided by the self-monitoring function of the central processing unit (CPU) or by input signal monitoring. Even if abnormalities develop, the actuator is blocked to maintain the present state of operation of the main engine. Furthermore, abnormal points are displayed externally as a batch alarm indication. This can be quickly detected to facilitate early restoration of defective components.

An electronic governor is an electronic version of the conventional mechanical governor that should not require any duplication. However, consideration must be given to sufficient numbers and kind of spare parts if it is intended to continue operation of the engine without manipulation of the local fuel oil handle by hand even when failure occurs. When the electronic governor is designed as an integral part of other important control

systems, such a system should have ample redundancy.

EXPERT DIAGNOSTIC SYSTEMS IN CONDITION MONITORING OF DIESEL ENGINES.

Another positive implementation of mechatronics is its contribution to the expert diagnosis technique. Generally, it is difficult to detect faults in mechanical structures and in many cases an abnormality is detected after observing its secondary consequences. With this in mind, the expert diagnostic system can offer various information which can be assessed on a real time basis directly through sensors. Faults can be detected in a shorter time enabling an effective response to machinery failures.

Condition Monitoring (C.M.) implies systematic monitoring of characteristic parameters in order to assess the condition of a component, and compare it with a reference or with accepted limits where a failure or breakdown is likely to occur. The main objective is to minimize the expenses related to maintenance of component systems.

Marine engineers have always relied on inspections at regular intervals or on occasion, for gaining knowledge about the condition of the machinery. However, the 24 hours visual inspection is not easily available on board ships in today's shipping environment due to ample human error that can occur and also crew reductions which have been implemented by shipowners in order to save labour costs.

The expert engine diagnostic system seems necessary due to the following considerations in modern shipping practices:

-A scheduled or planned maintenance scheme is not necessarily an economic one.

-The tight schedule of a modern vessel allows for very little down time; i.e. less frequent and shorter overhaul periods. The aim being to do most of the maintenance or repair work in harbour by well trained crew.

-As already mentioned, modern manning schedules of lesser crew make it very difficult to have personnel for engine maintenance work. The situation in the future is predicted to become more difficult.

In the past, planned or scheduled maintenance was based on performance records. The inherent problem associated with it was that the mean time between overhauls was largely dependent on several factors in which sometimes the engine manufacturer had little or no control. These led to maintenance work being carried out too early or too late which was uneconomical, particularly as a consequence of a breakdown. It is obviously clear that an accurate prediction of life expectancy of engine components, e.g. a piston ring, is very difficult. A reliability analysis of piston rings of slow speed two stroke marine diesel engine from field data of Sulzer engines illustrate this view quite well. see figure 2

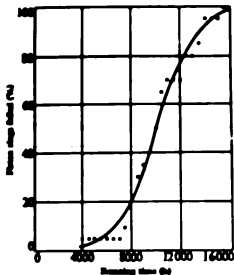


Figure 2. Failure frequency of piston rings

Source: Det Norske Veritas Technical paper-1987

Mainly due to these reasons an on-line engine diagnostic system is required to detect early adverse influences on the operation of the engine.

A brief classification of known sub-systems should be discussed before describing in detail the principles and methods of condition monitoring and diagnostic systems.

- Improved condition of data available from conventional instrumentation:

Data collected from instruments fitted on turbocharger filters and coolers of the air system, as well as exhaust temperatures and indicator cards, can be evaluated systematically. Nomograms are then used to produce trend development curves for maintenance prediction. Values from the nomograms are normalized graphically by a central computer or by a programmable calculator.

- Thermal load monitoring:

Temperature sensors mounted on the cylinder cover can detect thermal overloading and similar methods described above are applied for recording deviations from calculated values in order to develop trend curves.

- Cylinder liner temperature monitoring:

Temperature sensors in the cylinder liner are able to monitor the overall piston ring operating conditions. Due to load variations, the data can be normalized or limited to a specified loading of the engine. Variation of temperature during normal operation may be substantial; thus a statistical treatment of the measured data may be necessary.

- Direct monitoring of piston running condition (wear and lubrication):

Specialised sensors can significantly improve the possibility of detecting the onset of failure in cylinders. The engineer could take immediate action to avoid harmful secondary effects, thus elaborate mathematical algorithms for normalizing of values are not required.

- Combustion system monitoring:

The condition monitoring system can monitor the cylinder pressure, fuel pump pressure, and closing and opening time of the fuel injectors. A more complex computer based monitoring system is required.

FAILURE MECHANISM AND PROCESS PARAMETERS

To design an effective and efficient condition monitoring system, the possible processes and failure mechanisms must be known. Evaluation of the feasibility of instrumentation methods of reliability engineering have been found to be useful as well as detailed studies into specific failure types.

A simple method to meet this demand is the "fault tree analysis" which is an efficient tool for a complex system. A fault tree may be considered a particular

The procedure employs either working backwards from the undesired event to its cause or forwards from a cause to its possible end effects.

The development of improved condition monitoring systems has involved details and penetrating research into failure mechanisms in diesel engines and their behaviors under widely different service conditions over long periods of time. These have prompted the development of entirely new sensors to improve conventional types and their reaction to various engine conditions observed. Thus signal condition and data processing electronics had to be developed to give meaningful information to the operator. Efforts to develop sensors and instrumentation is a great challenge in order to achieve high reliability to ensure effective and efficient implementation of mechatronics in marine machinery.

1.4.0 SYSTEMS FOR CONDITION MONITORING:

Various systems for condition monitoring for diesel engines have emerged which differ widely on the following points:

- The part of the engine being supervised.
- The number of specialized sensors needed.
- The extent of signal conditioning.
- The algorithm being computed.
- The man/machine communication systems.

There are substantial variations in capital costs as well as in the requirement for specially trained engineers.

For the user, the main concern is the cost/benefit analysis relationship in implementing the condition monitoring system. Also optimal configuration will be varied from ship to ship depending on type of machinery, size, trade etc. Generally, shipping being very conservative in outlook, shipowners will certainly accept a system of moderate complexity.

CYLINDER LINERS TEMPERATURE MONITORING

The temperature in the upper part of the cylinder liner responds to most abnormalities and phenomena which may occur in the cylinder; blow-by, piston ring collapse and heat developed by friction (e.g. during scuffing periods). The liner temperature is therefore the best means of evaluating the general state of the cylinder unit. When the temperature remains at a reference value and is stable for long periods, it can then be concluded that the performance of the cylinders are normal. However, due to strong and frequent temperature variation as a result of faulty injection equipment, piston ring and liner wear, rotation of piston ring collapse cap across the sensor, the cylinder liner temperature cannot be used as the only condition in which the cylinders are operating normally.

The thermocouples are positioned in the cylinder walls 5-10 mm from the inner surface of the the liner. The most suitable level is between the first and second piston ring when the piston is at top dead centre position. Generally, four sensors diametrically opposed

are mounted around the liner circumference (fig below).
The probe is spring loaded to provide good thermal
contact with the liner material.

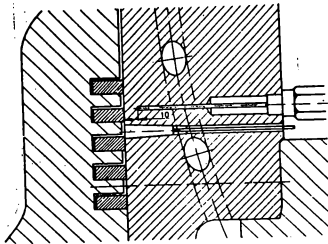


Fig.4 Positioning of sensors in a liner. The upper sensor is a liner temperature sensor and the lower is a typical wear sensor or a liner surface temperature sensor.

Source: Det Norske Veritas Technical Bulletin-1987

LINERS SCUFFING MONITORING

A surface thermocouple with unique properties is used. The response is extremely fast, enabling it to pick up the transient temperature caused by micro-seizure between rings and liner. The sensor which is shown in the figure below has an important feature in that it may

be worn down as much as 3-4 mm without loss of function. During wear, the measuring point in the surface is renewed continuously through dielectric crazing and metal bridge connections being formed across a two micro-metre thick dielectric. It has proved very useful in condition monitoring. Also a secondary slow thermocouple 10mm below the surface is provided in addition for ordinary slow liner temperature monitoring.

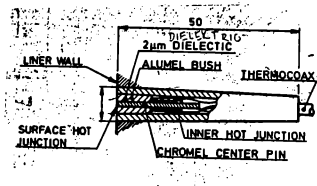


Fig.5 Schematic of a surface thermocouple.

Source: Det Norske Veritas Paper-1987.

The purpose of the surface sensor is to detect the temperature flashes produced when the oil film is disrupted and metal to metal friction occurs. For monitoring purposes, the number of flashes detected during a certain period is displayed as a condition parameter. An instantaneous indication of scuffing activity in the form of an alarm is incorporated for

immediate action to be taken when such anomalous conditions occur.

A large number of these sensors have been installed on engines in service for evaluation, testing and research. Experience from service has shown that the engineers could succeed in terminating ongoing scuffing activity by increasing the cylinder oil supply. It has also been experienced that the additional cylinder oil delivery if maintained for some time before reducing to normal supply can minimize cylinder liner wear and oil consumption.

It is typical that if the oil delivery is increased immediately on high temperature flashes occurring, scuffing would stop shortly after. However, if scuffing is allowed to persist for a long time, a longer period would be needed for an increased oil supply to have an effect. The reason for this must be damages developing in the surface of piston rings and liner thereby impeding the possibility of a stable lubrication oil film being formed; this requires running in. With condition monitoring the initial scuffing activity is detected immediately and action is taken to avoid damages and oil consumption is minimized.

The surface thermocouple must be perfectly flush with the liner surface and therefore the mounting hole has to be drilled through. No stress concentration, which could develop cracks on the through-holes for sensor, has ever occurred or been reported. The reliability of the sensors has been very high.

PISTON RINGS MONITORING

The sensor is a proximity transducers embedded in the cylinder wall to measure the distance between the liner wall and the piston ring surface. Similar to the surface thermocouples, the piston ring sensor is mounted through the liner wall. The end of the sensor is flush or within 0.5 mm from the liner surface. It may be worn down 3-4 mm without loss of function. The sensors are mounted diametrically opposed to each other and is sufficient for monitoring of the piston rings.

Presentation of piston rings function is done by estimating the mean number of failing rings within a specified period on a digital display or print out. Due to passing ring-locks giving a reduced signal, a certain failure frequency is displayed, even during normal operating condition. Incorporating an oscilloscope with the sensor signal, the piston ring dynamic signal can be displayed directly. This has proved to be sufficient for detecting defective and malfunctioning rings. In most shipping companies, the piston overhauls have been successfully governed by this system.

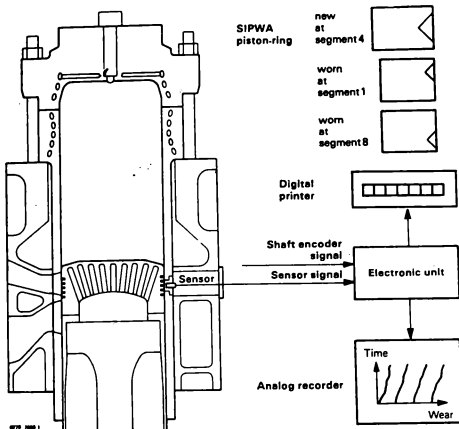


Fig.6 Piston rings monitoring

Source: Sulzer Technical Data for RLB-Marine Diesel Engine.

CYLINDER LINER WEAR MONITORING

The measured condition parameters described in section 1.4.1 are suitable for detecting conditions that could lead to undue wear rates in the cylinders. Known methods of collecting oil samples for metal oil content

examination can also be used. But measuring the wear rate directly and continuously seems a better option.

A wear sensor based on thin-film technology has been developed. The figure below shows the working principle of the sensor which is mounted as an integral part of the cylinder liner, just as the surface thermocouple. As the liner wears down, the resistance changes in the thin-film resistor. Accumulated wear, as well as the wear rate measurement is possible by this sensor. The sensor is mounted where there is the most likely severe wear in the liner. A substantial number of these sensors have been tested on several ships with positive results. (LB SULZER DIESEL ENGINE).

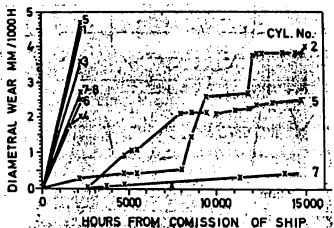


Fig. 7 Example of liner wear development in an LB engine
Source: Det Norske Veritas Technical Paper-1987

CYLINDER PRESSURE MONITORING

SULZER has developed a non-cooled piezo-electric type transducer used in measuring the cylinder pressure. In the prototype installation the sensor is mounted on the indicator cock. The only problem envisaged with this kind of mounting is the possibility of the connecting tube being blocked by dirt. However, a new cylinder pressure sensor has been developed (piezo-electric). This is mounted flush in the cylinder cover and is cooled by the cylinder cover cooling medium. To facilitate a fast and reliable cabling of the engine and to prevent cable damage, a prefabricated tube system containing all the necessary cabling is used.

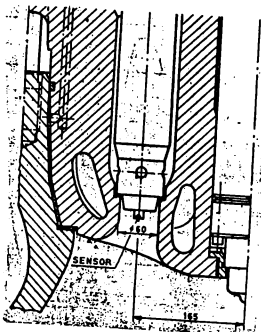


Fig.8 Position of temp. sensor for measuring thermal load
Source: Marine Technology Technical Bulletin-1990

AIR SYSTEM MONITORING

A simple system for monitoring air mass flow is to measure the pressure drop in the blower inlet diffuser. When the reduction of air occurs the engineer can then check individual components (filters, coolers, scavenge ports and compressor) by conventional methods in order to take necessary maintenance steps.

BEARING MONITORING

For slow speed diesel engines, their bearings are not so critical to introduce temperature measurement into the lower half of the bearing. The wear particle analysis of the lubricating oil is sufficient to monitor the bearing condition. Temperature measurement of the inlet and outlet lubricating oil from the bearing can also be used as a measure of the performance of the bearing in long term running.

On medium speed diesel engines, thermocouples are mounted on their main bearings in direct contact with the bearing shells to detect on-line abnormalities (Wartsila). Here the bearings are very critical due to their high speed; any abnormal load of the bearing could result in seizure. This system reacts quickly enough to detect critical changes in the bearing condition. The measured temperatures form the basic signal for which the microcomputer can automatically regulate the way these measurements are made, depending on actual condition.

1.5.0 DEVELOPMENT OF INSTRUMENTATION SYSTEMS FOR SIGNAL CONDITIONING

Various instrumentation systems of different and vast complexity have been developed for conditioning monitoring. The approach has been from simple analogue recording to computer based centralized systems. The current trend is smaller decentralized units performing specialized functions. Such modules are built together into a central condition monitoring system.

1.5.1 ANALOGUE SIGNAL CONDITIONING DIRECT RECORDINGS

The system is an automatic recording of primary parameters on ships and information of value to the engineers on board is limited or none at all. The data analysis is done ashore and the time lag involved between recording and data evaluation is enormous. This system is cumbersome for modern machinery maintenance and supervision; thus it is inadequate and obsolete except for experimental purposes.

1.5.2 DATA PREPROCESSING AND DIGITAL DATA TRANSMISSION

The transmission of low tension signals over greater distances from sensor to central processing units is unreliable. This is because they are subjected to electrical noise stemming from generators and high tension lines. Analogue transmission requires expensive cabling with shields in order to counter these disturbances.

Thus a digital data transmission and processing system is chosen. The preprocessing units can be mounted on the engine and contain the amplifiers, multiplexers and analogue/digital converter. In case of dynamic signals (cylinder pressure, fuel injection pressure and proximity signals), the preprocessing units can carry out most of the processing and data storage in order to separate (time-wise) the central processing unit from the engine process. The digital signals are transmitted in a sequential asynchronous manner over cheap telephone wires up to a distance of 400m. This means that extremely inexpensive cabling can be installed in a minimum time.

1.5.3 INTEGRATED CONDITION MONITORING SYSTEM WITH PROCESS COMPUTER

The system incorporates extensive and elaborate software for evaluation of the sensor signals and performs advanced calculations on the primary input signals to produce secondary parameters. Two mini-computer installations takes care of the monitoring requirement for the classification society notation of (UMS) unmanned machinery space, as well as the condition monitoring. For the man/machine interface, a teletype printer and cathode ray tube (CRT) display are used for communication.

Presentation of liner temperature scuffing activity and piston ring signals are done daily and weekly in a teletype printout. In addition the CRT display presents alphanumerical parameters, dynamic signals from piston ring sensors, and cylinder and fuel injection pressure transducers. A system of this size and complexity

provides the engineer with a large amount of information and there is an inherent risk of too much data, most of which represent normal operating conditions. Specialized engineers are required for operating and servicing this system.

1.5.4 MICROPROCESSOR BASED CONDITION MONITORING SYSTEMS.

With the microprocessor a number of monitoring functions are dispensed with; without sacrificing too much of the user value, as compared to a mini-computer. Requirements of direct monitoring of cylinder unit condition parameters to signals conditioning and calculation procedures are also reduced. This is realised by the design of a special purpose microcomputer which takes care of this particular task. The advantages are less volume, lower costs and higher reliability due to fewer components and a better man/machine communication.

1.5.5 THE MICROPROCESSOR CONCEPT

A microprocessor can handle virtually infinite word lengths simultaneously (a word length is proportional to the resolution of the numbers the computer can manipulate) than a mini-computer. Thus this machine gives a better performance than a minicomputer with regards to speed, cost, size and reliability.

The microcomputer consists of the following parts. The central processing unit is the brain of the system.

MICROPROCESSOR - BLOCK DIAGRAM

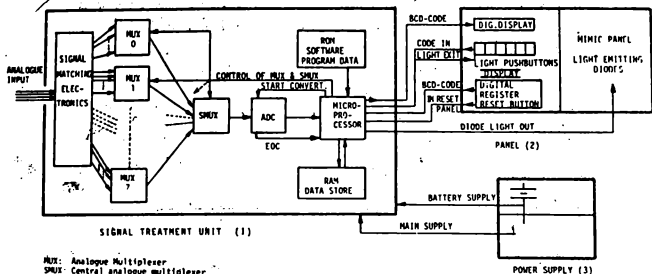


Fig.9. Block diagram of a microprocessor based condition monitoring system for LB diesel engine.
 Source: Det Norske Veritas technical Bulletin-1987

This unit controls all the signal transport and manipulations. The fixed program is stored in (ROM) READ ONLY MEMORY where the program is virtually indestructible and unaffected by power failure. The process data is stored in (RAM) RANDOM ACCESS MEMORY. Data stored in RAM is volatile; thus important data in RAM requires additional circuitry with a battery backup in case of power failure. The input/output circuitry interfaces the microprocessor to the outside world. This part collects signals for processing, and transports data to the operator or to peripheral devices. The clock generators create the timing pulses for signal transport and give speed to the system.

The micro-computer works on a set of primary input signals collected from the following sensors.

- Surface thermocouples
- Liner thermocouples (sub-surface)
- Liner wear sensors
- Piston ring sensors
- Bearing thermocouples
- Cylinder pressure transducers

The signals are conditioned for noise reduction, linearised, multiplexed and amplified in the analogue state. The multiplexing and amplification are done per cylinder unit by the preprocessor units embedded in the sensors, which also incorporate the analogue to digital converter that transforms the temperatures, liner wear and cylinder pressure measurements into digital signals for further conditioning by the CPU and then transfer to the display unit.

All communication with the engineer is via a push button and a keyboard.

The display consists of two parts:

- 3-digit display with resolution of one degree Celsius, one for numbers and 1/100mm for wear.
- Column display which shows the relative values per cylinder for the selected parameter. These assist the engineer for a quick look at relative values for temperature scuffing and number of piston rings across the engine.

Experience from the use of micro-computers in ships environment shows that the reliability of each component in the computer, this include CPU, ROM and RAM is similar

to that for other electronic components (logic circuits). Due to the high packing density in these chips, it offers the system a high reliability and low mean time between failure as compared to separately built components of other systems.

1.6.0 USE OF CONDITION MONITORING DATA

TREND DIAGRAM AND FAILURE DIAGNOSIS

The basic idea of condition monitoring systems has been trend presentation. This is achieved by the measurement of the condition parameters from the time the component is new or newly overhauled and plotting the difference between these values and reference values to produce a trend curve. Any deviation would enable extrapolation or prediction of the future trend to be assessed. The intersection between this and the action limit line established. See figure below. The main purpose of plotting a trend curve is to be able to foresee when a unit, for example, a cylinder should be overhauled-if wear progresses normally. The condition monitoring system is then able to express the present condition of the engine components as explicitly as possible, and then react to deviations from normal within the shortest possible delay. Readings from the system can provide instant information for diagnosis of the failure, thus making it possible to take corrective action before a failure develops that could cause damages.

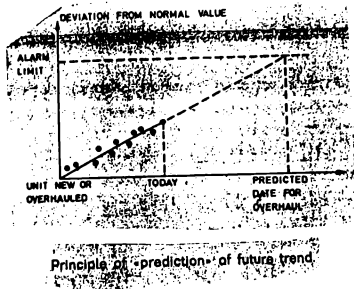


Fig.10 Trend analysis diagram

Source: Marine Technology Journal-1990

1.6.1 DATA REPORTING

Condition monitoring systems can also be used as a reporting system to minimise the engineer's work load while maintaining simplicity and clearness for optimum use of the available data. The system is designed for the following objectives:-

- As an integral part of the engine room reporting system in order to avoid redundant information.
- Only abnormal or critical conditions can be logged.
- Reporting sheets are kept to the minimum.

- Related information is only on one sheet.
- Filling in and evaluation procedure is self explanatory
- A long service period can be covered on one sheet.
- Maintenance data included so that effects of service and adjustments made are easily related to changes in condition parameters.
- Critical limits can be easily observed for condition parameters.

The condition monitoring system include separate report writing software so that trend developments and batches of data can be transmitted through electronic data interchange via Inmarsat C-terminal to a large computer ashore.

1.7.0 CONCLUDING REMARKS

The expert system is designed to provide automated engine faults diagnosis through an on-line interface with the ship's engine monitoring computers.

It has been shown from the description above that it is possible and advantageous to monitor the process and components directly by means of special sensors. Experience with most ships has shown that low maintenance costs and high reliability can be achieved in the diesel plant.

This has proved more efficient than parameters derived from numerous measurements externally on the

engine which required a large amount of data processing. This will certainly be the future trend in engine data analysis rather than depending solely on the engineer's skill which sometimes is wanting and also due to human error element present.

Further research and development particularly in the sensor field is continuing. These will certainly offer an improved reliability and long term stability to mechatronics in marine diesel engine condition monitoring.

Direct monitoring and decentralized signal conditioning electronics fit very well with the microprocessor technology. Very small, compact and inexpensive units can be obtained with high reliability.

Finally, future condition monitoring systems and instrumentation for diesel plants will probably be based on decentralised units which function independently. A central computer which may also perform other ship's data handling could be linked to these decentralised units for either propulsion or power generation data collection and control.

2.1.0 INTRODUCTION OF AUTOMATION ON DIESEL SHIP

The automatic control systems necessary on diesel vessels are usually simple and often the temperature and pressure are the only parameters automatically control. Jacket cooling water, lubricating oil and piston cooling water can easily be controlled by fitting a cascade system to provide a greater accuracy of control. The cooling system could be used in conjunction with a electric or steam heater to maintain engine temperature above a minimum value during warm up process before operation or at reduce power. The method employed is a split controller output signal and feeding to a regulating valve in the heater as well as the cooler valve.

Factors contributing towards this innovation were aimed at crew reductions, fuel and energy economy which later was linked to increase reliability and safety. One method of saving energy was the introduction of variable speed cooling water pump. The system works on a feedback control system for temperature as shown on figure 11.

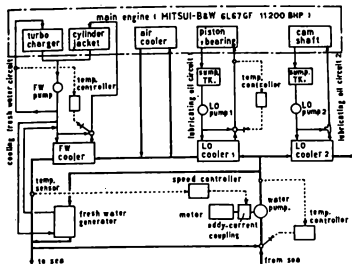


Figure 11. Main engine cooling system with variable speed cooling sea water pump on ship.

Source: Ship operation automation III

A diesel engine requires air, fuel, lubrication and cooling to operate. To operate satisfactorily, the quantity, pressure and temperature levels must be kept within limits set by the engine builder. Further, to utilize the output of the engine for propulsion, the direction of rotation and speed involves variation of power between zero and full limit. Automatic controls simplify operations and ensure safety as well.

2.1.1 MAIN ENGINE REMOTE CONTROL SYSTEMS

Numerous remote control systems for main engines are available and selection depends on the number of control stands and mode of control. It is also independent of engine design. All systems are suitable for operation by the deck officer having fairly minimum knowledge of the system and machinery or the requirements that are controlled by the control system. This allow the plant to be remotely controlled and operated from the navigation bridge.

With the available systems elements of the main engine and reduction gear box, controllable pitch propellers(CPP) if fitted are protected and emergency control is also provided. Some of the automatic remote control systems perform the following functions:-

- Engine start and programmed loading
- Engine stop
- Automatic quick transition of the critical speed range
- Attendance of propulsion plant operation, fault alarms and automatic reduction in load or stop of the engine in case critical parameters like drop in pressure of lubricating oil jacket/piston water occur etc.
- Shut down protections/emergency run/ engine stop/crash stop functions also provided in case of critical condition of the vessel.
- Ensuring a proper operation of engine with other main propulsion plant elements such CPP and gear boxes.
- Monitoring of the control system operation which includes passive control of the safety system.

The Figure 12, below illustrate the system configuration for monitoring, alarms and recording arrangement of the remote system.

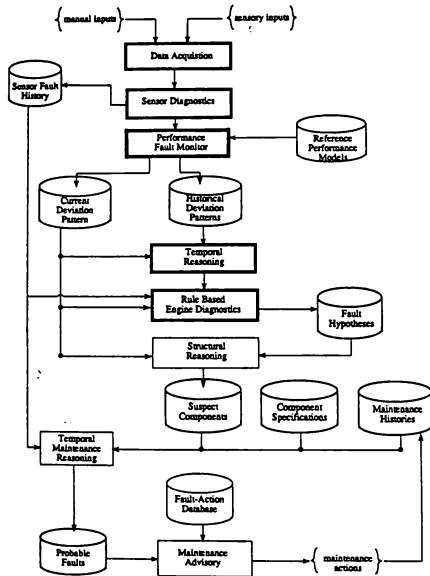


Fig.12 Dexter design for M/E remote control

Source: Marine Technology Bulletin-1990

2.2.0 CONTROL SYSTEM FOR ENGINE ROOM AUXILIARY SYSTEMS

This system aims at maintaining appropriate operating parameters which are essential for main propulsion and electrical power generation operation with other engine room systems. As main engine requires air, water, fuel and lubricating oil for operation, there are individual mechanisms, for example, pumps and associated equipment providing these logistics and the system control of such auxiliaries has also been automated. It is made to be remotely and automatically controlled and perform the following functions:

A stand-by equipment is started automatically in case of failure of the one in operation or after voltage decay for restoration of such equipment as pumps, compressors etc. Temperatures and pressures of lubricating oil, fuel oil, cooling water/oil, steam and other auxiliary system are automatically controlled.

As mentioned above the task of automatically starting a stand-by unit is achieved by arrangement based on relay systems which actuate a stand-by mechanism after receiving an alarm signal from a sensor. On the control panel, there are selectors switches and the equipment to be kept on stand-by is selected by operating the switch. There are also push buttons for manual operation both at the control panel and at the local station. On the control console running lamp indicator (green) and alarm lamps indicator (red) are fitted to indicate any fault in the system and starting duplex mechanism. In some cases a common signal for all stand-by machinery is brought up to the engine room central alarm unit. The system provide a sequential switching of machinery into

operation after voltage restoration.

The task of controlling temperatures and pressures, are performed by various type regulators. In the sea water temperature and fuel viscosity control systems, the PJ-type direct action regulators operating in conjunction with actuators are employed whereas for lubricating oil and jacket/piston water it acts on a preset value control; based on direct action regulators. The operating station for regulators are located in the engine control room (ECR). The system employs both pneumatic /electronic regulators, valves and actuators.

ELECTRONIC CONTROL OF CENTRAL COOLING SYSTEMS.

Engard is a microelectronic control unit for centralized cooling systems which regulates the capacity of the sea water pumps in accordance with cooling requirements. Substantial energy savings are claimed due to pumping not more than is necessary. It comprises an electronic control unit with a microprocessor linked to the sea water pumps, regulating valves and temperature sensors in the low (L.T) and high (H.T) temperature cooling circuits. It controls the temperature of two fresh water circuits by operating a regulating valve each. By using two or more pumps which could be of different sizes and of two different speeds, total capacity can be adjusted to the most suitable of up to four valves.

Most systems are designed for up to 38 degree

Celsius in the fresh water L.T circuit at maximum capacity and sea water of 32 degree Celsius. However, few vessels sail in waters always at 32 degree so that considerable energy savings are possible by reducing pumping.

The Engard system and cooling water circuits.

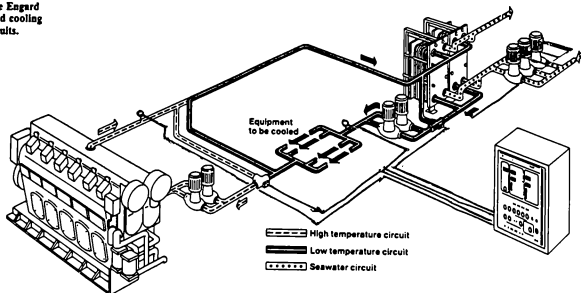


Fig. 13. The Engard system and cooling water circuits.
 Source: I.MarE. technical paper on energy saving
 May, 1985.

2.3.0 AUTOMATION IN ELECTRICAL POWER GENERATION SYSTEM.

A variety of systems exist with a wide choice of selection depending on the required automation levels in the generating plant system. The system generally provide electric power plant automation in the scope required by the owners and requirements of the classification societies. Electrical power supply for ships 300grt or more and having propulsion machinery of 1000kw or more are enumerated as follows:-

- Precautions are to be taken to avoid power supply units being overloaded.
- The ship main power supply is to be arranged according to the following methods:
 - a) In ships where one generator is sufficient for normal sea load operation, an arrangement for automatic start and connection to main switchboard of a stand-by generating set must be provided. Start and connection should be completed within 30 seconds.
 - b) In ships where more than one generator is necessary to cover normal sea load operation, there should be an arrangement for accessing tripping non-essential loads in case of disconnection or failures which will lead to connection of another generator ,so as to maintain ship maneuverability:
- Stand-by units are normally to have separate cooling water and lubricating oil pumps.

Alternative automatic start of standby pumps is to be arranged when they also serve other generating sets.

- In the event of automatic start by power supply units, automatic start of essential machinery is to follow in a pre-determined sequence. Units necessary for maneuvering of the vessel are regarded as essential machinery. Starting air compressors, bilge, ballast and fire pumps need not be included.

For essential consumers having power supply from the lighting system, precautions against power failures are to be similar to those taken for the units having power supplies from the main generators i.e the following should be applied:-

- a) Adequate automatic emergency lighting for access to stand-by by transformer for the lighting system and operating gear for manual connection.
- b) Automatic connection of standby transformer.
- c) Parallel connection of a sufficient number of transformers, and arrangement for selective disconnections.
- d) Automatic connection of emergency source of power.
- e) Dividing the system in two or more circuits with automatic switch over.

Having stated the classification society

requirement, the description of a common system available in modern vessels is as follows. The electric power plant automation system provides operation of the plant with continuous crew attendance. The system is arranged as a block system to allow assembling depending on the required automation consisting of any number of generating sets.

The following functions are performed by the automation system:

- Automatic starting and synchronization
- Automatic shut down and stop of generating sets
- Automatic frequency control
- Automatic load sharing for running generators
- Automatic load control and switching with provision for particular generator sets on and off depending on demand.
- Maintaining a generator in a standby mode.
- Alarm in case when permissible operating parameters are exceeded and stopping in case of critical condition. Diesel generator is stopped immediately in case of the following.
 - a) cooling water flow failure
 - b) lubricating oil low pressure
 - c) main switch cut-out due to short circuit

e) reverse power relay actuation

Provision also exists for the diesel engine to be automatically stopped in case of excessive temperature of cooling water and lubricating oil with slight time delay.

Under normal operating conditions generators are usually automatically controlled; however, provision exist for remote/manual control. In emergency condition the generator can be started with the manual control located on the set.

DIESEL CONTROL UNIT TYPE DSG 822

GENERAL

A typical system designed by AEG, term control unit is described below. The control unit built up in microprocessor technology is employed for the monitoring and control of diesel sets started electrically or by air. It performs the above already mentioned functions and can be used as a single unit or in combination with other control units(refer as "automatic power supply system"). see fig.14. Installation can be made into consoles, cabinets or switchboards. Monitoring is either with open or closed circuit principle. Group alarms for actuation of an external alarm system and a signal for suppression during standstill condition of the diesel are potentially free. Control functions such as pre-lubrication of diesel or preheating can be taken over by

the control unit depending on ignition speed. Data for a ship operation managing system can be made via an interface.

EQUIPMENT DESIGN

The diesel control unit consists of two main components i.e. the control and monitoring unit and the periphery connection board.

CONTROL AND MONITORING UNIT

It is integrated into the front of a switchboard or a control console with the aid of four instrument holders and comprises:

- one front circuit-board to house all indicating and control elements.
- one input/output circuit-board to process all digital and analog input/output signals.
- one power pack
- one central card to house among others, the standard or shipborne software program.

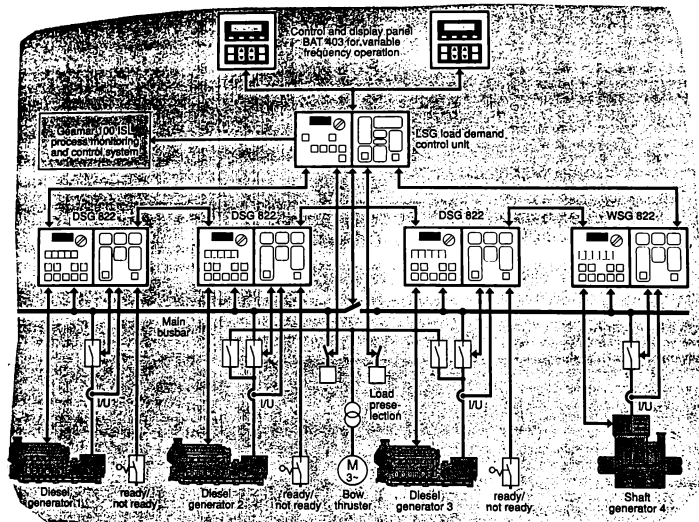


Fig.14 Automatic power supply system.

Source: GEAPAS-DMT technical manual.

PERIPHERY CONNECTION BOARD

The connection board is provided for separate mounting into the rear of the cabinet or console. It comprises all necessary components, such as transformers.

converters, output relays and terminals. The electrical connection between control and monitoring unit and the periphery board is realized by plugged flat cables.

FUNCTIONS

The control unit is ready for operation when the 24V direct current (DC) is available and the unit switched on. Twelve different momentary operational values can be requested via the segment display with the aid of the switch SELECTION OPERATING/ SETTING VALUES. Mode of operation can be manual or automatic selected with a luminous diode indicating the selected mode. In the manual mode, all commands must be given manually. In case of abnormal operating conditions an automatic diesel engine stop is initiated. In the auto-mode the engine is started automatically after a black out. When the control unit is working in compound operation with other control unit / diesel sets, the diesel set is automatically synchronized after a diesel engine start has been initiated manually; and after adding on the automatic active load sharing will be effected. In case of abnormal operating conditions, an automatic diesel engine stop will be effected.

After a starting failure the starting process is automatically repeated. In case of repeated false starts (5 starting trials maximum) - the automatic system locks the diesel set and gives the next standby set the starting command. For preselection of engines, the selector switch is used to preselect the set which is to start first in case of a blackout. Preselection of a

diesel engine is signalled by luminous diode. After starting the engine the control unit performs automatic synchronization and adding on of the diesel set, provided auto-mode has been selected; its also automatically shared the active load. In case of diesel operation - (without shaft-driven or turbo-generator,) the ship mains load is distributed over all feeding diesel sets proportional to the rated outputs. This unit can also be combined with shaft- driven/ turbo-generator control units. loading criteria which are specified to the system will be taken into consideration. For special applications, for example, thermal power coupling by additional supply, a diesel set can be controlled to full load independent of the frequency. For this purpose, however, an over-riding load demand control unit is incorporated.

The generator protection device is provided specially for the monitoring of three-phase ship's mains generators. The following criteria can be monitored:

- overcurrent
- short-circuit
- reverse power
- under voltage
- protection
- over voltage
- phase failure
- preference system
- under frequency
- stator winding

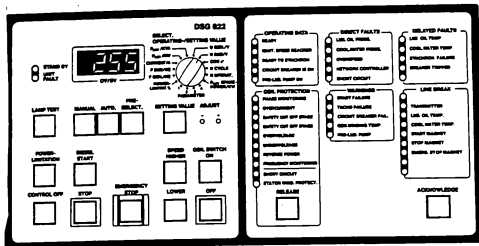
Occurring malfunctions will cause non-essential loads to be switched off from the main switchboard. All malfunctions causing a release of the the generator circuit-breaker are optically displayed and memorized.

FAILURE MONITORING /FAILURE INDICATION

After start up of the diesel engine and release of the alarm suppression all monitoring systems are activated. A wire break monitoring is standard for all binary transmitters (terminal strip) as well as different analog transmitters, start and stop magnet. Self-monitoring of the control unit allows for signal internal malfunctions. The respective malfunctions are detailed through the segment display.

PARAMETER INPUTS

Each diesel control unit is equipped with a software program based on empirical values. If due to certain operating conditions it should become necessary to change analog limit values or times in this program, it can be done any time. Parameters which have changed, could be chosen by the aid of a segment display, the switch "selection operating /setting value" and the button "setting value" in the front of the diesel control unit. The change will go into effect by using the (+) or (-) input facility and successive acknowledgement. To protect the engine against inadmissible time and limit value inputs, appropriate limit ranges are determined which can neither be exceeded nor decreased. All parameters are stored in ELECTRICAL ELECTRONIC PROGRAMMABLE READ ONLY MEMORY (EE-PROM'S), i.e. the data stored can not be wipe out even with power failure. The program functions are protected independent of time and also in case of power failure.



Front view - diesel control unit

FIG. 15 Automatic Power supply unit
Source: GEAPAS-Technical manual.

SHAFT-DRIVEN AND TURBO-GENERATOR CONTROL UNITS

The hardware of the control units is identical with that of diesel control units described above. The only difference is in the software program and by the front designation which is matched to the respective monitoring of a shaft-driven generator or turbo-generator. In compound operation both units can be combined to an automatic power supply system with asymmetric load control with the aid of a load demand control unit.

AUTOMATIC CONTROL OF OIL FIRED BOILER

As requirement for unattended machinery space operation, the oil fired boiler operation has to be automated. Water level is automatically maintained by

the control of starting /stopping feed water pumps by the control unit. A photo cell sensor monitors the flame condition in the furnace and if abnormalities occur, the boiler is shut down. The burner equipment , for example, the firing electrodes, the purge fans, etc, are also controlled automatically by the control unit. Connections between sensors and control units are based upon normally closed circuit controls, so that an open circuit leads to auto shut off of the oil supply. Both audible and light indicating alarms are provided to warn the duty engineer of any malfunctioning.

FIRE PROTECTION SYSTEM

The early ships had certain equipment, like portable fire extinguishers, sand buckets, firemen axe, etc. Later came fixed installations of carbon dioxide, foam, halogen, etc. which were integrated with smoke/flame detectors for cargo/machinery spaces. However, it became necessary and essential as watch keeping duties were undertaken by automated systems. Continuous vigil against outbreak of fire had not only to be maintained, but a system was developed that was potentially efficient to facilitate leaving the engine room unattended at night. Classification societies grew to be more stringent in their rules and their recommendations were designed to ensure that all potential fire outbreaks are monitored and alarms indicating such outbreaks are displayed on the bridge and at the fire fighting control centre where all necessary controls are located. The release of fire fighting media such as water from sprinklers in the accommodation areas came to be automated as well.

2.4.0 FULLY INTEGRATED SHIPBOARD MACHINERY CONTROL SYSTEM

INTRODUCTION

Rapid development in the field of information technology has encouraged the implementation of cost effective automation systems on board ships. These are showing secondary benefits to the engine room as part of integrated ship systems covering all aspect of operations from unmanned machinery space to bridge control for safe navigation of ships and the protection of marine environment. These has led to increased development and implementation of bridge systems and the periodically unmanned machinery space (UMS) concept with improved reliability of controls and alarms loops. These form a more comprehensive instrumentation , data logging, alarm monitoring and automatic shut-down systems which act as a surveillance systems. The shipowner has been able to reduce manpower requirements while improving the efficiency of the machinery and equipment installation with more attractive working conditions as a side benefit.

This section will describe the system requirements in which shipboard automation are successfully implemented on board modern merchant vessels.

The centralized data handling system employs a microprocessor computer which links to an integrated central control system. The computer provides an interface between measurement and control through

programmed functions which are interfaced directly to digitized control process. The computer is programmed not only to control machinery under all conditions but also to acquire start-up, emergency and shut down functions.

2.4.1 BASIC UNMANNED MACHINERY OPERATION REQUIREMENTS

It can be summarized as follows:-

- Bridge control of propulsion plant. The bridge watchkeeper must be able to take control action in an emergency situation i.e stopping and starting the plant. The control and instrumentation must therefore be as simple as possible.
- Centralized control and instruments required in machinery space. This enables the engineer to take control action when called to the machinery space immediately in an emergency, i.e. easily reachable and fully comprehensive.
- Installation of automatic fire detection system with alarms positioned at numerous points for rapid and quick response.
- Fire extinguisher system. In addition to portable extinguishers, a remote control fire station is required. From this station, control for the fire pumps, generators, valves for oil tanks, ventilation fire flaps and the extinguishing media are required outside the machinery space.

- A comprehensive machinery alarm system for control and for accommodation areas is also required.
- Automatic start of emergency generator which must be connected to separate emergency bus bar. This is to give protection in case of blackout.
- Local hand control of essential machinery e.g. main propulsion plant, generating sets and associated equipment for safe operation.
- Adequate settling and daily oil tank capacity is a requirement for unmanned periods of continuous operation.
- Finally, regular testing and maintenance of instrumentation to be carried out to ensure their proper functioning.

The aforementioned criteria for the (UMS) operation is the minimum requirement of the classification society. However, the present development has become more sophisticated due to new technology. Classification societies have accepted the present trend as described below.

2.4.2 INTEGRATED MACHINERY SYSTEM

The traditional approach to shipboard automation has been to install several separate systems with varying technical designs. As a result, a large amount of devices and internal wiring as well as expensive cabling has been essential features. Engine control room panels

with hundreds of instruments and switches are also difficult to supervise and can cause maintenance and service problems. To eliminate these problems, an integrated machinery control system has been developed by various manufacturers. The Datamic marine system of Valmet Automation AS, Siemens, Norcontrol, etc. offers unique systems that have proven in service which has led to maintenance and operational cost reduction. The new technology used is derived from the advance on-shore process industry. It offers the possibility of covering several instrumentation tasks in individual microprocessors , utilizing the same hardware concept. This integrated concept covers most of the instrumentation requirements onboard a modern vessel today such as:-

- Alarm and equipment monitoring of unmanned machinery spaces.
- Controller loops
- Diesel starters
- Generator power generation
- Ballast control system
- Cargo control systems for bulk and tanker vessels.
- Stand-by starters in case of failure
- Fuel economy.

From one common control room console located at the

upper level of the machinery space, colour monitors, multi-functional rather than alpha-numeric, keyboards and printers, allow the engineer to monitor and operate the entire engine room and ballast system from one or several workstations. This gives the engineer optimum control over the entire engine room as well as ballast systems.

The basic functions of the system is the monitoring and alarm system for unmanned machinery spaces which includes most of the control room units and functions needed for a fully installed system. Other functions, such as diesel engine starters, generator power automation and condition monitoring, are added to process bus through process stations with their hardware and application programs. From this the system can be built up as required.

An integrated system is extremely economical when compared to traditional equipment. The system design further minimizes the possibility of a total system failure, due to the presence of back-up microprocessors. The result also reduced installation costs, reduced service, smaller spare parts store and less training needed for both service and operational engineers.

The system is also a distributive system that gives it processing capability distributed in separate units performing dedicated tasks in parallel with each other. Each station in the system is dedicated to a definite task and consists of a control processing unit, communication unit and memory cards. The station are distributed as follows:

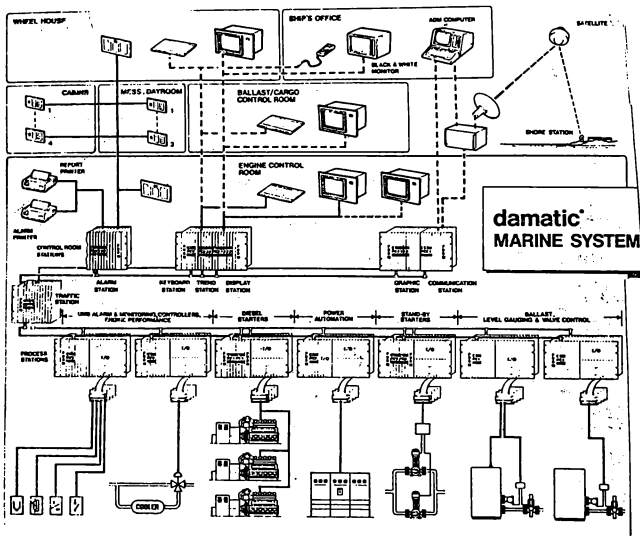


Fig.16. Fully Integrated Marine Machinery Automation System.

Source: From the paper presented by E.Ruud at the seventh International Marine Propulsion conference March, 1985.

a) -CONTROL STATIONS

The dedicated functions of the control rooms are programmed into distributed microprocessor units. Each of these units performs the dedicated tasks using its parallel processing capacity for batch or continuous processing, presenting the results to the data highway bus or to the various presentation media.

b) -TRAFFIC STATIONS

The main tasks of the traffic station are to coordinate all serial communication on the data highway buses at both control room and process levels. The station is the system's time keeper. There are cross-communication from one process station to another, from one data bus to another or other systems, and from process level to control level. It goes through an acknowledgement procedure in order to be recognized.

c) -PROCESS STATION

The main tasks of the process stations are:

- To interface the system with process instrumentation.
- To perform programmed control tasks, for example, continuous control, sequencing and interlocking.
- To use self diagnostic facilities for checking input/output units and itself for errors
- To activate switch-over to back-up process stations.
- To function as the last operator controlled man/machine communication, when all control room

stations which is in the machinery space have failed.

In the system, monitoring, regulation and control are combined in a single decentralized system. Security features are incorporated in the system and as a consequence of decentralization the failure of one unit will have only limited effects.

Standardization of hardware and software is a great advantage in the distributed system. All processors use the same type of hardware and are used for different functions only by altering the program. As altering programs is simple, functional changes and additions can be made easily and quickly both before and after start-up.

The following arrangement has been used in the Datamic marine system to achieve reliability and availability which are similar to other systems such as Norcontrol and Siemens:

- (a) Fault indication arrangement in different types of process interfaces such as transmitter current supply supervision, signal ring exceeded, short circuit, or break in signal time, are arranged on the analogue input card.

- b) When the test program detects a fault in any part of the system, an alarm is given in the control room. The self diagnostic system monitors the following types of faults within the entire system:

- Process unit faults
- Failure in voltage supply
- Disconnection or absence of process interface cards.

- The time reserved for programs exceeded on the execution tape

- Fault in the ELECTRONIC PROGRAMS READ ONLY MEMORY (EPROM) memory contents.

- Distortion of serial bus message

- Failures in process interface cards

- c) Operational error from operator i.e. feeding wrong data to the system.

- d) Signal traffic along serial buses is always redundant; the self-diagnostic system will shift automatically to the stand-by bus when the main bus become faulty.

- e) Each process control station is able to function independently even if communication with the control room is lost. Control circuits, logic operation and regulation elements can be brought to a safe condition during disturbances.

- f) To provide for failure of the processor itself, the process control station can be equipped with a "hot stand-by" processor. In the event of failure the changeover to the stand-by processor

will then occur automatically.

- g) The stand-by processor has two buses exactly in the same manner as the main processor. Processor operation is thus secured through double redundancy.
- h) The range of printed circuit cards in the Datamic has been minimized. The same type plug-in unit is used in all stations, reducing the amount of spare parts and makes the units easy to maintain; normally no maintenance is required. The devices are made up of high-quality, reliable components which ensure a long operating life.
- i) The Datamic Marine system also has a distributed power system. Each frame has its own power supply unit which isolates the rack galvanically from the main power supply. Each bank supply has monitoring and overcurrent limiter /protection units, which limit the effect of a fault so that it cannot disturb units in other frames. Each plug-in unit also has an individual supply current limiter. The construction of the power supply units ensures that the supply voltage cannot exceed the safe values, even in case of a malfunction.
- j) Retention of important process data through power failures of varying duration is secured in three different types of memories as a standard in Datamic marine system:

-Accumulator-secured RAM in the CPU, hold time

0.5 hour.

-Accumulator-secure CHOS-RAM

- EPROM

k) As a standard, the system has a main back-up battery supply connected to the system. A further securing feature is the warning given by the cabinet's central supply unit if supply voltage drops below a preset limit. Another logic sequence ensures that the system takes a certain sequence when supply voltage is reconnected.

The operational environment causes certain external stresses on the device in addition to the electrical stresses caused by its primary electrical function. Additionally, the operating purpose sets requirements for the device's operating life, reliability and cost. In some cases it also sets strict limits on regular maintenance. To improve the availability of the system, approval test according to classification societies has been conducted to a design ambient temperature of 0-70 degree Celsius (type approve equipment).

Serviceability and economy has been a very important aspect during specification and development of the Datamic marine automation system, since a ship is not a shore-based industry where a service engineer can be on hand within a short period of time if something goes wrong in the system. The following has been done to improve the serviceability and reduce the overall economy:

Due to its distributed structure, a sophisticated self-diagnostic system can monitor system operation and give alarm if any of the processors or devices fails during operation. This has given great benefit compared with a centralized minicomputer system which cannot write its own death certificate. The self-diagnostic arrangement gives the operators/engineers direct information on any failure in the system. Thus the engineers do not need long and detailed training to operate the system and it minimizes the system down-time and mean-time to repair.

The manufacturer has developed a test instrument for on board system testing and fault finding. All functions needed for testing input units, transmitters as well as analog and binary field instruments are built into this unit.

Because of the modular construction, all sub-stations are based on the same of hardware. All the various functions can be achieved with a relatively small selection of basic units. This is also advantageous from the point of view of spare parts, which can be kept reasonable. Spare parts consist mainly of replacement units.

Normally all spare parts delivered with the system are stored on board. Instead of keeping all processor units in stock, they can be placed into the system and act as hot back-up. This means that the system can repair itself if malfunction should occur in the main processor.

2.4.3 CONCLUDING REMARKS

Many advantages derived from an integrated system concept have been mentioned above, but the following should be emphasized:

The system is less complex from the crew's viewpoint because the degree of technical variation is reduced, while the available computing capacity means that a number of calculations such as trim optimization and fuel economy can be performed. Maintenance and service requirements are also greatly reduced.

The shipowner benefits from lower training costs, a reduced spare parts store and service visits from many suppliers as well as fuel economy which can bring reductions of around 4-8%. Because there is less likelihood of a major breakdown there is less chance that the vessel will have to go on off-hire.

The shipyards also benefit, since the cost is lower, not only in comparison with more traditional equipment, but also in terms of the basic engineering costs; only having a single sub-supplier instead of five or more is of great advantage. Such systems occupy about 30% of the volume of more conventional versions which can bring reduced installation costs. The various microprocessors can be linked together by a data bus rather than a number of multicore cables.

The type-approval of a single integrated system for a number of functions represents a big step forward in the development of a total solution for shipboard automation. Such systems are new tools in the rationalization of this equipment and the safe operation

of sea-going vessels.

2.5.0 INTEGRATED BRIDGE SYSTEMS

The integrated bridge system came as a result of labour costs and shortage of seafarers in the western hemisphere. Thus a reduction in crew, faster turn around, and pressure due to keen international competition have contributed to increasing amount of sophisticated labour and energy saving equipment being installed on modern ships.

Introduction of UMS was the starting point for radical change in vessel operation philosophies, with machinery being monitored and controlled by electronics through pneumatic and hydraulic operated systems. This eliminated the need for constant attention by the ship's crew. It was in turn followed by the installation of cargo control rooms, particularly on bulk and tanker vessels. It further developed with the evolution of sophisticated ships carrying liquid gas and chemicals.

The trend therefore has extended through modern vessels to the bridge, the control center of the vessel. By centralizing all the internal monitoring and control systems, the watch officer is free to monitor the situation. He can interrogate the system for any required information and general overview of the vessel status. This brings a safety belt to the present trend of crew reduction, thus enabling the officer to be in full control of the ship without being over extended by the performance of physical tasks and his attention then redirected to incidental operational requirement. In addition to his primary role of safety and efficient navigating of the vessel, the officer can now control all

functions of the ship including machinery and cargo systems remotely from a work station on the bridge.

With this added responsibility, the work load of the officer is made as light as possible. This established a requirement that all systems and equipment are as reliable as possible i.e. user friendly.

An ergonomic design and layout is a prerequisite of the system in order that the star wars appearance of some of the equipment can not be frightening to first time users. This is the philosophy behind the Racal-Decca Mirans system which is based on the following four major points describe below.

Safe operation of the equipment; each operator can be able to operate the system with minimum training and familiarization . Thus in combination with a full working knowledge of various individual components such as radars, etc. the officer on watch is capable of operating these independent of the system.

Each component has the capability of operating in a stand alone mode and can not disable the whole system in the event of individual component failure.

The system is easy to use, requiring minimum additional skills to those normally expected from professional mariners.

The system design takes into account the most vital tasks undertaken by the watch officer. These tasks being:-Traffic monitoring

- Position finding
- Monitoring and logging of data
- Course and speed alteration
- Starting and stopping of the main propulsion plant.

As with most systems, the Racal-Decca range is

expandable to meet shipowner requirements. The basic system, the Mirans 3000, comprises an ARPA radar, a position finding device and a means to monitor and pre-plan a voyage.

The basic unit can be upgraded to a Mirans 4000 system, which incorporates a live situation report console (LSR). This displays information for safe navigation of the vessel both on passage and during maneuvering. Details of the engine monitoring system and control can also be displayed at this work station. The system can be fitted with an electronic chart digitizing table which allows the integration of paper charts. It allows the transfer of information quickly and easily using the pen plotting device. The system has recently been upgraded to accept digitized replicas of the standard nautical chart on a 65 centimeters colour high resolution screen. A zoom feature enables the navigator to enlarge a small area of the chart and to more readily access the information contained therein.

Engine room monitoring and alarm input is derived from the ISIS (integrated ship instrumentation system) and with the 250C-version control is also available. A number of local scanning units (LSU) and local scanning and control units (LSCU) are fitted throughout the machinery spaces. With information passed to the group display on the bridge. Flexibility in the system allows other manufacturer's components to be incorporated into the system, enabling the integrated bridge to be developed for individual customers' needs. Interfacing and computer power allows for future expansion of the system.

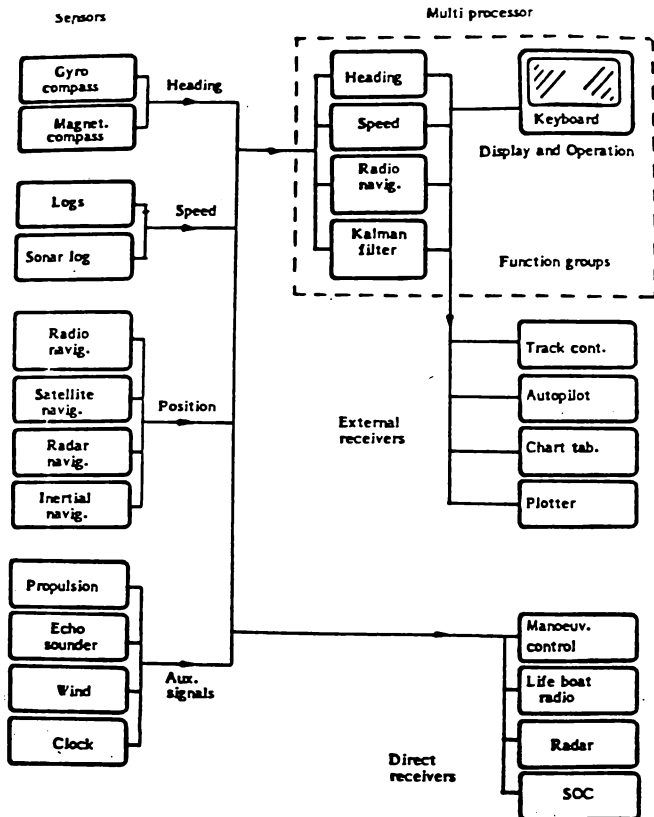


Fig.17. Integrated Navigation system (TELDIX)

Source: Flensburg Research Institute for ship operation automation.

With increasing acceptance of one-man bridge operation, Norcontrol has introduced a new modular bridge concept known as Bridge Line (Fig.17). The system incorporates all the requirements for the single watchkeeper, including the latest recommendations regarding safety for reduced manning levels.

The ergonomic bridge layout is designed to ease the workload and fatigue factor of the watchkeeper. At the center of the system are two workstations, each with a 29-inch high resolution colour display. The VDUS (visual display units) can show a radar display with ordinary functions, an ARPA display incorporating the presentation of electronic charts. All navigational activities are integrated into the two workstations, which in turn are linked to navigation instruments, propulsion control systems and the auto-pilot. By combining the navigational and propulsion control systems, operational economies can be achieved through voyage planning. The new system incorporates a data integrated navigation system, Datachief integrated alarm, monitoring and control systems for machinery, Datamaster integrated alarm, monitoring and control systems for cargo and Autochief propulsion control.

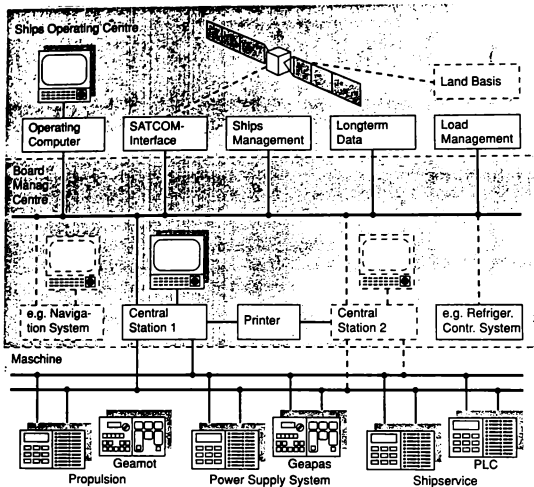


Fig.18 Integrated Monitoring and control system.
 Source: Gearmar 100 ISL manual.

2.5.1 CONCLUDING REMARKS

With the bridge line, emphasis has been placed on cost-effectiveness in order to prevent the shipowner with the best economical investment. However, system limitation is related to the ratio between cost and performance, and how much the end user is prepared to

spend in order to reduce operational cost of the vessel. Thus investment should therefore be analysis to determine if return is a viable proposition. Inevitably, orders for nice-to-have equipment specified by the technical department of the shipping company should then be considered when additional cost estimates are presented to the finance department. It is therefore follows that due to the high cost of an integrated bridge system, it would be better to be fitted /installed on new ships rather than as a retrofit to existing ships.

In recent years, ship officers has experienced the migration of technology from the machinery space to the navigation bridge. Training therefore has become an essential part of the entire investment. Most manufacturers offer a range of familiarization courses to users. It varies from in-house instruction using simulators to on-site ship's officer instruction with courses tailored to meet individual customer's needs.

Systems are expandable to allow interfacing with other shipboard requirements such as stock control and budgetary management. Many systems are already fitted with the capability for both onboard and external networking. Thus interfacing compatibility of equipment is a prerequisite of the systems.

Racal-Decca, for example, looks at the future of the integrated bridge system as developing in areas of electronic charts and the transfer to personal computer based systems, allowing for greater flexibility and permitting users to upgrade existing integrated bridge systems without the need for full replacement.

The long term future, therefore, lies towards further integration and total central control and

monitoring. This would lead to continued development of the concept dual ship officers who will replace the traditional seafarers specializing in deck or engineering.

Ultimately, as more vessels are fitted with integrated systems, there would be a phased increase in the acceptance of the new technology. Ship management will become more of a core function on board with all fields of work ultimately being totally integrated. This is in line with the fall in manning levels from the high numbers in the past decades to a complement of less than 15 already being introduced. Most Western European and the Far East countries have already established a dual discipline training scheme for their officers. On board their latest vessels, integrated bridge systems form part of the ship operation center. The ships are operated entirely from the bridge by one watchkeeper trained in both nautical and engineering functions. A series of workstations grouped on the starboard side of the bridge affords the duty watch keeper an immediate access to the ship status reports on control functions. Links for data transmission to the head office are facilitated through the ship's satellite communication system.

Most shipowners of the developed nations approached this concept of integration with a working group which includes the company's technical department and a cross-section of watch keeping seafarers. This keeps the office staff in touch with what is happening at the sharp end of the business and gives seafarers an insight into the budgetary restraint that beset the company. From this, the systems forms the most compatible profile and the trading role of the vessels.

CHAPTER THREE: IMPACT AND BENEFIT OF MACHINERY
AUTOMATION IN SHIPPING

3.1.0 AUTOMATION AND MANNING

About forty years ago, commercial vessels typically went to sea with crews of more than forty persons. Today, vessels on foreign voyages, average globally, have about twenty or less with the Western Europeans, Far Eastern countries 11 to 15 persons. These reductions in manning levels reflect more than a century of gradual technical and organizational change. Sail gave way to steam, and steam has largely given way to diesel engine. Ship designers and builders have automated and mechanized many shipboard systems, adopted more durable coatings and paints on their ship hulls, shifted some maintenance and cargo-handling duties to shore-based personnel, and made other transitions toward more efficient machinery.

These changes are far from having run their course. Ship technology is developing at accelerating pace throughout the world. The accompanying organizational innovations in the past few years have gone beyond straight forward crew reductions in some countries to reorganization of crews and reallocation of tasks. The traditional division of crews into deck and engine departments, for example, is fading as owners and operators seek to make the most efficient use of labour and new technology.

In general, improved operating economics is the main objective. Technological improvements, including

automation, have resulted in improved fuel efficiency, higher reliability and lower labour costs. In pursuing cost competitiveness, however, shipowners throughout the world have been faced with keen competition that has been even more intent on reducing crews. In the 1980s, more reductions came as a result of globally depressed shipping market. These drove operators in many countries- (often aided with government research and development programs) to cut costs and streamline operations by further automation. In 1970s and 1980s, operators in Japan, Taiwan and other Asian nations became leaders in applying ship technology and reducing crews.

Many nations have revised their manning statues and regulations to accommodate these moves toward operating efficiently. The classification societies have also accepted the new trend in automation application to shipboard machinery. One may also note that the tendency of crew reduction especially in the western countries is due to shortage of sea-going staff.

3.1.1 MANNING REDUCTION IN THE WORLD'S FLEET 1950s-1990s

Since World War Two, several generations of vessels have been launched. Advances in automation, mechanization, and reallocation of crew members' responsibilities have permitted reductions in crew levels.

All of these developments have been pioneered by

western Europeans and Japanese operators, often with government assistance. The late 1950s saw containerization of cargo, and the late 60s saw the first engine room automation; some engine room personnel were redundant, while most were relieved of watch-standing responsibilities. The mid-1980s produced highly automated vessels like the products of the German "ship of the future" program; with propulsion, navigation and communication controls centralized on the bridge. Engine room layouts arranged for easy maintenance, and installation of a variety of automated safety equipments. These vessels were designed for crew as small as eleven.

In the late 1980s to present, European and Japanese governments supported even greater automation, centralizing navigation, engine control, communications and administrative functions on the bridge (which came to be called "ship operation centre") and more automation throughout the vessel. Corresponding changes in crew members' job assignments were made in effort to make the most effective use of both labour and technology.

Table "2" compares the manning patterns of two representative generations of ships, from Nigerian flag ship of 1966 to highly sophisticated Japanese "pioneer" series. To illustrate the effect of current Nigerian manning statues and labour contracts, two manning scales are shown for the German "ship of the future", and the Nigerian flag ship.

CREWS	NIGERIAN FLAGSHIP	JAPANESE PIONEER SHIP	GERMAN SHIP OF THE FUTURE EARLY 1980	
	1966	LATE 1980	GERMAN FLAG	NIGERIAN FLAG
MASTER	1	1	1	1
CHIEF MATE	1	-	1	1
2ND MATE	1	-	1	1
3RD MATE	1	-	1	1
UNLICENSED DECK CREW	13	-	-	8
CHIEF ENGINEER	1	1	1	1
2ND ENGINEER	1	-	1	1
3RD ENGINEER	1	-	-	1
4TH ENGINEER	1	-	-	1
JUNIOR ENGINEER	1	-	-	1
ELECTRICIAN	1	-	1	1
UNLICENSED ENGINEER	9	-	-	5
CATERING	8	1	2	7
RADIO OFFICER	1	-	1	1
BOATSWAIN	1	-	1	1
MAINTENANCE CREW	-	4	4	-
DUAL OFFICER	-	4	-	-
	42	11	14	32

Table 2.

3.1.2 PROGRESS TOWARD UNATTENDED ENGINE ROOM

The initial reduction in crew size were brought about by making vessel machinery self-regulating, centralizing controls, and automating certain functions. These developments culminated in the so-called "unattended engine room", which can be monitored from the bridge or

other remote locations, and requires no watch-standing crew members in the engine room itself.

a). AUTOMATIC BOILER CONTROLS.

Early reduction in crew was made possible by the installation of automatic controls on propulsion boilers. Boilers so equipped could be operated without constant human attendance, and thus allowed the requirement for three fireman/water tenders (one for each watch) to be removed from the vessels certificate of inspection. A vessel with automated boilers controls still required constant attendance by an engineer and an oiler for each watch.

In the early 1970s, oilers were relieved of watch standing by centralization of machinery controls and installation of propulsion controls in the pilot house. A single licensed engineer thus stood each watch alone. On oil tankers, the same technology -fluidic systems, electronic solid-state controls, and data logging devices- were also used for cargo pump controls.

b). THE UNATTENDED ENGINE ROOM

Diesel propulsion came into common use in the late 1960s to early 1970s with utilization of slow-speed diesel plants. Greater economy than steam propulsion and better adaptability to full automation were the driving forces for this trend. It let the operators design machinery spaces for "periodically unattended" operation, with computers to monitor and control vital systems. Periodically unattended machinery spaces could be unmanned for prolonged periods of time, and therefore

did not require round-the-clock attendance by a licensed engineer.

The innovations was accompanied by further crew reductions (for example the elimination of one or more engineer assistants). The most important effect, however, was to free crew members from watch-standing, allowing them to do other jobs, such as maintenance; in this way it led eventually to the creation of maintenance department. (a more recent innovation in the industrial countries).

3.1.3 INNOVATION IN DECK DEPARTMENT

By a variety of labour-saving measures, vessel operators in the 1970s did away with the need for daymen, carpenters, and most ordinary seamen.

In the deck department, labour saving devices and the increasing use of shore-based personnel for maintenance led to further crew reductions. For example, navigation watch-keeping on the bridge traditionally required a licensed officer as well as a lookout and a helmsman (generally both ABs). A third unlicensed person (an SOS) was used for relief helmsman and to serve as additional lookout when needed. By the early 1970s, the relief person had been eliminated on many ships by placing sanitary and drinking water facilities on the same deck as the pilot house, installing watch-call systems (which wake the member of the next scheduled watch) and other measures.

Mooring, unmooring, and anchoring also became less

labour intensive with the installation of constant tension winches with strategically located controls, as well as lightweight synthetic mooring lines. New paints and coatings diminished the need for chipping and painting. Automated hatch covers also eliminated the need for much hard work.

The containerization of cargo in the 1960s and 1970s further reduced crew tasks and eliminated most cargo handling by crew members. For example, containerization reduced the need for deck maintenance by eliminating most shipboard cargo handling equipment.

The steward's section was also reduced by the application of technology. Microwave ovens and pre-packaged meals eliminated most food preparation and services. Officers began to make their own beds and clean their own rooms. Microcomputers came into use for inventory controls. This section has been presently eliminated in today's modern ships.

3.1.4 STATE OF THE ART AND THE DECADE AHEAD

From the 1980s, operators in the FarEast, Europe have led the world in manning related innovations. This phase of innovation has emphasized the centralized control of all ship functions on the bridge with more comprehensive automation of navigation, engine control, cargo operations, safety and emergency systems, and communications. These have been accompanied by reallocations of crew members' responsibilities and

dramatic crew reductions and have been supported by careful analysis and experimentation (Grove 1989, Yamanaka and Gaffney 1988).

In the state-of-the art ships the bridge has become a "ship operation centre", housing controls and monitors for all essential vessel functions. Many routine navigational tasks, such as chart updating, position plotting, and steering have been automated. For example, aboard the German "ship of the future", eight of which were built by early 1989, the ship's position is determined automatically by a computer that integrates information from satellite navigational systems and other equipment. The position is displayed as a dot of light on an electronic chart. Ballast is adjusted from the bridge while the ship is underway. Logs, reports, certificates, documents, and letters are computerized with electronic mail links via satellite to shore (Grove 1989, Kristiansen et al 1989).

The levels of automation in these ships and other advanced vessels, not only reduce the need for the helmsman (in good visibility) and the lookout on the bridge, but also reduce the need for deck and engine personnel generally. The result is that some foreign vessels operate with very small crews. Some large Norwegian vessels sail with crews of 8 to 12 (Kristiansen et al 1989). The Japanese "pioneer" vessels have 11-person crews (Grove 1989; Yamanaka and Gaffney 1988) The German "Norasia" vessels carry 16 persons, but were designed to operate with 12 (Gaffney 1989). Japan, which has carried out the world's most ambitious reduced manning program, has mounted a research program to design a fully automated vessel, capable of operation from sea

buoy to sea buoy by a single person or, ultimately, an advanced computer (Hamada,1989).

These radical manning reductions have led some European and Asian shipping companies to eliminate or blur departmental distinctions with "general purpose" rating and dual-qualified officers (i.e trained in both engine and deck skills). Further reductions may blur some distinctions between licensed personnel; in Japan, for example, some specially trained senior ratings are already permitted to take charge of bridge and engine watches (Yamanaka and Gaffney, 1988). In the Netherlands, some senior ratings supervise anchor watches.

THE GERMANY EXPERIENCE

GENERAL-PURPOSE RATINGS:

Since 1987, the former West Germany shipping industry has provided only general-purpose training for its unlicensed personnel, eliminating separate deck and engine specialties. These personnel are known as ship's mechanics and can advance to the position of ship's foreman.

In preparation for this change, Hapag-Lloyd AG, a German shipping company, experimented over 18 months with four ships manned by 18 crew members of whom 7 were general-purpose ratings. The success of this experiment led the German government in 1984 to change its manning

regulations, allowing the crew of even the largest ship to be reduced to 19 persons, provided that manning was based on the general-purpose concept.

DUAL-QUALIFIED OFFICERS:

To meet the operating requirements of state-of-the-art ships with controls and monitors centralized on the bridge, the German shipping industry developed the concept of the "ship management officer". The officer is responsible for the entire ship-cargo, navigation and maintenance - and thus required both technical knowledge and expertise in seamanship. A ship manned by these officers have a master and four ship management officers; at present, German ships carry three deck and two engineers, in addition to the master (Froese,1989). In 1986 as a first step in that direction, the industry, with government support, began offering officers with existing top level deck or engine licenses the opportunity to earn medium-level credentials in the opposite specialties.

THE JAPANESE EXPERIENCE

Japanese shipping companies, perhaps, have gone further towards departmental integration than those of any other flag. The initial experiments, in 1979, were succeeded by a carefully planned sequence of steps toward a new "hypothetical image of seafarers". The goal was the complete elimination of departmental distinctions and

the substitution of a shipboard management team.

In 1981, the first phase of these experiments began aboard several new vessels whose bridges were fitted with monitoring and control systems for propulsion machinery and safety systems; remote control for mooring winches, cargo-handling equipment, and ballast; and satellite position location and communication systems. The distinction between deck and engine departments was removed for unlicensed personnel, and junior officers' position (third officers and third engineer) were filled by dual-qualified watch officers. This pattern of organization, with an 18-person standard crew, was incorporated in the manning laws in 1983, and its application was widened to more diverse types of ships. By April 1985, 145 ships were operating with 18-person crews (anonymous, 1989).

Meanwhile, an experiment with 16-person crews had begun in 1982 aboard vessels with additional automated cargo-handling and navigation equipment. Watch officers replaced engine and deck officers up to the level of second engineer and second officer. In addition, specially trained ratings were used as watch-keepers on the bridge. The success of this experiment resulted in this manning pattern being put into law in 1986 and applied to 98 ships (Anonymous, 1989). Also in 1986, experiment with 14-persons were begun. The vessels' bridge were further automated, with all functions of the deck, engine, and radio watches centralized at the ship operation center configuration, and with additional labour-saving devices for mooring and unmooring.

The 11-person pioneer ship experiment began in April, 1987 aboard 7 new vessels. The main technical innovations were the placement of auxiliary engine and navigation controls on the bridge wing, a labour saving galley, and labour saving oil processing devices with sufficient disposal facility.

THE NETHERLANDS EXPERIENCE

Dutch shipping companies pioneered the use of general-purpose ratings and dual-qualified officers, beginning as much as 20 years ago. Dutch officers are trained and licensed with major and minor specialties (navigation and technical) and are expected soon to be completely integrated as maritime officers or "ship managers" (S. Cross 1988).

Highly trained ship mechanics with general-purpose qualifications have been employed aboard Dutch ships since the late 1970s. However, they are reportedly being used in the traditional engine and deck specialties since there has been too little highly skilled work available on today's modern automated ships. Vessels may carry one or two ship mechanics to maintain mechanical systems. More recently, they have been assigned as core crew aboard vessels manned largely with unskilled third world crew members. In the guise of ship technicians, they may assume supervisory responsibilities in such cases.

3.2.0 EFFECT ON SAFETY AND MAINTENANCE WITH SMALLER CREWS

Recent reductions in crew sizes aboard Asian and Northern European vessels have been preceded by extensive government sponsored programs to define through careful step-by-step experimentation, the potential operational impacts.

Safety concerns expressed over crew reductions relate primarily to three operational considerations:

- Fatigue: Will there be greater demands placed on the remaining crew members, and, if so will there be a reduction in alertness negatively impacting safety of the ship or its crews? Or, will the overall impact of changes hold even or reduce working hours and/or fatigue levels for the remaining crews?
- Training: With the higher degree of automation (often used to justify crew reduction), will the remaining crew be able to handle emergencies if automated systems fail? Are higher or different levels of competence required? Will the crew be adequately trained for the new conditions?
- Maintenance: Will crew reductions result in the neglect of essential maintenance? To what extent will better equipment, more durable coatings, riding maintenance crews, and other measures compensate by improving reliability of equipment?

Lack of attention to all these problems will raise the risk of injuries and vessel accidents with attendant social, economic, and environmental costs.

3.2.1 THE PROBLEM OF QUANTIFYING MARITIME SAFETY

The problem of assessing maritime safety goes beyond the lack of crew size data. Determining the overall safety impacts of moves toward smaller crews requires estimating not only the associated marginal increase or decrease in the frequency of casualties, accidents and marine environmental pollution incidents, but also the impacts of those events on people, property and the environment. The information on which to base such an assessment is subjected to great uncertainty. It is at present inadequate for development of sound conclusions.

The most fundamental problem is that the impacts of casualties, personnel accidents, and environmental pollution incidents are highly varied, and thus difficult to assess and compare. Property damage, environmental damage and human pain or death are very different things. Assessing and comparing impacts of maritime safety lapses must therefore be largely subjective. In practice, regulatory priorities of this kind are established by policy decisions, reflecting the values society places on the various potential losses involved.

The frequency of such incidents, in contrast, are quantifiable, given adequate information. Several organizations maintain records of these events both domestically and world-wide. For example, data on the numbers of casualties, personnel injuries, and oil spills per year are easily obtained. However, this information by itself is inadequate for meaningful statistical estimates of the contributions of vessel manning to the safety record. First, the available data bases do not include information on vessels' manning in computer-searchable form.

In addition, they do not generally offer information

on the many other variables and causal factors that interact to determine the safety record of an individual vessel. Management practices (e.g.,maintenance, training, and scheduling), extent of compliance with regulatory requirements, the performance of those entrusted with operating and navigating vessel is put (its trade and routes); all must be known or statistically estimated before the causal role of manning in safety performance can be assessed.

Finally, there is no general agreement on an appropriate measure of expose to hazards. Casualty and accident data must be related to an exposure variable. One obvious approach might be to compare the percentage of a given flags (or a given fleet's) of tankers experiencing the same class of accidents. However, this comparison may be misleading, since tankers of different flags may have markedly different services and routes, thereby encountering different hazards. Studies thus far have used at least three approximation of exposure to hazards: Port calls, tonnes delivered, and tonne-miles. These measures yield very different estimates of accident frequencies and can yield different rankings of risk. For example, as tanker size increases the rate of accidents and pollution incidents increases when tabulated by port call, but decreases when tabulated by tonnes of cargo delivered. (Mead et al 1981). Furthermore, collection and analysis of exposure data is not routine; obtaining and working with it can be time consuming. Development of maritime exposure data bases is therefore required.

Accurate maritime safety assessments require precise, reliable, and highly detailed data on vessels casualties, accidents, and pollution incidents. In addition, identifying trends requires intimate knowledge

of the validity and variability of data from different sources and complex multi-variant analysis. At present, such a treatment cannot be supported by the available data and analytic methods.

SHIPPING INDUSTRY SAFETY INFORMATION

In general, the broad industry-wide data contain no direct information on crew levels involved in accidents. However, such data, collected consistently over the past few decades are meaningful, since crew sizes have been substantially reduced during this periods. Thus, these data may offer some general insight into the safety implications of smaller crews. This insight is clouded, however, by other developments over the same period, such as more stringent requirements for safety equipment and procedures.

Though there are some variances, the available industry safety statistics indicate the following:

- There has been a measurable and substantial improvement in the rate of both vessel casualties (accidents) and personnel injuries during the past twenty years. More specifically, there has been a declining rate of vessel losses as a result of accidents, and declining rate of personnel injuries. These trends are evident on a non-dimensional basis (e.g. percentage of total vessels, percentage of total gross tonnage, incident per ship, and injuries per seagoing employee), that is, as a result of a methodology that eliminate the impact of changes in fleet size, numbers of employees, and other

variables. These trends are consistent whether one considers statistics published by the International Maritime Organization (IMO), by Lloyd's casualty Reports or, by the Marine Index Bureau etc.

- During the same 20 years period, the average crew size has declined substantially (from the high fifties to high thirties for Nigerian flag vessels and to the high teens for many foreign fleets).

While these two trends have occurred during the same time period, other factors have also changed. Technology has improved, operating procedures have been refined, and the scrutiny of maritime operations by governments and industry bodies has increased. The safety data available from the various worldwide sources is not sufficiently detailed to correlate vessel casualties and personnel injuries with crew size. It is therefore not possible to isolate the effect of crew size to determine whether any casual relation, positive or negative, exists between crew size and safety. Neither is it possible to determine from the available data whether crew size in itself interact with other variables to enhance or reduce safety.

LLOYD'S VESSEL LOSS DATA

Figure 19, displays worldwide total number vessels loss from 1985-1990. During this period, the number of vessels loss has dropped from about 307 to 188; about 40% decline. Although total losses worldwide are a gross measure covering large and small vessels (individual years aside), the figure demonstrates that the combined

impact of all factors—including changes in the size and types of vessels sailing, ship design, manning and operating practices—has been to reduce total vessel losses substantially. In terms of tonnage (a more accurate indicator of commercial activity), a downward trend is also evident (figure 20). Over the past five years annual tonnage losses have declined about twenty percent with a large dropped experience in 1989.

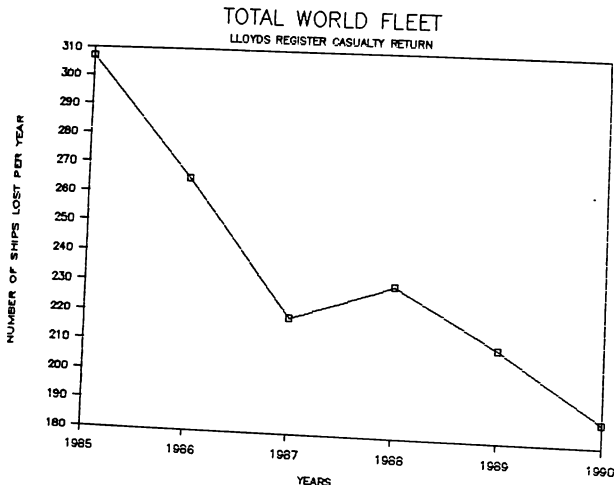


FIGURE 18. Worldwide vessel loss for commercial ships, 1985-1990. The decline in the total loss of commercial ships since 1985 has been linear at a confidence level exceeding 99%.

Source: Llodys Register casualty returns-1990.

TOTAL WORLD FLEET
LLOYDS REGISTER CASUALTY RETURN

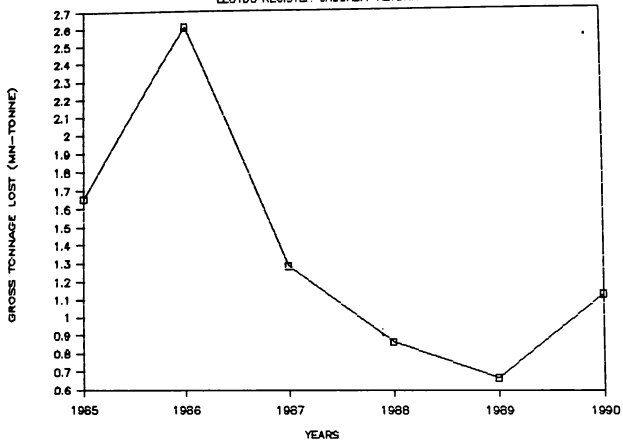


Figure 20, Worldwide vessel loss (total gross tonnage) for commercial ships, 1985-1990. The decline in rate of loss of commercial tonnage since 1985 has been non-linear (power function) at a confidence level exceeding 99%.

Source: Data from Lloyds casualty returns-1990

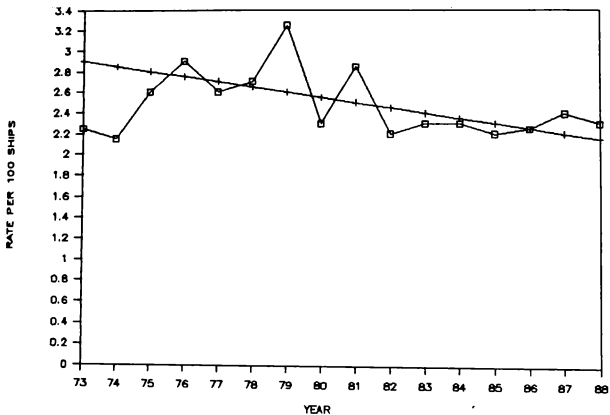
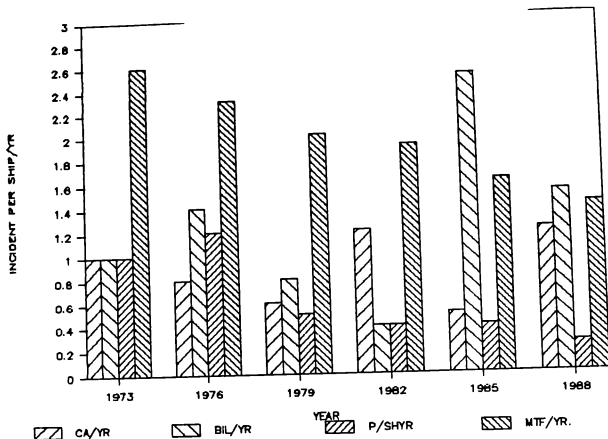


FIGURE 21. Rates of serious casualties of oil tankers (actively trading vessels over 6000 grt.) 1974-1988. The decline in the rate of serious tanker casualties since 1970 has been at a confidence level exceeding 90%

Source: Data from International Maritime Organization.



1. CA/YR=CASUALTIES PER SHIP/YEAR.

2. BIL/YR=BILLETS PER SHIP/YEAR

3. P/SHYR=PERSONNEL INJURIES/FATALITIES PER SHIP/YEAR

4. MTF/YR=MATERIAL FAILURES/BREAKDOWNS PER SHIP/YEAR

FIGURE 22. Trends in number s of billets, casualties, material failures/breakdowns and personnel injuries/fatalities per ship for company "A" during consecutive three-year intervals from 1973 to 1988 (indexed with 1973=1.0) Source : U.S.A. Marine board survey.

3.2.2 SAFETY IMPLICATIONS OF AVAILABLE DATA

The historical data, viewed from several perspectives, shows that the rates of vessel casualties and personnel injuries have improved over the last two decades. These improvements have occurred simultaneously with a significant reduction in the average crew size. However, no direct link has been detected between crew size and vessel or personnel safety. The broad statistics should not be considered a basis for complacency. The limited data from individual companies show that safety records are not uniform, illustrating the fact that safety must be addressed by each company in terms of its specific operations.

The data's importance, however, stem from known steady decline in average vessel manning, approaching 50% since World War Two, due to introduction of newer, more automated vessels with smaller crews and to manpower reduction on existing ships.

Replacements for older vessels invariably have more automation and lower required manning, so the trend toward lower average manning will continue. Developed countries operators have vessels operated with as few as eight to twelve persons. If they continue to operate safely, pressures will rise throughout other maritime nations including Nigeria to follow suit.

3.2.3 SPECIFIC SAFETY CONCERNS

Initially, many union representatives in countries with smaller crew and automation believe that safety will deteriorate. They point to increased fatigue due to longer working hours, poor maintenance practices, and

fewer opportunities for on-the-job training.

More important than the general opinions expressed by labour, was the fact that they identified many safety concerns. These concerns are the objective to further improved safety:

Fatigue: The potential for fatigue is the safety concern voiced most often and is taken seriously by both labour and management. They recognized that inattention can cause accidents. A few casualties have been attributed to inattention associated with fatigue.

Long working hours are common in the maritime industry, and indeed desired by many labour union members as a means of increasing their take-home pay. Since shipboard workers do not commute or cook their own meals, long hours may not be as tiring as they would ashore. Where long hours are a recognized problem (e.g. the round-the-clock cargo responsibilities of deck officers or the heavy workloads imposed by frequent port calls), most operators have opted to use shore-based personnel for cargo and maintenance operations, to allow the crew members to rest for deep sea duties.

However, little information is available to indicate the increase or decrease in working hours as crew have been reduced. Although some operators indicate that overtime has not changed significantly, some labour organizations are genuinely concerned that smaller crews means more hours worked more fatigue for personnel and therefore degradation of safety. Management responds worldwide is that properly managed work, need not increase average working hours and that in some cases fatigue has been reduced; for example, in the engine room certified for unmanned operation, engine department personnel can work days only instead of standing four-hours on, eight-hours off watches. In a given situation,

either point of view may be correct, depending on the degree of work planning and management of work effort.

MAINTENANCE PRACTICES

Traditionally, vessel crews have done most routine deck and engine maintenance. Newer materials and design changes have eliminated some of this work or made it a biennial shipyard repair item. Nonetheless, ship safety would be impaired if reduced manning causes a reduction of needed maintenance on safety-related equipment.

Experience with operator is to carry "riding crews" or repair firms to perform needed maintenance in port. These approaches may be quite acceptable, but it remains incumbent on the companies to maintain records demonstrating compliance with international and national regulation.

In modern automated vessel, all safety related equipments are duplicated thus ensuring continuous operation of the vessel if the running equipment malfunction.

EMERGENCY RESPONSE CAPACITY

Operators and labour unions agree that more attention to safety systems and emergency procedures are necessary as crews are further reduced.

Three general categories of emergency are considered below:

- First, and perhaps most critical is that "all hands" on deck type, such as fire and explosion, collision, or grounding. Vessel design and personnel training can ensure the shipboard capability to evaluate and respond. On-line diagnostic and preventive maintenance programs ensure that the vessel is in condition to operate properly and safely. Strict adherence to safety procedures (e.g. the use of fire proof doors in cargo areas etc.) is also necessary.

- Second, the vessel must be able to operate safely in case of power losses and failures of vital equipment such as steering gear, navigational equipment, mooring equipment, the main propulsion plant (including loss of automation and problems with diesel generators or boilers), and cargo gears. This problem of loss of automation is solved by manual operation incorporated in the system. Emergency generator and battery systems ensure equipment such as steering gear, navigational equipment etc., are operational for the vessel safety.

- Third is the ability to handle personnel casualties. Manning decisions must allow rapid and efficient response without depriving the vessel of its ability to operate. For example, evacuating a crew member by helicopter requires enough

personnel to transfer the injured person (including at least four stretcher bearers) as well as enough personnel to operate the ship. Rescues at sea presently involve at least six people in addition to those left aboard to operate the ship. Launching and retrieving lifeboats also can be labour intensive. These problems are tackled by providing redundant safety systems and equipments. To ensure that the vessel could at least limp to the nearest port before major maintenance can be effected.

REDUCED TRAINING OPPORTUNITIES FOR UNLICENSED CREWS

The elimination of entry level positions (such as wipers/greasers and ordinary seaman) on many vessels has reduced the opportunity for on-the-job training, some of which is required for the more responsible positions that remain such as oiler and able-bodies seaman. Both labour and management agreed that inexperienced or inadequately trained personnel can create safety problems, whether on watch, cargo handling, or operating safety equipments.

To prevent such problems, most companies have instituted "cadet" programs to train unlicensed personnel with sea service experience.

A few companies in recent years have negotiated labour contracts that provide for employment continuity among key personnel, thus ensuring that investments in

additional training can be recaptured (American Presidents lines, 1989). Whatever the approach, it is essential that the National Maritime Administration certifications be based on demonstrated proficiency and that management exercise due diligence to promote or hire only qualified people.

SERVICE CONTINUITY BY CREW MEMBERS

All operators agreed that continuity of service by crew members is an important safety factor, particularly with sophisticated shipboard systems requiring intimate knowledge. Repeated service aboard the same vessel ensures familiarity with equipment and promote team work. Continuity is most desirable among key personnel (master, chief engineer, chief mate and second engineer), and is helpful with junior officers and unlicensed personnel as well.

PHYSICAL DEMAND ON CREW MEMBERS

Concerns are also expressed about the growing need for physical fitness of crew members. Smaller crews mean fewer people available for emergency operations and very likely fewer physical strong people in situations where

strength is needed. Assessments of minimum manning levels must take into account the degree to which labour-saving devices are available or task requiring strength have been eliminated. Thus the fully automated vessels are designed to minimize things such as unnecessary ladder climbing or heavy lifting to eliminate some of the causes of injuries as well as impediments to emergency response. Annual physical and medical examination is recommended.

To be effective in improving safety, the national administration must adhere to the strict rigid standards of fitness for duty as recommended by International Maritime Organization.

CHANGED SHIPBOARD SOCIAL CONDITIONS

Recognizing that attitudes may affect alertness and attention to safety rules; most operators expressed initial concerns over the impact of reduced manning on the shipboard social environment. With smaller crews and the breakdown of some of the traditional distinctions between the deck, engine and stewards' departments, new social structures is necessary. This problem could be countered by promoting the ship team concept, an effort that may be assisted by movement toward greater continuity of assignments.

3.3.0 BENEFIT OF AUTOMATION

Merchant ships increased in size during the last few decades which necessitated increase in manning due to operational and maintenance requirements. The machines and equipment on the bridge, engine room, deck and in cargo pump rooms were then haphazardly installed. A great number of operators and watch keepers were required during operations of such equipments and machines; and there were improper communications and coordination between operators and watch keepers of different machines and equipments. The concept of centralized control was not yet developed and also human elements being prone to errors made vessels operation not so safe.

In later years, effort were made to centralize equipments on the bridge and improved engine room machinery layout thereby introducing centralized control and monitoring console. The concept of modern automation and remote operation was developed which resulted in establishing a balance between crew size and ship safety.

This was followed by fitting of complex and sophisticated automatic monitoring, fault diagnostic and control equipments in the console. Installation of control equipment to carryout every day operational tasks with the integration of audio/visual alarms for watch keepers were incorporated.

Advantages ensured by automation are reduction in crew size and ease of operation. It also provide increased efficiency, reliability and safety of shipboard machinery. In the context, reference to Norway which pioneered the adoption of shipboard automation and whose loss ratio of its fleet is probably the lowest.

Automation systems have now become the integral part of the ships operational systems. With satellite communication, data transmission between ship and shore has facilitated decisions between companies head office and ship. Therefore total decision making concept for vessel operations have been greatly influenced.

Initially, automation in engine room was, perhaps, to ease the work load of the engineers. But on more recent years automation has produce better engine room arrangement which eliminate continuous attendance to machinery particularly at sea. Engineers previously employed for watch keeping has been freed to carryout maintenance work.

Finally, the main purpose of increase automation in modern vessels are aimed at:

- a) Optimizing plant and machinery operation close to design conditions.
- b) To give early warning of fault conditions in machinery thus improving safety.
- c) Reduced the risk of personnel injuries as starting and stopping of machinery could be done using computers.
- d) Provide better working conditions by abolition of watch keeping practice, reduce fatigue and thus allowing personnel to respond to emergency with clear mind and strength.
- e) Reduce crew cost by achieving manning reduction
- d) Reduce maintenance cost by using the fault diagnostic features that reduced frequency of machinery maintenance.

ENERGY SAVING THROUGH AUTOMATION

Before this time, developing countries did not show much enthusiasm towards automation because of availability of cheap and abundant supply of crew. However, in 1973 came the oil price increase and this cause the shipowners in the developing countries as well as worldwide to seek means to reduce fuel consumption; thus the idea of energy saving measures and energy saving ships were born.

A typical system to combat this was the application of electronics. For example, electronic injection which control injection almost perfectly rectangular but can also be controlled within wide limits in terms of commencement, duration and pressure of injection.

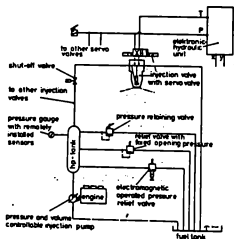


Figure 23. shows the principle of electronic injection.
Source: Ship Operation Automation III

An engine-driven high-pressure system supplies fuel flows along the shortest route to the injection nozzle and the nozzle needle. The overlap between the opening and closing of two control needles release fuel injection. The very short electronic pulses are optimized in terms of load points in the microprocessor. It is intended and natural to impose on this control system ambient conditions as input values. Finally, the system is conclusive to optimizing and matching the performance of individual cylinders. Optimization is possible in accordance with various freely selectable parameters:

- Heat release, combustion pressure and combustion chamber temperatures can be matched to different fuels.
- The minimum fuel consumption point can be set for any load point.
- The emission characteristics of the engine can be influenced
- Within certain limits, wear in the injection system, for instance can be balanced out so that time between overhauls (TBO) of such items increases.

Electronic injection yields better operating values than mechanical injection. This system reduces specific fuel consumption and the improvement noted is possible at part load. (see figure 24).

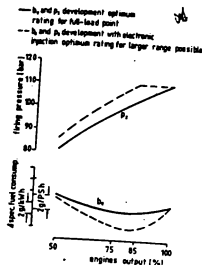


FIGURE 24.

However, the hydraulic injection still offers comparative results and because of this engine manufacturers are reluctant to introduce electronic injection except in high speed engines. The hydraulic injection so far still gives marginal savings especially in slow speed engines.

Another example was the use of satellite communication for accurate fixing position by electronic navigation system. The total navigation system is able to guide the ship from departure point to destination by means of optimum routing. The tracking pilot used with total navigation system is expected to allow a saving of about 6% of fuel oil as compared to the old system. (

Automation has facilitated the accurate operation of engine, use of controllable pitch propellers etc., all

have been done as energy saving measures. Computer trimmed sails fitted to motorships have been built with the expectations of giving about 50% saving of fuel oil. Results obtained from such ships are very encouraging indeed.

Automation came to be developed and implemented very fast in modern ships; no doubt, reliability and safety are the most important elements of the ship automated equipment.

ADDED SAFETY AND RELIABILITY THROUGH AUTOMATION

Results from automation showed that the performance and reliability of machinery was improved due to automation being integrated into them. This feature plus the high cost of fuel attracted the attention of ship owners of developing countries as well. Automation came to be adopted on ships belonging to developing countries also.

All equipments namely the main engine, auxiliary engines, steering equipment, navigation equipment, cargo gears have with the introduction of automation exhibited decreased failure rate. In analysing factors that has influence safety, speed, course, and communication; monitoring of machinery safety system and cargo would definitely be considered. With the introduction of automation it has been made possible to keep ship on the course at the required speed determined according to weather conditions by the use of automated navigational aids, supplemented by efficient automated communication

systems. Monitoring of cargo status and planning have become easier and safer by the use of computers due to efficient automated systems introduced to merchant vessels in recent years.

CHANGING PATTERN OF ORGANIZATIONAL STRUCTURE DUE TO AUTOMATION

Automation in the shape of maritime satellite communication and aids to administration in the form of computer has greatly influenced the organizational structure and work distribution between ship and head office.

To compensate for the higher costs, shipowners have resorted to competitive measures such as greater efficiency, improved safety and reliability, less energy consumptions, improved marketing and service. All these could be achieved by only additional investments on ships to make them more productive, reliable and labour saving. This demanded increased use of instrumentation and automation which improved or increased operating reliability and safety; more efficient cargo handling and storage; utilization of equipments and operational systems that increases fuel economy; investment in labour saving aids that reduces or lightens the need for manual operations; introduction of efficient and more computer oriented methods in organization; increased operational safety and cargo services; efficient information processing by investing in automated communication equipment; using modern planning techniques especially ships of the 80s and 90s have to a large extent been

optimized with regards to operational cost rather than production cost. The figure 25. indicates the radical changes in the cost of distribution pattern between a conventional and a modern fuel economic medium sized bulk carrier.

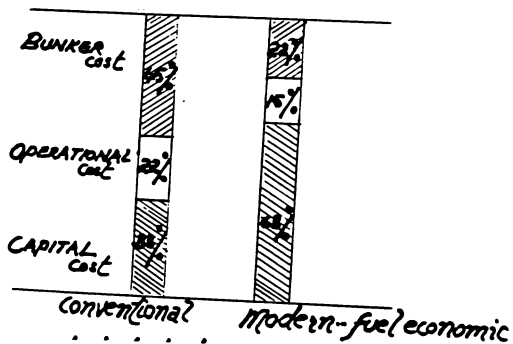


FIGURE 25. Cost distribution pattern; conventional and modern automated ship.

Source: Fairplay International Shipping Weekly-1988.

AUTOMATION AND OPERATIONAL COST

Automation has played a great role in curtailing the operational cost of vessels which has greatly increased due to influence of certain factors. Some of these factors can be summarized as follows:

- High price of fuel oil and inferior bunker quality.
- Short sailing period of crew
- Increased ship specialization
- International requirement for safety and environment

AUTOMATION AS COST REDUCING MEASURE

Automation has great influence on the cost reducing measures such as :

- Optimization of route
- Improvement of navigation
- Hull roughness supervision
- Docking and related procedures optimization
- Bunkering and bunkers procedures (purchase, quality testing etc.)
- Optimized cargo loading and handling (use of

loading computers)

-Improved routines for maintenance and spare parts inventory

-Improved equipment for condition monitoring.

3.3.1 FUTURE TRENDS IN ENERGY SAVING DUE TO AUTOMATION

The trend in energy savings have been till now been concentrated on each equipment individually. Examples are electronic control of central cooling systems. It must not be forgotten that ships are considered as a link in the total transportation system. Integration of the whole system therefore becomes the need of the hour. Such integration can be achieved by systematic engineering, in consideration with the ships operational conditions, the ships equipment safety and reliability, efficiency, profitability, upkeep and maintenance as well as logistics for repairs and spares gears.

Measures to save energy include the achievement of optimum engine load condition; accurate engine operation, improved rudder efficiency, reduced propulsion energy requirement through propulsive improvement; for example, the fitting of highly skewed propeller) which can increased thrust up to 50% of conventional propeller as claimed by the maker (KAMEWA); reduction of ships weight and propulsive resistance; employment of fuel saving diesel engines, maximum recovery of residual/waste heat,

for example, the fitting of turbo-generator to generate electrical power free of charge by utilizing the exhaust gas energy to raise steam that run the turbine; conversion of existing diesel engines burning marine diesel oil into engines that can burn low grade/blended fuel and finally the introduction of sail assistance and utilization of available solar energy.

ADAPTIVE AUTO PILOT

Automatic steering of a ship can improve its manoeuvrability. When the steering characteristics change, the parameters of the autopilot have to be adjusted in accordance with these changes. During manoeuvring, the autopilot coefficients are adjusted according to changes in the ship's behaviour. Information of the behaviour that can be expected is obtained from the log and echo sounder, but continuously changing conditions make manual adjustment of the autopilot settings unpractical. To make it possible to use an autopilot in this situation, automatic adjustment is a necessary requirement. An adaptive autopilot offers this solution by automatic adjustment of the counter-rudder setting. The control system is based on a relatively simple, non-linear second order model of the ship. This model is implemented in the autopilot and determines the optimum performance. In the autopilot a filter is implemented to prevent undesired rudder movement. This reduces the rudder angles to prevent the speed of the ship from decreasing too much, but also keep the deviation from the desired course to a minimum. It also minimize the rudder movement to prevent wear of the

steering gear. Autopilot generate the rudder signals to get the ship in a minimum time to its destination therefore saving in fuel consumption.

The revolutionary adaptive pilot (ADP) or auto pilot therefore, can provides energy savings of about 6% when compared with the conventional auto-pilot. The saving in fuel in most cases can be as much as 15%.

POWER DRIVEN SAIL-ASSISTED SHIP.

Aitoku-Maru is the world's first commercial sail-assisted ship. It embodied a fully automated computer controlled mode thus obviating the use of extra crew for handling of sails. Experience with this ship has shown that energy saving of up to 50% could be achieved by automated computer controlled sails. Another benefit of the sail was the improvement in the stability because the sails behaved as some kind of aero-dynamic stabilizer; making use of all winds except on 20 degree on either side of the bow. from this experience, it can be said that sail will be regarded as an indispensable part of future ship design.

An engine is the main means of propulsion in the modern sail assisted ship and the sails are auxiliary. Such sails can not ordinarily be installed on existing ships, rather it involves extensive calculations, design and planning in pre-building stage with special attention being paid to the hull design characteristics to match the sails. The engine burns low grade fuel even at low loads, thereby aiding to achieve maximum power gain from sails that is fed back to the engine system.

The gains obtained from such ship can be summarized as follows:

- Energy saving - maximum power gain of 22% to 26% at wind speed of 10m/s and 81% to 95% at true wind speed of 20m/s when sailing at 14knots at a wind direction of 90 to 100 degree.
- Increased stability at low sailing speed.

The engine, the hull form and sail all fall into a broad integrated system. The achievement from encouraging results with such energy saving ship had been made possible due to use of extensive automation. This has resulted in two-fold gains of reduction in manpower as well as energy saving.

AUXILIARY MACHINERY ENERGY SAVING DEVICE.

High turbocharger efficiency in modern diesel engine has allowed the power generating plant to utilize exhaust gas from the main engine to generate electrical power. A micro-computer is use to optimize load allotment to engine and generator set. Such a plant is the ICS (integrated combined system) genset which incorporate a turbo-generator driven by the excess energy from the main engine. This turbo-generator is coupled directly to a diesel generator which can run on low load. In the event of exhaust gas shortage, the computer senses this and cause the diesel generator to speed up to make up for the shortage of electrical power requirement of the ship. The computer limits the demand from the diesel generator to just the amount of power of power require to supplement the total exhaust generator (genset) power at low load operation of the main engine. Besides starting/

stopping diesel generator and overseeing parallel operation with exhaust gas generator, the computer also carried out proportional output allotment between the generators.

TREATMENT OF LOW QUALITY FUEL.

Automatic water separators are used for the treatment of water content in fuel. Such separators are capable of reducing the water content to less than 0.02% for fuel of high density at 15 degree Celsius. Separation of aluminium silicate from high density fuel is still a problem. However, homogenization, micro-explosion and subsequent atomization of emulsified fuel contribute between 1% to 5% fuel saving. An economic evaluation of fuel economy measures made to determine its worthwhileness.

3.4.0 CONCLUDING REMARKS

Analysis of National and worldwide maritime safety data supports the conclusion that number of vessel casualties and personnel injuries has declined steadily over the past two decades. (U.S.A. Marine Board Survey figure 22.). During the same period, average crew sizes have been substantially reduced. In gathering and analysing worldwide maritime safety data, I have not been able to establish a causal relationship between manning levels and safety.

Available data on maritime safety are inadequate to

support firm judgements about the contribution of various factors, such as crew levels to safety. A worldwide effort is needed to standardize, gather, and evaluate safety data in order to identify trends and provide the technical basis for constructive management of maritime safety. The following developments are needed worldwide:-

- Standardization of information about casualties, their causes, and their consequences.

- Collection of information about the exposure of ships to casualties including data tabulated on the basis of tonne-miles and numbers of port calls; and

- Collection of comprehensive data, including size and organization of crews on all levels.

The pace of change continues. Foreign fleets have set the pace at which new technologies are being adopted on ships. They have well planned methodical programs to use technology effectively and safely, bringing crew levels in some cases down to the low teens. Innovation in Nigerian fleet is essential for better competition. The way in which innovation is implemented will determine whether safety is helped or hindered. Above all, the Nigerian fleet should leverage other countries' experience with their systematic programs in developing its own reduced crew ship of the future.

Progress can be achieved only by close cooperation among all interested parties, including ship operators, the sea-going workforce and its union, and the industry's safety and economic regulators. This collaborative effort should encompass training, research, evaluation and dissemination of information on international

developments and pilot programs under the Nigerian flag. Government can serve as a catalyst in this endeavour, but the industry itself (including operators and labour) will need to lead.

The introduction of new technology should consider ships as socio-technical systems, consisting of personnel, technology, organization structure and external environment. Changes in any of these four subsystems should suggest appropriate changes in others.

New ship technology coupled with appropriate training, organizational innovations, and ergonomic design can enhance safety. For example, these approaches can reduce potential problems of stress, fatigue and boredom.

The Nigerian Maritime Administration (Maritime Inspectorate) do not presently have the necessary human factors analysis methods to make solid certification decisions on minimum safe manning for highly automated ships.

In establishing safe crew levels, government and industry needs to consider demands on the crews on different vessels, taking into account specialized technologies, type of service, skills required and quality of management. Formal analytical methods need to be incorporated into the establishment of safe crew levels and the consequent issuance of certificate of inspection. Lack of an analytical approach has led to inconsistent certificate determinations and has made it difficult for the Administration to exercise its port state control authorities.

The skills needed to operate ships are changing with advances in technology. Lines dividing deck and engine departments are fading, along with the need for engine room watch keeping. The importance of individual and team

skills is increasing as crew are reduced. These changes need to be reflected in training programs and licensing requirements.

Training programs must therefore reflect not only technical skills required, but subjects such as management of personnel and communications. Licensing requirements must become more specialized to reflect the differences in vessel type and service and to require periodic re-certification of skills to ensure that crew members develop and retain necessary qualifications. The certification and licensing of general purpose ratings, dual-qualified officers and watch officers should be established to reflect the changing ship organization structure.

Finally, automation on board ships has played a great role on the management of condition monitoring and maintenance activities by the use of work saving technology and use of advance communication media. This has also serve as an effective aid in the shipowners endeavour to keep cost low and productivity high.

By changing the automation levels on board ships, some gains in the form of economy, reliability and efficiency have definitely been achieved. Statistics gathered over the past years has, revealed the loss ratio of world fleet has declined by 40% (Lloyds Casualty Return 1990), and this definitely has been due to implementation of automation since these trend occurred as automation were being introduced.

Automation has increased efficiency, safety and reliability and has brought about reduction in manning scale and operational costs. These perhaps the main reason to which it has tended to strengthen its foot on board ships.

CHAPTER FOUR: PROPOSAL FOR SHIPBOARD MACHINERY AUTOMATION LEVEL FOR FUTURE NIGERIAN MERCHANT FLEET.

4.1.0 INTRODUCTION

In the previous chapter, the advantages of adopting extensive shipboard machinery automation were highlighted as claimed by some users and equipment manufacturers who are mainly from developed nations. These claims when analysed are found to be based on the prevailing circumstances in such technologically, industrialized and economically sound countries which has the necessary infrastructure for effective utilization of automation.

The socio-technical, economical or industrial environments prevailing in Nigeria are entirely different. In evaluating automation from from Nigerian viewpoint, there seems to have some shortcomings. This has created the need for scientific evaluation of introducing the amount of shipboard automation by a study of operational experiences with automated vessels already in Nigerian fleet. The technical level, training and facilities, wages structures of crewing must therefore be analysed. Also what may be applicable in the near future, spare parts and shore side repair facilities and the study of the economical viability of automation installation must also be considered.

4.1.1 OPERATIONAL EXPERIENCE WITH SEMI-AUTOMATED SHIPS IN NIGERIAN FLEET

In 1978, the Nigerian national shipping lines procured 19 semi-automated ships which were of the unattended machinery space (UMS) class notation as certified by the classification society. The ships when delivered left the Nigerian crew in limbo as they were trained originally to man conventional ships. These crew had no knowledge of operation nor experience on fault diagnosis on electronic equipment that were installed by Siemens of Germany. This became a nightmare for the technical department as no plan was made to up date the present crew knowledge (e.g. marine /electrical engineer). The problems were compounded as the system were soon to breakdown and the ships reverted to manual operation. In an attempt for the management to put the ships back on the UMS class, the maker of the equipment were employed around the globe (Siemens) to visit any ship in difficulty for maintenance. This seriously drained the hard earned foreign currency of the company and suddenly there were mounting debts to pay. The ships were soon to be arrested for non-payment of debts on maintenance all over Europe within a span of 5 years of the ships deliveries. Today the fleet has been reduced down to 13 vessels as the company had to sell off most of the ships to pay maintenance debt. Equally too, the remaining 13 ships are now being run manually as conventional ships with crew as many as 42 members. The question then arises as to what had caused the company to invest in such expensive ships but just to revert them to conventional operation which sometimes were costlier to operate.

To answer the questions therefore, the role played mainly by the operational and technical managers must be looked into. The shipping managers and superintendents who supervised the managing of the vessels had little or no knowledge of automation themselves as they were trained on the operation of conventional vessels. The lack of such knowledge created an oversight for the managers to realize the level of problems they were into when decision was taken to build these class of ships. There was no proper planning to update or develop the skill of the crew to have the sound electronic background needed to operate such ships. This shows that automation with unskilled crew could greatly undermine all the advantages claimed through automation as highlighted in the previous chapters.

Another problem was the availability of repair services at Nigerian port of call was nil. The control systems fitted required very frequent services with high degree of skill which could not be provided by the average quality of maintenance and skill available. Also the reliability of the installed automatic equipment could not be ascertained as non-stop false alarms and malfunctioning of automation system were reported almost from the time of delivery of the vessels. This implies that the guarantee period was not properly utilized to remove the faults as well as to draw conclusions to stop installation of Siemens equipment on preceding vessels.

Some of the problems related to management concerning the said vessels could be summarized as follows:-

- Lack of planning in introducing advanced equipment

while the company was not prepared for such innovation.

- Trained staff that joined the hand-over team were replaced after certain period and they themselves had little electronic background to analyse and to diagnose automation faults.
- Inflexible restrictions in calling for repairs and lengthy procedures for ordering spare parts.

As these problems were occurring on the early delivered vessels, the management advice the crews to operate the machinery by traditional watch-keeping method, arguing for more security and safety with relatively cheap labour cost.

Problems related to the vessels can be summarized as follows:-

- Automation equipment were from a single manufacturer.
- Periodic maintenance and service of the installations were irregularly done at European ports of call and home port.
- The ship compliment who joined with the hand-over crew were not kept for long before changing.

Observations derived from the entire experience could be summarized as:-

- There were lack of experience and expertise in operation, maintenance and repair of automation equipment.
- Difficulty existed in the procurement of spare parts.
- In general, the extent of defective automation devices ascertained were relatively high.

- In some of the ships with foreign crews with automated experience, it was noticeable that the engine room staff were considerably relieved from wasteful occupation of watchkeeping and the man hours were use for maintenance and overhauls much more than the conventional vessels in the fleet.

From these evaluation of the operational experiences, ships equipped with unattended engine rooms had many problems which could be related to the level of technological circumstances that were prevailing in Nigeria at the time. These was mainly due to lack of experienced and well-trained operating personnel cause by improper training and lack of facilities, absence of suitable repair facilities at home port and deficiencies in the management.

4.1.2 FACTS ABOUT SHIPPING INDUSTRY IN NIGERIA

Initially, shipping in Nigeria was totally in the hands of colonial operators and private sector, for example, Elder Dempster and the Nigerian Palm line. Nigerian National Shipping Lines, the national flag carrier was established in 1966 by the Federal Government as a parastatal of the Federal Ministry of Transport. The national shipping lines introduced 19 modern cargo vessels by 1980, the fleet strength rouse to 35 ships. The management of the company is by board of Directors with a Chairman appointed by the Ministry of Transport. The 19 modern vessels were of the UMS notation purchased during the year 1977 to 1980. There are also privately

own companies operating coastal, fishery and a few deep sea going vessels. The Government own ships which stood at 35 in 1980 has now dwindled to a mere 13 ships. This could be linked to the poor management and lack of expertise in the company which hurriedly introduced automated vessels without due planning. Also by the end of 1970's, the automation equipment was still far from reliable and the management failed to notice this too.

Modernization and expansion of the fleet is a necessity but there are constraints to this. Most of these problems are of the same nature as faced by other developing nations. Improvement and expansion would require high capital investments. At present with the world experiencing the worse recession since World War Two, availability of capital in the form of foreign exchange is scarce in Nigeria. But if Nigeria is to take its place in international maritime world then investment is a pre-requisite to achieving this goal.

In terms of technological level at the moment the country is better placed than most developing nations. Lack of finance, improper planning and implementation has always been the main hindrance in the development programmes, be it in area of manpower development or attempt to modernize the fleet or upgrading of repair facilities to adequately cater for new technological advanced vessels and equipment.

Presently, the ships in the Nigerian fleet are not dependent on foreign staff for operation and management as in the past. In fact, recruitment of foreign officers was stopped since late 80s. Most maintenance work on board ship are carried out by the ship staff, be it a

conventional or UMS vessel of the fleet except in areas of automation.

Shore repairs are carried out at home port by contract through many engineering firms operating near the ports. All the automated equipment repairs are still being carried out in Europe or by flying staff from the equipment maker any where in the world the vessel visit. Also none of the automated electronic equipment or their parts are manufactured in Nigeria, though most spare parts are available locally in the market.

The Nigerian merchant fleet has witnessed its transformation from very obsolete steam/diesel engines to advance diesel propulsion vessels then to ships with fairly good amount of automation.

Operational experience with UMS ships despite the initial problems has definitely enhanced knowledge on the systems and provided training to the ship personnel both in hardware and software. Self training has always been the nature of training.

The Maritime Academy in Nigeria only at the moment provide pre-sea training to cadets and the certification in competency are obtained either in the United Kingdom Marine colleges or Arab Maritime Academy Egypt. There is an immediate requirement to equipped this establishment with automated equipment for proper skill training of officers for future fully automated vessels. This will enhanced the country self-reliance in modern technology and upgrading Nigeria technological statue in the maritime industry.

It has been about twelve years since the first automated vessel was operated in Nigeria. The problem encountered as describe in the last section shows that it has not been beneficial to the country. With this experience in mind, future automated ships in Nigeria will require careful planning to cater for required skills and the logistic in spare parts for effective implementation of automation.

Crew cost at the moment is very low compared to the developed nations, but there should be no complacency to sit back. The country should proceed in its quest for technological advancement so as to be technically and economically competitive in the shipping trade which can contribute to a large extent in foreign exchange earnings.

There is a shipyard in Lagos (Nigerdock) which in 1990 repaired a total of thirty two vessels, with clientele that span a wide spectra of the international economy. About 43.3% of these vessels were foreign owned. Still in 1990 the yard veered into ship building. The first two ferries(Yankari and Badagri) were built locally for mass transit use. In the same vein, an off-shore oil loading buoy was built by the yard. Other construction works which include 280 passenger water craft buses, two vehicular ferries and nine harbour and mooring launches also commenced. With improvement in expertise through proper training and education at the Maritime Academy, the stage will be set for the yard to commence the building of deep sea ocean going vessels.

At this stage, it must not be ignored the fact that there had been an increase in the competitiveness of

developed maritime nations fleet through resort to the institution of open registries or flags of convenience, over and above the already existing technological edge. Developing countries like Nigeria should try to bridge the gap and move ahead towards technological developments and self-reliance.

When establishing policy targets, Nigeria should aim initially not to the attainment of highly automated ships as a measure to reduce the gap but should focus on improving training, development of repair facilities to obviate dependency on foreign countries and later should endeavour to enter into manufacturing of parts needed in automated systems and equipments.

Finally, enthusiasm for purchasing highly automated ships should be exhibited only at a stage where dependency on others can be totally ruled out.

4.2.0 PROPOSAL FOR TRAINING AND SKILL CERTIFICATION FOR FUTURE NIGERIAN VESSELS.

The members of smaller crew on modern automated vessels must be more broadly skilled. First, small crew imply broader individual responsibilities. Second, vessels designed for smaller crews are generally technically more sophisticated. Training and certification of personnel qualifications must reflect these changes.

In most advanced shipping nations of Asia and Northern Europe, both officers and unlicensed personnel

are trained in the broad technical skills demanded by evolving technology and crewing practices. In Nigeria by contrast, most formal training still reflects traditional departmental divisions of labour. However, the Nigerian Maritime Academy should be updated with equipment and personnel to meet the requirement of the industry in training skill labour to a broadly qualified watch officers (with training in both navigational and technical skills, as well as business and logistics) to take charge of the flagships of the future. This should be the only way forward in order to avoid mistake of the past. Shipboard maintenance now the province of highly trained certificated engineers, should become the responsibility of specialists (perhaps unlicensed technicians) and riding crews. Shipping companies should undertake their own training programs to broaden crew members skills in response to the new technology.

New training beyond that necessary to inculcate technical skill will be required. A course at the Academy should be instituted in shipboard management for both deck and engineer officers to cater for the technical and management skills as well as watch keeping effectiveness. Latest new automated shipboard systems have in-built capabilities for individual and team training, which permit operators to simulate training exercises and mentally rehearse typical and atypical conditions. The Academy should therefore be equipped with simulators to give the cadets and officers the opportunities to update their technological skill to operate the fully automated vessels.

The growing sophistication of crew members responsibilities on modern ships will lead the Nigerian

Maritime Administration to take more control over the precise qualifications of licensed and unlicensed personnel. Some qualifications may become more specialized to reflect differences in vessels type and service. For example, the administration would have to permit the introduction of additional skill requirements as employment conditions aboard ships will require specialized knowledge. Periodic re-certification of skills will become more important to ensure that crew members develop and retain the necessary qualifications.

4.2.1 TRAINING AND CERTIFICATION PROGRAMS OF ADVANCED SHIPPING NATIONS

Fleet of the Federal republic of Germany, Japan and The Netherlands are among the most advanced in the world today. Their training and certification programs illustrate changes Nigeria should anticipate.

JAPAN

Japan has moved much further towards general purpose ratings and dual-qualified officers than any nation. The initial experiments, in 1979, were succeeded by carefully planned steps towards a new "Hypothetical image of seafarers ". The newest Japanese vessels with crews of 18, 16 or 14, are staffed largely with watch-officers, dual-qualified officers who hold major qualifications in navigation or engineering but are operationally qualified to stand watches in both engine room and navigation

bridge. All of them hold a certificate of watch officers, with appropriate specialty in navigation and engineering.

Uncertified personnel aboard these Japanese vessels are trained for general purpose work. Specially qualified officers are trained and certificated to head bridge watches in the open sea, although not in restricted waters. Shipping companies themselves have borne most of the substantial cost of training for these new position (Yamanaka and Gaffney 1988).

THE FEDERAL REPUBLIC OF GERMANY

The German shipping industry provides another illustration of training that may be required. In 1987, building on shipboard experiments conducted on vessels operated by Hapag-Lloyd AG, the industry shifted all programs for uncertified personnel to general purpose training, eliminating separate deck and engine training. After three years, the neophyte sailor is qualified as a ship's mechanic. Further training aboard ship and/or in a technical college can lead to an examination for position of a ship's foreman.

The country has not moved completely to dual-qualified officers. The shipping industry there, however, expect highly automated state-of-the-art ships, with controls and monitors centralized on the bridge which would required ship management officers for the most efficient operation. This class of officers would

be responsible for the entire ship -cargo, navigation skills (Froese,1989).

In 1986, as a first step in that direction, the industry with government support, began offering officers with existing top-level deck and engine training leading to medium-level credentials in the opposite specialties. The course involves eight months of practical training aboard ship, followed by one year of study at a technical university. (All officers are required to complete the standard ship mechanics course).

THE NETHERLANDS

In Netherlands, all officers are now being trained in both deck and engine skills. The training is only partly integrated at present, but Dutch authorities expect to achieve full integration with only one class of certificate for new officers in the near future.

The four year course for officers of large vessels includes a year at sea with both technical and navigational experience. The traditional department distinctions are preserved to the extent that each graduate receives major and minor certifications (in navigation and technical qualifications), depending on the results of a series of final examinations. Further optional training is offered to bring graduates to fully integrated status. This training will soon be included in the standard four-year course, whose graduates will be certified as broadly qualified "Maritime officers" or

"ship managers" (Steve cross 1992).

Some uncertified crew members in the Netherlands are also trained in both deck and engine skills. For example, skilled ship mechanics, with general-purpose qualifications have been employed aboard Dutch ships since the late 70s. Most vessels, however, carry only one or two ship mechanics to maintain mechanical systems. More recently, these personnel have been assigned as core crew aboard vessels manned largely with unskilled third world crew members; in the guise of ship technicians of which they could assume supervisory responsibilities.

4.2.2 PROPOSED PROGRAMME OF TRAINING IN NIGERIA

Based on the above analysis of the advanced nations training and experiences acquired in touring various Maritime Institutions in Europe and America whilst at the World Maritime university (WMTU), it is my believe that the right approach is to opt for a programme of education that shift emphasis from the descriptive type to a more analytical one. This will raise the curriculum to a bachelor's degree level. The thought is in the direction of a very sound science and mathematics base. This will build a firm and broad-based theoretically oriented specialization that will include some aspects of social sciences in the concluding stages of the programme, to be followed finally by the professional training.

The proposed programme which should address the issue of upgrading the academic course to the first

degree level, should be an undergraduate four-academic-year bachelor of science in Marine Technology course with options in Marine Engineering, Electrical Electronics and Nautical science. The proposed course should be structured to combine scientific and technological knowledge with practical training as outline in annex 1.

This approach aims at producing an officer that will be a specialist up to the highest level in one discipline but with adequate knowledge to at least be able to stand watch in the other. This is to say, a Master mariner by specialty but can perform the third engineer duty and Chief engineer -a third officers job. In fact, an officer suitable for todays's operational realities yet ready for the challenges of tomorrow.

The focus of the course is the training and education of seagoing officers who are able to operate, manage and maintain dynamic systems ranging from heavy main engines through delicate monitoring and control equipment to modern merchant marine transport vessels in conjunction with associated ancillaries shipboard and port facilities. See annex 2.

This course should be structured to provide the scientific and technological foundation to manage self-contained systems fitted on board modern vessels as well as provide a degree of proficiency in interpersonal relations and communication skills. Elements of shore related industries in which graduates may eventually seek employment are also included.

The main aims of the course is to prepare student

to:-

- Understanding engineering principles based on an appreciation of natural and applied sciences.
- Manage maritime transport plant and equipment through analysis and optimization of operation and maintenance of such systems.
- Appreciate and cultivate multi-disciplinary approach to problem solving.
- Accept responsibility for safety of the people and environment affected by maritime operations.
- Know the importance of management principles, interpersonal relations and communication skills.

After graduation, the professional training should continue in line with regulation 3/2 and 3/4 of the International Convention on standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW).

With the above objective in mind, a working group should then be established between the Nigerian Maritime Academy and the Nigerian universities council for Technology, with a view to preparing a course structure and detailed syllabus. This to be then considered and approved by the Board of Governors of the Academy and the University council. If the programme should ever be considered, the university council should award the degrees until such a time that the Maritime Academy could build a competent staff to set up its machinery to award such degrees.

PROPOSED FACILITIES TO MEET THE REQUIREMENT OF THE TRAINING.

The training facilities to meet the requirement of the stated objectives should include among others, an engine room and navigation simulators for effective instruction in automation operations.

- A diesel engine of limited power that could be coupled to an alternator.
- Automation laboratory- to cater for both electronics and pneumatic systems training including programmable controllers.
- A layout of engine room with possible old machinery that can be obtained as scrap from ships, e.g. refrigeration and air condition systems, purifiers, steering gears, oil fire boilers and other ancillaries equipment etc.
- A machine shop
- Computer laboratory

With these facilities, deep sea training and experiences required by the Maritime Administration with regards to STCW convention 1978 can be reduced. The student can then spend more time in the college to go through the degree programme. The course can fit in within 17 weeks at the academy and it would be sufficient

to meet their training requirement of the Administration.

The Government alone should not bear the cost of these facilities. The shipping industry especially ship owners should endeavour to provide some of these facilities as they will benefit most from the training offer. Maritime Education should not be considered as a waste of resources but as an investment on the future technological advancement in maritime and related industries in Nigeria.

The regulatory authority and shipowners should consider the shore-based practical training as superior. These remove training from the commercial pressures on vessels as officers barely have enough time to make such on board practical training to cadets possible. Thus national shipowners should acquire stepwise ships with increasing complexity of automation to allow crews to adapt in best effective way to new technologies.

TRAINING STAFF REQUIREMENT

Presently, Nigeria has a lot of Marine engineers and mariners of the old school. Most of them could be recruited into Education and training with the possibility to updating their knowledge at the World Maritime University to meet present requirement in maritime transportation. Needless to say that a good academically sound with practical experience staff is a pre-requisite to realize the goal of proper and efficient training to future maritime officers. As such, I proposed that most of the academic staff should be drawn

from the maritime environment who has had practical knowledge in ship operations. Specialized lecturers also required in social and applied sciences.

TRAINING OF UNCERTIFIED CREW MEMBERS.

Uncertified crew is one with experience at sea as a rating. They require training to be able to work on modern automated ships. As done by most countries, their training initially should reflect traditional shipboard divisions of labour between deck and engine and finally to be geared towards the general purpose training as adopted by the Germans. This will help them to adopt to the technological innovations that is taking place in the industry. Introduction of an electronic technician course for the deck and engine ratings can help meet the maintenance requirements in automation and communication systems in direct supervision of an officer.

Courses in the use of computers for managing steward's inventories, oil spill containment and clean up, marine propulsion automation and sea lift operations and maintenance can be offered to the uncertificated crew at the Academy; as increasing flexibility of shipboard assignments in the future may require uncertified crew member to develop and use skills traditionally reserved for officers. For example, they may be members of a tight-unit bridge operation team with advanced skill in radar monitoring and open-sea watch-keeping.

CERTIFYING SKILLS FOR FUTURE SHIPS OF NIGERIA

The Nigerian Maritime Administration (Maritime Inspectorate) procedures in certifying crew members' skills will evolve to reflect the changing nature of shipboard duties. Both officers and rating certificates and documents will reflect the departmental distinctions and specify more precisely crews members' particular skills. To ensure that sophisticated skills remain up to date, the administration should demand more comprehensive recertification of skills on periodic basis.

The crew will be called on to develop specialized skills to accommodate the sophisticated technology of modern vessels. Certificates and documents will therefore carry endorsements certifying the attainment of special skills in ship handling, maintenance of electronic equipment, operation of specific engine types and so on.

The advance of shipboard technology will tend to render skills obsolete as time passes, unless crew members receive new training or maintain their skills on the job. Officers may have to be retested every five years to verify skills. To ensure that sophisticated skills do not decay, the Administration may be called upon to recertify through periodic testing - that skills remain fresh.

The existing training facilities at the Maritime academy is not enough to achieve these objectives; thus adequate facilities are required so that the capacity for much additional training can be accommodated- which would likely play a strong role in maintaining and updating

crew expertise.

4.2.3 PROPOSAL FOR SHORE SERVICE FACILITIES IN NIGERIA

In addition to the heavy industry of the Nigerdock, future specialized trained engineers and deck officers from the Academy should be utilized to establish shore service facilities. This could be in the form of either a national workshop attached to the ship repair yard or as a privately own company to service automated equipments. This will reduce dependability on developed nations and will certainly conserve our foreign exchange. The company will also provide services for foreign flags ships visiting Nigerian ports thereby bringing in the much required foreign earnings. This will accelerate the pace of technological advancement in the shipping industry. When carefully managed will eventually lead to manufacturing of spare parts. All these are possible, as experience has shown that most of the Asian countries started technological development in the servicing industry and finally into manufacturing whose products are being consumed worldwide today.

Research into frequency of faults on equipment can also be carried out by the workshop in close cooperation with staff from the Academy. If Nigeria is to excel in maritime and related industries, investment in research and development is highly necessary as practiced in advanced maritime countries. Data on serviceability, type of spare parts and availability, quality of service and repair facilities ashore, latest innovation in shipping and their service preparedness can be made available to the industry. This will certainly reduce

dependence on other countries.

4.2.4 CAPITAL AVAILABILITY FOR INVESTMENT IN NEW SHIPS.

Capital availability in developing countries is scarce to purchase new ships. Capital cost of the ships remains one of the largest single cost, but is one of the most difficult to quantify with any precision. There are large variations in the price of similar ships with different amount of equipment and automation. Heightened inflation and economic difficulties has seriously affected the supply of capital to developing countries especially Nigeria, in the form of aid or direct loan. An initial analysis set by the government often reveal, generally, that shipping does not stand high in the list of priorities with the scare resources. But it should never be forgotten that shipping can provide invisible earning to the nation which can help to offset the high trade deficit and of balance of payment.

With these lack of capital, most developing countries shipowners especially Nigerians embark on second hand ship acquisition from developed nations. It is also evident that most of these second hand vessels are either fully or semi automated. Such ships can present to the owner lot of problems as earlier illustrated if skill crews are not available. The in-availability of ships and large losses due to high maintenance cost will be very prominent and will not encourage the owner to continue such a business. Therefore, in today's shipping environment, it is a harsh reality that all ships has one form of automation or the

other; thus there is no option not to adopt automation in Nigerian fleet. Finally, despite the hard economic climate Nigeria still import and export products needed for its survival. This shows that investment in shipping is a task that should be fulfilled to remove or reduce dependency from other nations.

4.3.0 SUGGESTED AUTOMATION LEVEL FOR FUTURE NIGERIAN VESSELS.

Application of automation onboard ships although not very old development has been given extensive consideration by shipowners all over the maritime world particularly of developed nations.

In the foregoing chapters , attempt had been made to describe automation as available today on modern vessels; its development, practical applications and benefit claimed through its implementation. Analysis and evaluation of factors that would greatly help in selecting the extent to which it could be adopted on future ships of Nigeria has also been highlighted.

Having considered the guiding factors, in this section , therefore , instead of referring to a hypothetical country, Nigeria has been selected to state my personal views with recommendation on the level of automation that can be feasibly adopted on future Nigerian ships. Also cargo vessels are selected as these represent majority of ships in merchant fleet of the country. Further evaluation and analysis would be considered in future on automation application for

SUGGESTED AUTOMATION LEVEL IN THE MACHINERY SPACE

Simple UMS or equivalent machinery automation is recommended for newly build ships and should include the following:

- There should exist a control room inside the machinery space with air condition unit for maintaining the electronic components within acceptable temperature and humidity limits.
- Under sailing conditions, including maneuvering, the direction of engine and speed should be controllable from the navigation bridge in addition to control from engine room and local hand control station.
- Suitable safety interlocks on the main engine to be provided e.g. starting engine without lubricating oil etc.
- Overload protection device for main propulsion also provided.
- Emergency stop/crash maneuvering to be provided on the navigating bridge and engine control room.
- Alarms and displays referring to main and auxiliary engine and other ancillaries to be fitted on the bridge and control room. This should include for critical and non-critical situations.
- Audio/visual alarms to be provided on the bridge, engine room and in engineer's cabin for the UMS operation at night.
- Provision to activate engineers' alarm in such

- circumstances where an alarm has not been acknowledge within a specified time limit.
- Provision for continuous power supply to alarm system and automatic change over facility to stand-by power supply in case of loss of normal supply.
 - Normal power supply failure should also be indicated by an alarm.
 - Provision for continuous alarm indication until it is acknowledge and fault rectified. On correction of fault, alarm system should automatically reset to normal condition.
 - Safety arrangement to be incorporated in the main propulsion plant, power plants and boiler which should be capable of initiating automatic shut down/slow down due to malfunctioning to stop immediate danger and complete breakdown of the plants. Alarm must also be incorporated.
 - Shut down of main propulsion and electrical power plants should be activated only in case of condition which could lead to serious damage- complete breakdown or explosion. Arrangement for overriding the shut down must be incorporated at the controls on the bridge/engine room as modern diesel plant can accept 110% overload for at least an hour. Overriding control only to be operated to facilitate running of propulsion plant to get ship out of a disastrous situation e.g. collision. This control to be used only when it is obvious that the ship and life there-in are in imminent danger.
 - Fuel oil temperature to main engine to be automatically maintained.
 - Lubricating oil and cooling water/oil temperature

- of both main and auxiliary plants to be automatically maintained.
- Automatic change-over arrangement to be provided to start and put on load a standby power generator in case of malfunctioning of the running plant. This will ensure continuous propulsion etc., and alarm to be activated during the process.
 - Means to detect and initiate an alarm at an early stage in case of fire in the scavenge trunk of both main and auxiliary plant and boiler uptakes must be incorporated.
 - Alarm indication for all important pressures, temperatures, fresh water -fuel oil tanks including the auxiliary and main engine sump tank levels etc. must be provide on the bridge and engine control room.
 - An alarm for control air failure also must be provided.
 - Provision should exist for automatic starting /synchronization and on to main switch board a stand-by generator sufficient in capacity to maintain main engine and steering gears to ensure safety of the ship with automatic reset of essential ancillaries.
 - Automatic starting of main air compressor to maintain starting air pressure with an alarm incorporated to indicate when the required conditions are not met.
 - Provision for monitoring of bilge wells at normal heels and trim/list accumulated liquid with an alarm to indicate any abnormality.
 - Oil fired/exhaust gas boiler must be provided with automatic controls and alarms to ensure a safe, reliable and economical operation.

- Fire/smoke detectors incorporated with alarms must be provided in the machinery space and cargo holds.
- Refrigeration and air condition plants and systems must be provided with suitable automation to maintain desired conditions. Also alarm to activate if critical limit occur and a shut down control.
- Provision for indication at the same time more than one fault conditions with alarms. Acknowledgement of one should not disrupt other alarm condition.
- Diagnostic features for the main engine and diesel generator plant as described in chapter one should be incorporated. Initially automatic on-line monitoring should not be used but data should be collected from such sensors and fed manually on either MIP (Maximum Indicated Pressure) calculator or computer; for example computer aided performance analysis of the MAN-B&W (CAPA). This feature is very important as it acts as a tool to the engineer in analysing and planning maintenance of machinery to achieve the best economical result.

All the above systems should be integrated to ensure centralization on the bridge and engine control room monitoring and control systems display data. The Datamic marine system of Valmet automation or Siemens/ Norcontrol offers unique systems which has been proven in service. This system would lead to vast reduction in maintenance and operational cost.

NAVIGATION BRIDGE AND DECK AREAS

There should be fairly reasonable amount of automation at the navigation bridge to cope with ever increasing traffic density , rising ship speeds, cargo values and the ship. This would assist the watch officer on the bridge to reach better decision more quickly and accurately.

The navigation bridge is the only position that is manned throughout 24 hours at sea. It is therefore, the most convenient place to have a fair amount of automation for alarm condition monitoring of the main and auxiliary machinery with steering plant. Fire control station should also be installed on the bridge for fire/smoke detection with an alarm. (Considerable work has been done by International Maritime Organization (IMO)). It is therefore necessary that guidance from IMO conventions should be followed when installation on the bridge is carried out. (Suggestion to refer to SOLAS'74 would be very appropriate).

The integrated bridge system describe in chapter two could be scaled down initially to accommodate the following automation installations:

- Automatic helmsman to steer the ship automatically though not in fog or near coast or in area of high density traffic and must be incorporated with an alarm to automatically activate in case of failure.
- Repeater compass to assist navigation.
- Course recorder to keep a graphical record of all courses steer.
- Radars which serve a two-fold function combining

- that of an easy to use position fixing device with an all-weather lookout functions. (This equipment has been made mandatory since 1984 by International Convention)
- ARPA (Automatic radar plotting aid); These are sophisticated radar sets with built-in computers and is also mandatory.
 - Log to measure ship speed.
 - Gyro-compass to give true direction, but being mechanically sophisticated is carried in addition to magnetic compass. Mandatory regulation in IMO since 1974 and entered into force 1984.
 - Radio direction finder - also compulsory on ships over 1600grt. With this device, the bearing of known radio beacons can be taken and also the bearing of radio distress signal. It has a safety feature as well as a navigational tool.
 - Decca, Loran-C or omega as required by International regulation.
 - Navigation satellite receiver; it can be used worldwide and fixes can be obtained on an average of about every hour. It computes and prints out the level of accuracy that can be relied on for a given fix.
 - Echo sounder; is a sonic device capable of measuring the depth of water under the ship. It can display the depth either graphically or on a visual display monitor. It is recommended by IMO for all ships over 500grt.
 - Weather facsimile recorder: This facilitate ships at sea to receive weather forecast charts from the main forecast centres of the world. It can be considered as a complementary and in addition to external weather-routing.

- Main engine revolution and rudder angle indicators.
- INMARSAT- In 1993 GMDSS (Global maritime distress safety signal) will enter into force. This satellite system will solve all communication problems between ship and shore and between ship to ship. It will therefore facilitate contact between ship and head office using telephones and teleprinter via computers concerning matters of operation, maintenance and spareparts.

This system can be extended to incorporate:

- a) Radio-auto-alarm - to listen automatically for distress calls.
 - b) Telephone communication between ships, pilots control, tugs, and canal authorities etc.
-
- Internal communication system within the ship should also exist.
 - For mooring winch, self-tensioning type should be installed. This will automatically tighten the mooring ropes when vessel is at the quay.
 - A simple loading calculator should be used. This will assist in ballasting and de-ballasting operations by planning and calculating the centre of gravity of the ship. It can also be use in loading of cargo by working out the ship draft, trim, heel as well as the overall strength and stability of the ship.

MANAGEMENT AREA

Shipboard management system should be installed in Nigerian vessels. This is a computerized information and management system like SPRINTMAN developed by DNV. It covers the following functions:

- Maintenance planning
- Accounting
- Spare parts control and ordering
- Load calculation.

Maintenance planning comprises of the following functions:

- :Long term planning
- :Annual planning
- :Running hour- based planning
- :Job card
- :Maintenance history documentation
- :Progress report
- :Breakdown report
- :Classification society report etc.

This type of system will certainly ease the management work load by dispensing cumbersome paper work and improving the process of decision making.

4.4.0 CONCLUDING REMARKS

The above level of automation for Nigerian ships of the future has been suggested, taking into account the past experiences with semi-automated vessels, possibility of technological advancement in the country that could be achievable, technical aptitude of the people, level of

training already proposed, capital availability, repair and spare parts availability, crew wages, social and other economical considerations in future technological advanced nation. With these level of automation, it will be possible to crew such ship with less than 30 people initially. As progress is made to establishing a good shore repair facilities and probably less and less crew could be employed. It must be understood that the primarily aim of automation level suggested is for safety, reliability and economical operation but not for crew reduction, so that shipping in Nigeria can remain competitive in world trade. Such a level will, beside fulfilling the basic requirement of safety, but would also facilitate maximum repair and maintenance work by the crew of which in the long run will ensure extensive savings.

As already mentioned, all actions to implement the above suggested automation in Nigerian fleet must be carefully executed in order to bring the desire benefits claim through the use of such systems. If not, it could increase the cost of operation leading to loss of earnings through maintenance. At the end of 1991 financial year, about 18% of total earnings from the present fleet of the Nigerian National Shipping Lines was used for only maintenance with ample off-hire periods due to these. This can not be accepted as these cost can be drastically reduced by careful application of automation with adequate skill to man the ships. Evaluation of type of maintenance being necessary to carry out preventive, breakdown, planned etc.; most probably common failures and reasons could be revealed and then educationally oriented towards avoiding such costly breakdowns.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION.

The depressed world economy, increased oil prices, increased labour and operating costs coupled with stringent international requirements for safety and environmental protection has greatly influenced the design and installation of equipment onboard ships.

Developing countries especially Nigeria had therefore been largely influenced by advanced maritime nations to adopt automation. These has been done without due planning for the required manpower development, shore maintenance facilities at home port and the level of technological development of the country. Thus experience with semi-automated vessels in Nigeria was a complete failure as benefits claimed through the adoption of automation as a cost reducing measure, energy saving and reliability of machinery were not realized. It must be worth noting that shipping is an international industry and in recent years more sophisticated automated systems had been applied on ships. Thus Nigerian shipowners at the present state of technological development must adopt a fairly amount of automation so as to remain competitive in the shipping trade.

Automation therefore can be advantageous if Nigeria is technically equipped both in hardware and software. But if this is not achieved, it can diminish efficiency, reliability and safety of the ship. This could result in

accidents with the possibility of total investment loss or heavy repairs with ample financial burden to the owner.

High initial investments are needed for very high technological ships and the cost of similar ships varies with suitable level of automation as suggested in chapter four of this paper. Thus the latter automation level ships is suitable for the Nigerian industry at the moment as there are limited access to capital and less skill manpower to enhance safe and economical operation.

Presently, Nigeria is plagued with severe unemployment problems; thus with these abundant supply of manpower if properly trained can be very economical and productive to both the country's shipping industry and can supply manpower to the developed nations of which are currently experiencing shortage. This will set the pace for technological development and improvement in shipping and related industries. It will also provide additional foreign earnings to the trained crews and reduce unemployment in the country at large.

Though crew costs at the moment in Nigeria is very low as compare to industrialize nations, but it should not be forgotten that the emerging industrialize nations of the Far Eastern countries like Japan, Taiwan and Singapore had similar experience. Today their crew costs had shut up and have now turn to automation to reduce the labour cost so as to be economically viable in the shipping business. Such a situation will likely occur in Nigeria as the economy and technology improve. Therefore, there is need to adopt at least minimum level of automation to keep the work force in touch with the

technology so as to facilitate a smooth change in future.

In an attempt to develop and improve the national fleet, Nigeria may request developed maritime nation for their technical and management expertise in shipping. It is wise to suggest that such cooperation in this field may have the potential bad effect of fostering rivals. As potential shipowners should embark on purchasing second hand ships which are cheap on the present market, man them with Nigerian crews and update the present maritime academy facilities for training in modern ship operation. Cooperation can be sort with the regional academies in the West Africa region which has already the equipment for training and later can equip the country's academy to do same. The level of training will be upgraded so as to familiarize maritime officers and crew with operating, fault tracing and repair procedures of modern automated ships. This would eliminate dependency on developed nations both in manpower training and technological advancement.

It is worth recommending that in vessel certification process for high technology, shipowners should conduct a thorough assessment of shipboard functions and tasks required by the particular vessel. It should also submit a functional analysis (with specified crew members and structure, skills and training, voyage profiles and operational and maintenance plans) to the maritime administration for approval. Upon conditional approval, vessels should be subjected to such sea trials as the Administration deems appropriate with logs of crew activities. Data from trials should be used to validate the results obtained from such model. (see figure 26). Unwarranted barriers

to innovation in ship operation like limited manning should be discouraged too.

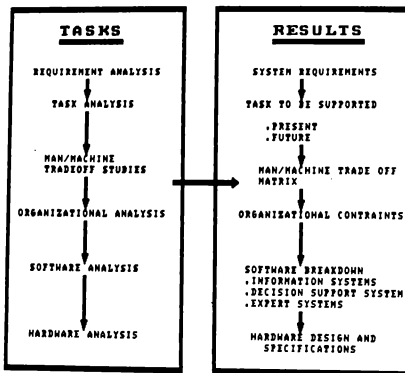


Figure 2.

With the present state of Nigerian shipping, shipowners also should opt for ships with minimum automation. The ship should be manned with fairly large number of Nigerian crews which are not very expensive and have most of the repairs and maintenance work done by the crew.

Perhaps, elimination of watch standing in engine room with adoption of minimum UMS requirement would enable day work system. This will create the possibility for the more important and efficient maintenance work to be executed as all the engine room staff can work as a team. This would facilitate better plan maintenance system.

Nigerian shipowners should never be lured into adoption of highly automated equipments, rather it have the necessity for a slow, steady adoption to be sure that equipment have proven to be dependable , reliable and safe onboard ships. Also the level to be adopted should be in conformity with technological, operational and service preparedness with associated social economical factors of the country.

Finally, it could be concluded that automation can improve system efficiency by reducing power requirements, reduce maintenance, increased sensitivity, accuracy and consistency, improved working conditions and reduced manpower requirement.

A proper design automatic control system can keep the process operating at maximum efficiency for the established limitations. A control system is extremely sensitive to any parameter in that the quality of the output and efficiency of the process are no longer limited by or even depend upon the sensitivity of the engineer. For example, a modern autopilot, in addition to its many other inputs, can measure the vessel's acceleration and it therefore can minimize the rudder applied by applying it early thereby reducing the speed

loss from the use of excess rudder. One very important engine room example is the feedwater and combustion control for modern boilers. Firemen cannot maintain the water level or the firing rate as efficiently as a well designed control system. Because of the high sensitivity of the feed water control system, modern boilers can be operated at higher temperatures and with smaller drums and therefore higher efficiency. Additionally, for processes which result in a product, use of automated control systems can improve the consistency of the product. Because all of the little inconsistencies and variations in the product which were caused by human fatigue or inattention can be eliminated thereby reducing the quality control reject rate. Even while changing ship's speed, efficiency does not have to depend on the skill of the operator if the proper control system is installed.

Employers, except those who maintain condition which are not even humane, tend to consider that improved working conditions are to both the employer's and employee's advantage because if men can be released from exceptionally unpleasant environments, job repetition and from hard physical effort, their efficiency will improve. Workers and watch keepers are normally positively impressed with new automated control systems that improve working conditions.

When an automatic control system maintains or exceeds the efficiency, reliability and safety of a manual system, then it may be possible to reduce staff. Staff reduction aboard ships has a beneficial ripple effect in that a manpower reduction implies not only a salary reduction but it carries with it a reduction in

crew support costs including the initial cost of accommodations, living and stowage space, food etc.

Processes which are being automatically controlled at maximum efficiency will probably experience less wear and fewer breakdowns than manually control systems and therefore require less maintenance. This comes about because the stresses and load placed on a system under automatic control can be less than those created by manual control. Though it is possible for the maintenance required by the control system to exceed the reduction in maintenance on process equipment, this is rare , and when considered in the light of the reduced repair costs because of reduced damage to equipment attributable to inexperienced personnel, automatically controlled systems usually cost less to maintain.

Correctly functioning automated equipment does not make human errors such as changing the throttle in the wrong direction or turning the rudder to port when starboard is ordered. If the system's safety is reduced by automating it, then serious consideration must be given to leaving it the way it was.

If proper human, technical and economic engineering design practices are used, there are no disadvantages to automatic control systems. This does not mean that everything that can be automated should. Proper design practices would not recommend automating systems which do not need it. It is true that automated systems require more design effort, skilled labour, sophisticated testing, training and equipment cost. However, if life time costs do not go down as a result of automating, then automating is probably not the right thing to do. It

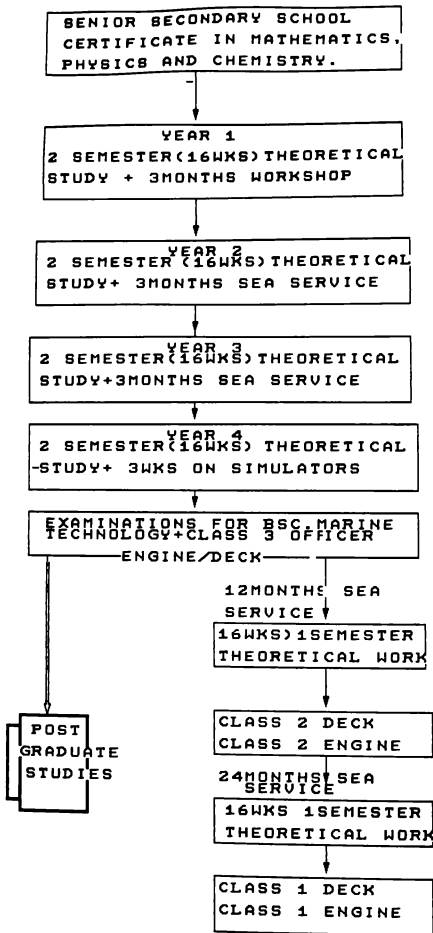
should be noted though, that automated systems which are constantly by-passed because the crews does not know how to fix it, does not like it or cannot understand its operation is probably not yielding the benefits the designer thought was available.

In conclusion, therefore, the main purpose of an automatic control system can be summarized as follows:-

- a) To relieve an operator from the tedious activity of constantly adjusting a sensitive process by hand.
- b) To improve the quality of the product or performance obtained from the plant.
- c) To increase profit.
- d) To exploit an unstable, explosive, or otherwise intractable process.

ANNEX 1

PROPOSED PROGRAMME STRUCTURE



ANNEX 2
PROPOSED SYLLABUS STRUCTURE

COMMON COURSE

MATHEMATICS
 ENGINEERING DRAWING
 WORKSHOP PRACTICE
 ELECTRO-TECHNOLOGY
 THERMODYNAMICS
 APPLIED MECHANICS
 NAUTICAL SCIENCE
 SEAMANSHIP
 MACHINES THEORY
 COMPUTERS SCIENCE
 ASTRONOMY
 MARITIME SAFETY
 ELECTRONICS
 MARINE ENGINEERING SYSTEMS
 NAVAL ARCHITECTURE
 SHIP OPERATION TECHNOLOGY
 MARINE MATERIALS

**MARINE ENGINEERING
OPTION**

MATHEMATICS
 MARITIME LAW
 COMPUTER SCIENCE
 NAVAL ARCH.
 INST./CONTROL
 PROPULSION SYSTEMS
 MACHINE DESIGN
 THERMODYNAMICS
 SHIP STRUCTURE
 SHIPPING ECONOMICS
 COMMUNICATIONS
 CONTROL SYSTEMS
 REPAIR AND MAINT.
 A/C REFRIGERATION
 ENVIRON. STUDIES
 ELECTIVE
 PROJECT.

**NAUTICAL SCIENCE
OPTION**

MATHEMATICS
 NAV. SYSTEMS
 NAVAL ARCH.
 NAVIGATION
 MARINE TRANS.
 MET/OCEANOGRAPHY
 SHIP OP. TECH.
 HYDRO SUVERVING
 MARITIME LAW
 SHIPPING ECONOMICS
 COMMUNICATIONS
 CONTROL SYSTEMS
 OCEAN TECHNOLOGY
 SHIP ECON/TRANS.
 SAFETY ADMIN.
 ELECTIVE
 PROJECT

**ELECT/ELCETRONICS
OPTION**

MATHEMATICS
 POWER GEN/DISTR.
 ELECTRONIC SYSTEM
 TELECOMMUNICATION
 NAV. SYSTEMS
 CIRCUIT THEORY
 INST./CONTROL
 MARITIME LAW
 COMPUTER SCIENCE
 MANAGEMENT
 CONTROL SYSTEMS
 COMPUTER ENG.
 ENVIRON. STUDY
 PROJECT

Bibliography

- 1) **Chapman and Hall**; Mechatronics- Electronics in product and processes.
- 2) **V. Daniel Hunt**; Mechatronics- Japan newest threat.
- 3) **Charles Edquist & staffan Jacobsson**; The Global diffusion of new technology in the engineering industry.
- 4) **Edited by J. Vliestra**; Ship operation automation III.
- 5) **C. Kuo & A.J.Thunem**; Computer applications in shipping and shipbuilding.
- 6) **Marine Engineering review March 1985**; Energy and cost saving in ship operation.
- 7) **Minister press briefing (Federal Ministry Of transport)- 1991.**
- 8) **Leslie Jackson**; Reeds Instrumentation and control system.
- 9) **Fairplay International shipping weekly**, March. 1992.
- 10) **Masato Matsumoto & Tohru Okayama**; N.K. tech. bulletin. "Views of the classification society".
- 11) **M.K.Eberle- Sulzer brothers Ltd**; Technical journal: Diagnostic system for diesel engines.
- 12) **J. Listerwnik (Professor, Maritime University-Poland**; Technical paper on bearing loads as a diagnostic factor in diesel engine condition monitoring.
- 13) **A.J.Hind**; Automation in merchant ships.
- 14) **A.Sagen** ; ship operation of the future.Tran. I. Mar.E(c).
- 15) **Y. Iijima**; Ship automation - past, present and future.
- 16) **A.Sagen**; Veritas World. Satellite assisted ship operation of the future.
- 17) **Marine Engineering/Log**. Meet the intelligent ship.
- 18) **DNV**. How can manning go with safety.

- 19) Lloyds Register Statistics; 1990.
- 20) Bouzouba; H.P. Drewery; shipping statistics.
- 21) L. Johansson; The application of electronic systems in engine room: Joint conference I. MarE and N.I. 1974.
- 22) Marine Technology; Technical Bulletin-1990.
- 23) Chr. Grum Schwensen; Coagency between piston rings and cylinder liners N.S. Jan. 1979.
- 24) Otto Martens, Geir Fiska & Helge Santory; Computerized predictive maintenance of diesel machinery IV- International symposium on ship automation. Geneva 13-15th Nov.1974.
- 25) M. Langballe; Investigations into the thermal loading of large bore diesel engine. European shipbuilding -1969.
- 26) T. Wiborg; Wear resistance of cast iron cylinder liner materials.
- 27) Sverre Bergmann; Nye sensorelementer, Teknisk ukeblad No.8 1974.
- 28) K. H. Drager; Proceedings of the 27th annual ISA conference. new York, oct 9-12th 1972.
- 29) Captain T.Darkey; Harmonization of the Maritime Education and Training system. IMLA conference New York 1992.
- 30) Barry Talyor & Rashid Klan; Naval Engineers Journal- May 1988. Integrated Machinery control- The way of the future.
- 31) The motor ship Journal Nov.1991. UMS demands require better automation.
- 32) Interviews conducted in Dec.1992 with Marine Engineers serving with Nigerian National Shipping Line.
- 33) Norwegian Maritime Research papers Nr.3 vol. 3, 1975; Condition monitoring of diesel engines.
- 34) Research papers, United states of America Maritime board 1990.

WORLD MARITIME UNIVERSITY

ADVANCED INTEGRATED CURRICULUM
FOR THE TRAINING
OF MARINE ENGINEERS IN NIGERIA

BY

EFIONG ETIM M FON

NIGERIA

A dissertation submitted to the World Maritime University
in partial fulfillment of the requirements for the award of
the degree of

MASTER OF SCIENCE


IN

MARITIME EDUCATION AND TRAINING (MARINE ENGINEERING).

1992

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

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

Signed: -----

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DEDICATION

This dissertation is dedicated to my nephew late Etim Effiong Abia. He served me honestly and faithfully, but passed away from this life during my studies abroad.

ACKNOWLEDGEMENT

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Finally, I thank my colleagues Uy Van Dang, Erdal Adnan, Farnupong Pattisink and Abebe Araya for the part play to bring what seems a hurricane task to the successful end.

To my wife and children, I am grateful for the patience, and the endurance for two year in pursuance of the programme. My wife Ikwo, was intimately involved with helping me to collect some of the information. Without which it could not have been possible. I am forever indebted to these people.

ABSTRACT

The existing marine engineering curriculum in Nigeria was designed and installed between 1977 - 78, but came into operation in 1979. It is more or less, a pattern of the United Kingdom's old system.

The programme focuses less on education but more training on shipboard operation.

The programme proved to be very useful, in that it produces skilled operators needed for ship operation. But fails to provide flexibility for someone wanting to change for new jobs ashore.

Curriculum can never be static. Not only is it unlikely that a single curriculum could ever be agreed upon, but one curriculum could not satisfactorily meet the legitimately varied educational goals. A multiplicity of paths to certificates and engineering degree would be best.

The changes in professional activities have a strong influence on objectives and contents of engineering training. The present curriculum is based on the **Standard of Training, Certification and Watchkeeping for Seafarers, (STCW), 1978**. There is a low level of trust everywhere in the convention. Its prescriptions is not only out of date with machinery but the ship design, multi-purpose programme, and automation system.

This dissertation, therefore, is necessitated by the needs to restructuring and upgrading the existing curriculum to the bachelor degree level. This is supposed to run in parallel with Certificates of Competence.

Education (NBTE), in the other hand. The paper, therefore, suggested means to either bridge or narrow the gaps.

I have used the **Standard of Training, Certification and Watchkeeping for Seafarers (STCW) 1978**, as a minimum standard for License. This level should be exceeded to meet the requirements of Nigerian Accreditation Board for purpose of degree award.

For the new approach, I have recommended the curriculum to be divided into knowledge acquisition and skill training. The idea being to maintain a balance between the fundamentals and specialization.

I have listed out the existing facilities in the Maritime Academy and the training scheme. I have also enumerated the deficiencies connected with the scheme, for which reasons the cadets and the industry are getting the real of time and investment.

For solution, I have shown in my recommendation, how the proposed curriculum can be implemented, with little or no constraint. This proposal is to take account of the drastic and revolutionary changes in the maritime industry.

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LIST OF ACRONYMS

ACP	African, Caribbean and Pacific
BIMCO	Baltic International Maritime Council
DWT	Deadweight Tonnage
ECOWAS	Economics Community of West Africa States
FOB	Free on Board
FCC	Federal Craft Centre
GMDS	Global Maritime Distress and Safety system
GCE	General Certificate of Education
IMO	International Maritime Organization
ISF	International Shipping Federation
IMLA	International Maritime Lecturers Association
MSA	Maritime Safety Administration
NNPC	Nigerian National Petroleum Corporation
NNSL	Nigerian National Shipping Line
NPA	Nigerian Ports Authority
VTS	Vessel Traffic System
FRONT-	
LOADED	A standard system of training in which the basic academic knowledge needed, is given in one continuous part prior to the skill training and experience.
SANDWICH-	
SYSTEM	The system of Maritime Education which is made up of alternate times of academic studies and skill training.

CHAPTER I

INTRODUCTION

1.1 HISTORICAL BACKGROUND

"From the dawn of history, maritime trade was carried on by merchants who conveyed their own commodities and sometimes those of others" (Rinman and Brodefors, p.10).

History shows that the geographical position of Nigeria made early contact with the European merchants possible. Nigeria comprises a number of areas formerly under separate administrations. Lagos, ceded in August, 1861 by King Dosumu, was placed under the governor of Sierra Leone in 1866. In 1874 it was detached, together with the Gold Coast (now Ghana) colony, and formed part of the latter until January 1 1986, when a separate "colony and protectorate of Lagos" was constituted".

Apparently, the United African Company had established a British interest in the Niger valley and in July, 1886 the company obtained a charter under the name of the Royal Niger Company. In January, 1900, the greater part of its territory was formed into the protectorate of Northern Nigeria.

Along the coast, the Oil Rivers protectorate had been declared in June 1885. This was enlarged and renamed the Niger Coast protectorate in 1893, and on 1 January 1900, by absorbing the remainder of the territories of the Royal Niger Company, it became the protectorate of Southern Nigeria. In February 1906 Lagos and Southern Nigeria was united into the "colony and protectorate of southern

Nigeria".

In January, 1914 the Northern and Southern protectorates were amalgamated to form the "colony and protectorate of Nigeria", under a governor-General. October 1, 1954 Nigeria became a federal state. In 1960, Nigeria became a sovereign and independent country.

1.2 GEO-POLITICAL INFORMATION

Nigeria is a Federal Republic with thirty constituent states as at August 1991. It is located on the west Africa, and falls within latitudes 4 and 14 and longitudes 3 E and 15 E. It covers a land area of 923, 768 sq.km. and is bordered to the west by the Republic of Benin, to the north by the Niger Republic and to the east by the Republic of Cameroon. Nigeria also shares a common border on the Lake Chad with the Republic of Chad to the north-east, while the Atlantic Ocean demarcates its southern coast line.

The Nigerian land mass is drained by many rivers and waterways including the two major ones, the River Niger, from which the name derives, and the River Benue. The two rivers form a confluence at Lokoja in the centre of the country from where the River Niger fans out into a delta before flowing into the Atlantic.

There are two main seasons in Nigeria; the rainy season which lasts from April to October, and the dry season, which runs from November to March. The vegetation of the country ranges from the Mangrove forest in the delta area of the southern Nigeria through tropical rain forests and the Sudan savannah in the extreme north. The temperature in the southern part of the country is somehow stable and does not normally exceed 32 degrees centigrade whereas in the north it goes from 13 centigrade to 40 centigrade.

Nigeria is a federal state. Originally, Lagos was the federal capital, but this status has been removed to Abuja the new federal capital city. Lagos now remains commercial centre and seaport.

Nigeria comprises of 30 states. The states include Abia, Adamawa, Akwa Ibom, Anambra, Bauchi, Benue, Borno, Cross River, Delta, Edo, Enugu, Imo, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Kwara, Lagos, Niger, Ogun, Ondo, Osun, Oyo, Plateau, Rivers, Sokoto, Taraba, Yobe and Abuja the federal capital territory.

1.3 SOCIAL-ECONOMIC INFORMATION

There are about 252 ethnic groups and languages in Nigeria. However, Ibo, Yoruba and Hausa are spoken, but English remains the official language of the country. Christianity and Islam are the two main religions, therefore, by the constitution the country is a secular state.

Nigeria has substantial natural resources. Properly exploited, Nigeria's fertilized land is capable of making the country self-sufficient in food. The country also has substantial quantities of minerals like petroleum, natural gas, coal, colombite, gold, limestone, manganese, tin and uranium.

Broadly, Nigeria is one the largest producers of petroleum in the World. Its production target for the first quarter of 1991 was 2.1 million barrels per day, while proven reserves at the end of 1990 were 17.1 billion barrels. Since then more oil has been discovered. The natural gas reserve are even more substantial.

The country is an agricultural country, agriculture sector of the economy employs nearly 65% of the working population. It accounts for 28% of the gross domestic product (GDP). Crude Oil sector accounts for about 30% of the GDP. However, the economy depends so much on revenue from the petroleum export, because it accounts for about 82% of the country foreign exchange requirements.

1.4 POPULATION

Nigeria's population provides a large human resource pool and it has invested substantially in education and training of its manpower. In view of its great economic potential, Nigeria is a developing country, whose economy depends largely on the export of petroleum for its foreign exchange earnings. However, with prudent management the future of Nigeria is guaranteed. It is now self-sufficient in food and its industrial base is large enough to meet domestic requirements and exports.

Population census has always been a thorny issue in Nigeria. But Babangida's administration has succeeded to produce a census that by and large is acceptable and seems reasonable to the vast majority of Nigerians. The population of Nigeria is 88,514,501. The break down against the 30 states are follows:

CENSUS FIGURES

STATE NAME	POPULATION PER STATE
- Abia	2,297,978
- Adamawa	2,124,049
- Akwa Ibom	2,359,736
- Anambra	2,769,902
- Bauchi	4,294,413
- Benue	2,780,398
- Borno	2,596,589
- Cross River	1,865,604
- Delta	2,570,181
- Edo	2,159,848
- Enugu	3,161,295
- Imo	2,485,499
- Jigawa	2,829,929
- Kaduna	3,969,252
- Kano	5,632,040
- Katsina	3,878,344

- Kebbi	2,062,226
- Kogi	2,099,046
- Kwara	1,566,469
- Lagos	5,685,781
- Niger	2,482,367
- Ogun	2,338,570
- Ondo	3,884,485
- Osun	2,203,016
- Oyo	3,488,789
- Plateau	3,283,704
- Rivers	3,983,857
- Sokoto	4,392,391
- Taraba	1,480,590
- Yobe	1,411,481
- Abuja	378,671

Country Total = 88,514,501.

SOURCE: West Africa March, 1992.

1.5 WATER\PORTS

The government has established eleven River Basin Authorities, for water resources development. The principal ports are, Lagos, Port Harcourt, Tin Can Island, Onne, Warri, and Calabar. There is an extensive inland waterway.

1.6 INTERNATIONAL ORGANIZATIONS.

Nigeria is a member of the following organizations: Economic Community of West African States (ECOWAS), Organization of African Unity (OAU), Organization of Oil Producing Countries (OPEC), Commonwealth, United Nations Organization (UN), and the International Maritime Organization (IMO). Additionally, Nigeria is a party to fourteen IMO conventions. It holds an African Caribbean and Pacific (ACP) status in the European Economy Community.

Nigeria is blessed with an abundance of marine resources. It has many rivers, lakes, and lagoons. On the south, it has a coast line of about one thousand nautical miles. It has also an annual trade volume worth more than two million metric tonnes.

It enjoys a status of a maritime state in the west African sub-region. But it is not a maritime state in a true sense of such a definition, like Norway, Japan, the United States of America and others. The fact is that the ruling colonial power, Great Britain was a great maritime state, within the true sense of such definition, and attempted to induce such maritime interests upon Nigeria.

1.7 MEANS OF TRANSPORTATION.

Naturally, seafaring is a learning while you work occupation. The main reason for this might be because the seafaring is one the oldest professions known to man. In Nigeria, coastal communities, along the bank of Oron, Cross River, Opobo Rivers, et al, used rafters, floating wood, bamboos, calabash and other forms of floaters, tied together for transportation. These floaters, were relied on ebb and flood tides.

Carved canoes (miniature boats) made out of single logs and powered by means by hand paddles were later introduced. By 1846, the canoes were highly developed and were used freely to convey passengers and goods from one coastal town to another. Fishing was prominent and was mainly the principal occupation for a good number of coastal communities as a result of improved of canoes.

1.8 THE EARLY TRAINING METHOD.

The training and education of seafarers was purely informal in approach. Broadly, man has always been able to use the oceans as a means of transportation. However, he was not a seafarer in the true sense of the word. Somehow, life at sea is different from the natural mode of living. Basically it takes several years of practical experience for one to adjust to a seaman's life.

Traditionally, an average Nigerian seafarer in those days, started a seagoing life in youth as an apprentice. The young man promised to serve the master obediently and faithfully, the master was also under obligation to teach him the art and tricks of the profession.

It is worth mentioning that international trade was under the control of the private companies. The only training schools in the country were organized by the private companies. The so-called training schools could just produce quarter masters, river-master, marine engineering assistants, et al.

1.9 COLONIAL INFLUENCE AND LEGACY.

In particular, the influence of Britain is felt in Nigerian shipping and maritime circles up to the present. Broadly, Nigerian maritime education training must be seen in that perspective. When Nigeria was a British colony, and of course even beyond that time when Nigeria was either self-governing or semi-independent, British shipping laws became Nigerian shipping laws.

There have been relatively few changes to basic evolution since then. At the present, wordings of Nigerian shipping Acts reflect the British system. One is not suggesting that something was wrong with all this. Nigeria simply followed what the former British colonies did. In between early and late 1950s, some remarkable progress was recorded in Nigerian international trade. This saw the establishment of a Ports Authority in 1950. It was not autonomous but was simply placed under the department of marine affairs.

1.10 THE NATIONAL IDENTITY

As a result of buoyant economy in the maritime sector, the following departments were created: Government Coastal Agency, Nigerian National Shipping Line (NNSL) and Nigerian Navy. Notably, immediately after independence in 1960, the Maritime Safety Division and the Nigerian Merchant Shipping Acts came into effect in 1962. (Otobo, WMU, 1985).

The problem, however, was that Nigeria was different from Britain in many ways, but most importantly, Nigeria did not have the maritime consciousness which underpinned the British maritime policy and MET. As Nigeria developed its own national identity and economy more and more, maritime considerations became less an issue. However, it also shows that a long-term Nigerian maritime policy was not in the forefront of national thinking.

1.11 NATURE OF CURRICULUM.

The pattern for an integrated curriculum for the training of the marine engineers, which this paper proposes, differs from the dual-purpose or bivalent programme. What is being proposed in this paper is a curriculum which will bring together both instructions designed to make a potential marine engineer succeed in his profession as well as give him an Academic degree. It is also suggested that consideration be given to the creation of professional degree programmes for students inclined towards practice. Such a programme, without thesis requirement, might offer a master degree of Engineering (M.E), or might be cast as a B.SC-M.E. dual degree programme.

As for a bivalent system the Nigerian economy, its work ethics and culture can not support the dual-purpose MET system. When we talk about a change in technology, we

should also keep in mind that this will bring a disruption in social settings. We often hear people ask such a question as "How has Japan sustained technological change without social and organization disruption? In this consideration, Nigeria should learn from Japan and Western approach. For instance, new technology or development is normally based on a long term view of the needs of the nation or organization and relies heavily on appropriate learning systems. Japanese problem solving ability is supported by the industriousness of its people, the standard of education, and a relatively stable labour management.

1.12 BACKGROUND PROBLEM.

The Maritime Education and Training is perhaps the least studied and understood sector of education in Nigeria. The reason might be because few of those who administrate or write about Maritime education have been through Maritime education, or it could be because the market is comparatively small.

Principally, another factor could be because of all sectors of education, maritime education is subject to constant change in response to the pressures of new technologies. This common element of change, together with other strands, unites widely different developments between Maritime education and other sectors of education.

The history of Maritime Education and Training in Nigeria can not be complete without special reference to MET in the United Kingdom. Before the first established government owned MET programme in Nigeria, MET was organized by private companies, and it was badly done. This system produced mediocre types of seafarers, even though the system was approved by the law.

In the words of Akinsoji (34), candidates for "examinations for the certificate of competency" have always had to study on their own and as a result "the performances were never commendable." He stated that in most cases examiners have had to relax to a "ridiculous level" (Akinsoji, p. 34).

1.13 ACADEMIC CONTENT

The existing curriculum lacks the necessary academic and professional contents which is suitable for the training of today and tomorrow. It is not broad-based, the change which is being proposed in this paper should result in cadets focusing on broad rather than concepts, paying more attention to social, economical and political context of marine engineering practice, as well as written and oral communication skills.

In the words of Gerald, "The engineering curriculum should be taught in the context of the real world to enable engineers policy process" the way we legislate technology today is based on law, and not on technology. Engineers (ibid) need to play a more responsible role in leading the society and explaining the technology to the society (Engin. Edu.vol.11,1988).

1.14 HYPOTHESIS.

In this case, the hypothesis is to give a short answer to the problem, to see whether the study is valid or not. Therefore the hypothesis of this study will be framed as follows:-

- A. There is no relevant difference between the existing marine engineering curriculum in Nigeria and the requirements of the Standard of Training, Certification and Watch-keeping for Seafarers (STCW) 1978, International Convention for the Safety of Life at sea (SOLAS 1974/78).

- B. There is a relevant difference between the existing marine engineering curriculum and the requirements of the Standard of Training, Certification and Watch-keeping for the Seafarers (STCW , 1978), International Convention for the Safety of Life at Sea (SOLAS, 1974/78).

1.15 SIGNIFICANCE OF THE STUDY.

This study is interested in a new approach to the training of marine engineers in Nigeria. The paper Proposes that training starts off on a clean slate. The curriculum of the existing marine engineering programme, both at the Maritime Academy and at the River State University of Science and Technology Port Harcourt, have no introductory courses that cover decision making, design, methodology, time management, study skills, laboratory report writing, philosophy and ethics an engineer may need during his years of study and life time practice.

As we observe closely, training too has come a long way

from "chalk and talk". Simulators are capable of accelerating experience in a way that was never before. They can provide much more than training in radars, to the operation of main machinery and pump room controls, cargo control handling and much more. These areas, though expensive, provide good ingredients for the training of the new breed of marine engineers.

Godson argues, " the status of subjects tends to be measured by the extent by which they moved away from the utilitarian or pedagogical traditions and have become academic" (Godson, 1983).

This becomes relevant in the sense that the existing curriculum appears to be running a race against time. The progress of marine automation and the application of other technological advancements are likely to be delayed in the Nigerian Maritime industry by a lack of well trained and educated personnel. It remains doubtful whether the number of new breed marine engineers will be sufficient to match the needs of future ships. This could only be a reality if a face lift is given to the existing curriculum.

Looking at the dramatic turn of event and development in the maritime industry, Bryan made the following observation:

the development of the microprocessors in the electronic engineering and its impact upon all facets of mechanical and electrical engineering are proving to be a watershed; and on that watershed is a signpost which indicates that the professional marine engineer needs to add a further competence to the many faceted talents which are required to design, build, and maintain the very varied structures which operate on, over or under the sea, (Tran. Imar. E (TM), vol. 97,

When we take a critical look at such areas as machinery control monitoring, alarm and safety system, optimization of machinery efficiency and others. It is this wide spectrum of ship-board use that expedite the wider introduction of microprocessor and personal computer (PC). This development calls for upgrading and updating the existing curriculum.

Figure 1.1 shows areas where micro-based system are being used in the modern shipboard system and management.

Good engineering combines the quality of common sense, good economic, and elegant simplicity. Adequate improvements in the latter two qualities are often found by stepping outside the boundaries of conventional Marine engineering practices, which have evolved through optimization rather than innovation.

Many developments in engineering came as a result of using ideas born in parallel disciplines. For instance, marine and aircraft automation depend so much on electronics engineering. Taking advantage of such new techniques may involve re-tooling and re-education of large sectors of marine industries. It is only by such adjustment and adaptation that the marine industry can survive in Nigeria.

1.16 THE SCOPE

The limit in dissertation will be a certificate of competency in the Maritime Academy of Nigeria and the bachelor of technology degree in the University of Port-Harcourt Nigeria. When the need arises, references will be made to The International Convention on the Standards of Training, Certification, and Watchkeeping for Seafarers, (STCW) 1978, International Convention for Safety of Life at sea, (SOLA).

This paper is not intended to be a report like those of experts or committees. Rather it is an academic exercise. Education writing today is in an age when criticism has overpowered creation. Awed by watchful eyes of my colleagues in the academic profession, and learned professors, I will as often as practicable, try to take refuge in professional magazines, text books, specialized dissertations, and others which can easily defend me from attack.

1.17 METHODOLOGY.

Instruments and data collection for this study will be descriptive, obtained from reference books, marine engineering journals, newsletter, newspapers, professional engineering bodies.

Data collection was also largely by means of a structural interview plan. Items on the schedule sought answers to the research questions. A random sample of some seafarers was selected for pretesting of the schedule, and the split-half reliability co-efficient of 0.72 was obtained. Some of the items were administered to the seafarers.

Near a 100 % response rate was achieved. In addition, one set of each of the unstructured interview schedules was administered to some officials in the Ministries of Education and Transport, lecturers in the Maritime Academy of Nigeria and the River State University Port Harcourt, were all inclusive in the interview. A cross section of the students and cadets in the two Institutions were also interviewed.

In view of the above, changes in the marine industry, since the last few years, have been extensive. My proposal, therefore, is to take account of the drastic and revolutionary changes.

FIG. 1.1 INTEGRATED SHIP SYSTEM

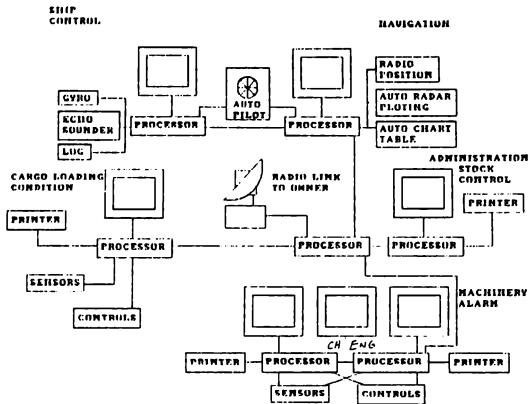


Fig. 1.1 Integrated Ship System.

Source: B. Hildrew, Institute of Marine Engineers.

CHAPTER I I

E D U C A T I O N A N D T R A I N I N G

2.1 INTRODUCTION.

Tanner maintains that, " the study of the curriculum history can identify past problems that have interfered with the curriculum reform, which may provide lessons to help contemporary curriculum workers". Curriculum specialist can, she suggests, overcome immediate difficulties by searching for similar problems in the past (Tanner 1982 p.406-07).

In 1951, Nigeria was divided into three regions namely, Western, Eastern and Northern, and education became a regional function, administered by a regional Board of Education and Ministry of Education headed by a minister.

The curriculum was an integrated one aiming at socialization and character building. At the lower level, it was traditional. Fufunwa identified seven common educational objectives around which the traditional curriculum was organized:

- to develop the child talent and physical skill.
- to develop character .
- to inculcate respect for elders and those in position of authority
- to develop intellectual skills.
- to acquire specific training and to develop a

healthy attitude towards honest
labour.

•

- to develop a sense of belonging and to participate actively in family and community affairs.

- to understand, appreciate and promote the cultural heritage of the community at large.

(Fufunwa, 1974).

In general, the existing education system provides six years of primary education, three years of junior secondary, three years of senior secondary and four years of University or tertiary system, simply cast as a 6-3-3-4 system.

2.2 TECHNICAL EDUCATION AND THE NEW SYSTEM.

The current structure of the technical education permits the existence of gaps within the various levels of this system. These gaps are clearly seen in both the old system and the present 6-3-3-4 system.

This unorderly structure makes transition from one level to another difficult. In a well designed system, it should be possible for a person to enter the system at the bottom and come out at the top, if his ability permits. Someone should be able to move freely within the entire educational system, sideways or upwards as he may choose. The author has suggested a way out of this.

2.3 NATIONAL POLICY ON TECHNICAL EDUCATION.

In 1983, the National Policy on education defined technical education as "that aspect of education which leads to acquisition of practical and applied skills, as well as basic scientific knowledge". In his definition, Olojo, (7) defines technical education as "that education designed to prepare individuals for entrance into and progress within technical educations. It requires an understanding of the fundamental laws and basic principles of mathematics, sciences and technology supported by appropriate courses". (Olojo, 1987, PP.9).

2.4 OBJECTIVES OF TECHNICAL EDUCATION.

The objectives of technical education as stipulated in the National Policy on Education (Ibid.), are as follows:

- to provide people who can apply scientific knowledge to the improvement of environmental problems for the use and convenience of man.
- to provide trained manpower in applied science, technology and commerce.
- to enable our young men and women to have intelligent of the increasing complexity of technology.

2.5. STRUCTURE OF TECHNICAL EDUCATION IN NIGERIA.

- University.
- Polytechnics.
- Colleges of education (Technical).

- Technical colleges (Maritime education inclusive)
- Vocational (After primary) and
- Pre-vocational.

2.6 NATIONAL PHILOSOPHY OF EDUCATION.

In view of what has been said, it is necessary to have a quick look at the basic philosophies of Nigerian education so that we can place technical education on its rightful place. These are:

- free and democratic society,
- a just and egalitarian society,
- a united, strong and self-reliant nation,
- a great and dynamic economy,
- a land of bright and full opportunities for all its citizen.

From the theoretical point of view, it is hard to fault the principle, as they have been put down. But what one sees in practice is that the country still has a lot of ground to cover in actualizing these ideals. And since technological progress hinges on technical education, any obstruction in the way of technical education has to be removed.

Prior to 1986, the educational system was six years of primary, five years of secondary and four years of tertiary, which in short produced a pyramid structure, with a large number of drop outs. This system was elitist, and

consequently inadequate. Worse still, each level of technical education was almost a terminus. This is shown in figure 2.1

2.7 PROFESSIONAL CERTIFICATES.

It is observed that vocational schools provide training for technicians, and the products come out with a Federal Craft Certificate (FCC), the federal college of education provides training up to National Certificate in Education (N.C.E). At present, graduates of this institution are required to spend two academic sessions for a bachelor degree.

Competency certificate, Higher National Certificate H.N.D, among others, appear not to be wanted in Nigerian Universities. What, however, is really absurd is that good HND holders are admitted straight for higher degrees overseas.

If Nigeria sincerely wants to develop technologically, she has to think over these things. No institution should be allowed to be an island unto itself. No matter how difficult the route, every academic institution must be linked in a continuous chain.

Technical education, no doubt, equips one to fit into the labour market and many of such are so reabsorbed. But provision still has to be made for that percentage of products of the technical institutions, no matter how small, who will have the aptitude and willingness to pursue further education, without let or hindrance. Apart from any thing else, this will give psychological relief or satisfaction both to those who will want to advance and those who will be content to stay on the job.

It is useful to distinguish a vocational education from a general education on one hand and vocational training on the other. My preference is for a broad concept of vocational education, which recognises that vocational education has a "dual mandate" to develop the individual both in the interests of self and of employment. If we tip the balance too far in the interest of self, then we cross the boundary into general education; if we tip it too far towards employment then we cross the boundary into vocational training.

I know there is an inherent conflict between these two elements. Its implementation always requires a compromise. The way in which this conflict is resolved may well be a question of political philosophy of national or local culture, the influence of culture is surprisingly strong in general education in Nigeria than in vocational. The way in which this will be resolved is hard to predict.

"Vocational" is often taken by an average Nigerian to mean "work related", this is fine provided the work is not always equated with immediate task, but all too often this is exactly what happens. The author has lived and worked in the United States of America, and has found Vocational education in the USA as vehicle for the entrepreneurial spirit. The main goal of the entrepreneurship in maritime education is to provide a broader look at at the career options and to identify way to reach these options.

Equally, failure to distinguish between vocational education and vocational training has led many educationists in Nigeria to use the adjective "narrow" when anything vocational is considered. This tendency results in Government negative attitudes towards Vocational Education and Training.

I regard as intellectual arrogance that all vocational education is "narrow". Take for example, electrical circuitry. Design of electrical circuit normally requires a higher level of intellectual skills than its installation. The same person who does the installation, however, may be responsible for fault-finding if the circuit is not functioning correctly; this activity may require the application of considerable knowledge and intellectual skills which are moving close to those of design, especially if the circuit is a complex one. This higher intellectual skill is likely to be developed, and the knowledge (often based on principles not of obvious immediate application) gained, through "education" rather than through "training".

The point raised above is necessary, according to Jemie, (Guardian, one national newspaper, September 1984) "Any educational system that will be effective must take into account the psychology of the people. It either tailors itself to the peoples' psychology as it exists, or works hard to transform or modify that psychology to coincide with the system".

Since rapid industrialization is our professed goal, it makes no sense to down grade the manpower with practical skills. Figure 2.2 illustrates a new system, which is also not still better.

2.8 EXISTING GAPS

Many perceive the gap between the developed and the developing world in terms of wealth, but the knowledge gap is great and is increasing just rapidly. The concept of the knowledge gap is important because it should be less difficult and costly to transfer knowledge than to transfer wealth, and the knowledge so transferred may be a generator of wealth. Such a means of overcoming the "north-south" divide alone would justify paying greater attention to the study of vocational education.

In spite of the new system, gaps can still be identified. The working relationships among tertiary institutions is still not harmonious. The Universities sit on the progress of aspirants for a University education, and prefer to have nothing to do with each other. The other institutions are also an assemblage of unrelated parts.

2.9 PROPOSAL FOR IMPROVEMENT.

In any event, it is necessary to start somewhere. The main constraint in technical education is change. One must understand the changes which are taking place and the reasons behind them before one can undertake any helpful study relating to content or the way in which discipline are best learn in different cultures. Because consistent failure to invest in Technical\Vocational education will bring disastrous consequences to our economy.

At this point, it is worth mentioning to note the remark made by the former Secretary of State George Schultz, in a key note address to the National Academy of Engineering, December 19987:

"It is as though we have a race between the Engineer and

the politician, the creators of the new knowledge and the statemen for the idea of a nation, and the concept of national sovereignty, is affected. It is long past time that the politician caught up with reality. But, if the lag between the political concept and the technological reality creates problems, the opportunities which such vast change now offers should provide us with optimism and inspiration to turn these times to our advantage"

The blueprint on technical education (1978-79) clearly puts it. "there should be an opportunity for the admission of craftsmen to technician courses, and technician to university or professional courses". No level of education should be an island, this is the heart of the matter.

The Bagauda Seminar (1980) highlighted this problem and suggested a restructuring of technical institutions, as mounting an excellent public image drive for technicians and technical education. To illustrate the interrelationship that is being proposed, a composite representation is shown figure 3.

A person should be able to progress from vocational school through technical college, and advance from craft school to Maritime Academy , polytechnics and higher degrees, if chooses. The system should not be designed to prevent this. HND holders should have no difficulty in going straight for higher degrees like his B.sc. holder counterpart.

2.10 MARINE ENGINEERING TRAINING IN NIGERIA.

Literatures on the training of marine engineers in Nigeria are hard to come by. Neither the Nigerian Shipping Act of 1962, nor the legal instrument setting up the Maritime Academy of Nigeria of 1978, showed how such training should be organized.

As disputed by Umejuru, in the parts of Nigerian shipping acts which deal with the competency certificate of chief engineer/master, and crews, no mention was made to maritime education and training, nor was there any provision in the Act except names of overseas countries where certificates of competency may be obtained", (Umejuru, 1988).

This dissertation refers to marine engineering training as 1) the supply of educated and skilled engineers to Nigerian shipping 2) the supply of educated and skilled engineers to non Nigerian shipping, 3) supply of educated and skilled engineers to Nigerian and non-Nigerian offshore oil industry, 4) the supply of educated and skilled engineers to marine related regulatory agencies at the national and international level, and 5) the supply of educated and skilled engineers in the consulting, advising and training areas at the national and international levels.

All the areas mentioned above require marine engineers that are educated and trained within the frame work of the International Maritime Organization, (IMO), as contained in the Standard of Training, Certification and Watchkeeping for Seafarers (STCW). However, the STCW level should be exceeded for the interest of future jobs mobility and for the purpose of meeting the requirements of Nigerian National Accreditation Board for the degree award.

Evidence points to the fact that there is considerable growth in the regulatory sectors every where, and Nigerian seafarers are generally welcomed abroad. In the true sense of the words, if persons are properly trained in these sectors, they can always be absorbed by the industry and its related areas.

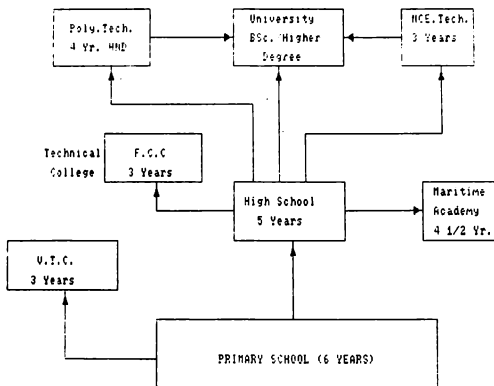
2.11 MARITIME INSTITUTIONS IN NIGERIA.

The Nigerian Federal Government provides for limited Maritime training, such as the Maritime Academy at Oron. The River State University of Science and Technology, Port Harcourt is run by that State government.

The training of marine engineering cadets takes place at the Maritime Academy at Oron. The institution prepares the trainees for the certificate of competency, and none for the academic degree. Facilities, human and material resources are grossly inadequate. Contrary to the prevailing conditions at Oron, the University of Port Harcourt trains academic engineers, with little operational exposure.

This is a situation where IMO mandatory courses are not properly handled. As a result the University cannot prepare students for licensing examinations (1)

The latter, though State controlled, is provided with excellent facilities, and enjoys a high academic prestige like its counterpart all over the country.



Key: 1 HND - Higher National Diploma
 2 FCC - Federal Craft Centre
 3 VTC - Vocational Training Centre
 4 NCE - National Certificate in Education

Fig 2.1 OLD EDUCATION SYSTEM (6-5-4)

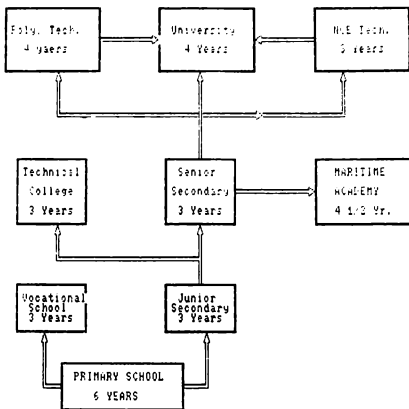


FIG. 2.2 THE NEW SYSTEM (6-3-3-4)

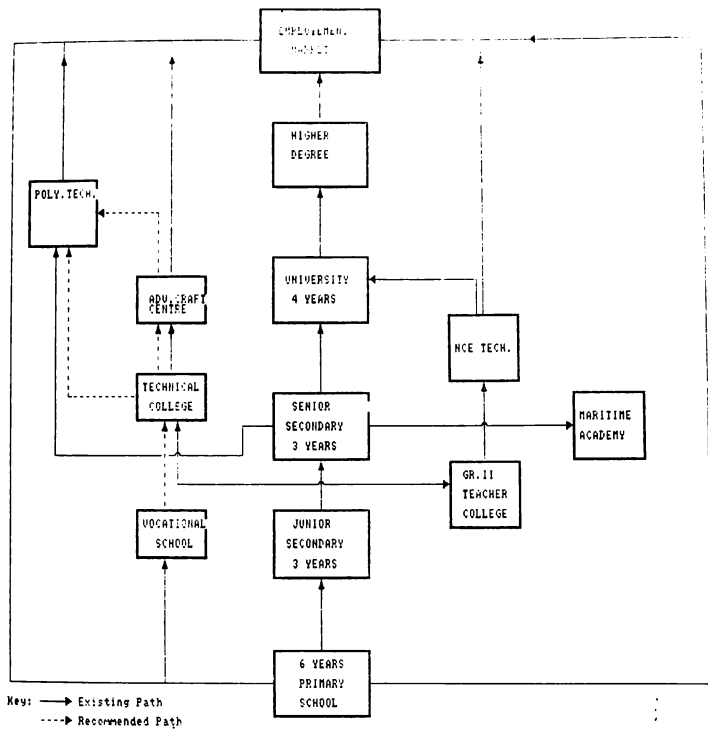


Fig. 2.3 IMPROVED NEM SYSTEM

CHAPTER III

MANPOWER REQUIREMENTS

3.1 INTRODUCTION

Shipping is an international trade. A glance at the organization and management of the industry itself will prove this right. The financial interests and management of a ship do not have to be, and often are not located, in the same country. The crews who operate the ship may come from different countries. On this point, Edward Agbakoba, (1-2) successfully argued that, "ship management does not have to be located, in the same country" (Agbakoba, 1991).

The crews who operate the ship may come from different countries, the flag under which the ship sails is no longer reflecting the nationality of the owners ("Ibid., p.2). It is on the above background, that any study, or projection of Nigeria's manpower requirements in the near future, should take into consideration, the present state of the labour market for seafarers generally and globally.

3.2 SHORTAGE OF OFFICERS.

More than half the World's ship managers say there is an acute shortage of officers. A report by Lloyds Ship Manager published in "The Sea Newspaper" (1), of March 1992, showed that some 85 percent of maritime management believe that the shipping industry is facing a serious skill shortage, particularly of engineer officers.

The worst shortages were reported in North America. However, the problem extends throughout the industry, both in the developed and the developing countries.

3.3 STATISTICAL EVIDENCE

In October 1989, a joint study by the International Shipping Federation (ISF) and the Baltic International Maritime Council (BIMCO), was undertaken. The results were released in 1990. The statistical reports of the research indicated that 400,000 were officers, while some 840,000 were ratings, available throughout the world. These figures were against an estimated 450,000 officers, and over 600,000 ratings, required to man the world's commercial fleets.

The figures clearly revealed that in 1990 there was a shortage of some 50,000 officers and a surplus of over 200,000 ratings. The source pointed out that the anticipated upturn in the global economy, would produce a 33 percent increase in the number of ships, by the year 2,000. This again, would lead to an increase in demand of some 90,000 officers.

The shortage of maritime manpower, which the study indicated would persist over the next decade. The situation is already felt. While the study perhaps naturally concentrated on the number of seafarers, it is the new appreciation of the need for improved quality that is making the numbers even harder to get. Appendix 1a and 1b, show the world-wide demand and supply of seafarers by region.

The situation in seafaring in Europe, North America and Japan has two main causes. Firstly, the economic pressures on the shipowners to recruit labour from the cheapest source, and second, the reluctance of their nationals to take up seafaring as a career. Land based marine related jobs are becoming more lucrative. Seafaring is no longer attractive as a profession, to the nationals of rich

countries of North America, Europe and Japan. Simply, because living standards ashore have risen. Conversely, the working conditions and improved leisure facilities have also increased substantially.

3.4 PERIOD OF SEAFARING.

The BIMCO and ISF study which I have earlier referred to, shows the following wastage rate among the seafarers world wide. The percentage represents the total who leave the profession from all causes (retirement, death, injury, et al). The percentage due to death and injury is very insignificant and the figures mainly represent those who leave by choice. Table 3.1 shows the short span of sea service region by region.

Region	Age	Officer Ratings	
North America, Europe, Japan	41-45	52%	53%
	46-50	78%	79%
Indian sub-continent	41-45	58%	35%
	46-50	89%	61%
Africa	41-45	92%	54%
	46-50	100%	81%
World-wide	41-45	47%	42%
	46-50	74%	70%

Table 3.1 . : Age distribution due to retirement

SOURCE: BIMCO/ISF, 1990.

Considering the figures for Africa, it shows that by the time the officers are 45 years old, 92% have taken alternative jobs ashore. And by 50, a good number have left seafaring. Empirically speaking, an average Nigerian at 40, must have taken ashore job. If he stays beyond that age he must have not been lucky to secure a new job. The trend is the same all over the world.

The question now is, where do we get manpower to staff our maritime industry ?. What quality of engineers do we have in mind to operate Nigerian's modern ship ?. Answers to these questions are clear. Maritime technology is not just an "item" that can be bought over night to develop commercial applications. Before it can be taken onboard, appropriate expertise must be in place to operate it.

Today's merchant fleet in Nigeria, should not be like some organizations, that can be "topped" up by the inexperienced. with little knowledge of law, safety, stability, stresses, automation, and commercial operations.

One does not doubt that a "sea-man" brand trained officer of the armed forces could operate fully automated merchant ship, without too much of a culture shock. But there is much more to it than , particularly in the senior officer roles on board. But one has to ask how seriously the ship will be operated, or if the intention is merely to fill the ship with sufficient warm bodies, with a qualification of some sort.

3.5 PRIORITY AREAS.

The maritime organizations in Nigeria covered in this analysis can be classified as follows:

- Nigerian National Shipping Line (NNSL)
- Nigerian Off-Shore Industry
- Maritime Safety Administration (MSA)
- Nigerian National Petroleum Corporation (NNPC)
- Nigerian Ports Authority
- the supply of engineer officers to marine-related regulatory agencies at the national and at the international levels.
- the supply of engineer officers to the private sector.
- the supply of key engineer officers to the design and ship construction.
- the supply of engineers to the training institutions.

The supply of engineering personnel to the marine sectors enumerated, in the foregoing list, shall continue to be a mirage in the next decade, unless positive action is taken, within a foreseeable future.

3.6 NIGERIAN OFFSHORE INDUSTRY.

History teaches how quickly unforeseen events can change the direction of society. But it is certain that any expanding economy needs energy from one source or another. In the near future, in the modern world, neither coal, water pressure, nuclear power, nor sunlight are likely to replace the central role of gas and oil. In providing immediate, clean, comparatively inexpensive sources of energy. Especially as fuels for special demands, for commercial transportation and military machines.

In view of all efforts at diversification, Nigeria depends increasingly on its earnings from oil. In 1990 oil constituted 96.1% of total exports (94.6% in 1989). Surprisingly, the Gulf War had a large impact on the government's economic expectations. For instance, in mid 1990, before the Gulf crisis, the price of Nigerian crude oil was \$16 per barrel, by October this had risen to \$32. This windfall resulted in development of a new export terminal for petroleum products at Bonny, River State, as part of a major oil rehabilitation plan. The terminal is expected to reduce bottlenecks.

3.7 EXPENSIVE COMPONENT.

By far the biggest cost component of offshore oil production, in Nigeria is transportation. My personal experience with the Mobil Oil Production, at the Qua Iboe Offshore operation, Eket - Nigeria, led me to this conclusion. This cost does not refer to the supply of boat and helicopter aspects of getting supplies and personnel to the field facilities. But to the daunting prospect of how to get trained indigenous personnel to move output the product to the world market from the remote locations.

The choice between pipelining and tankering depends on individual circumstances, of each field development, such as production site location. For instance, at Qua Iboe Offshore location, there is no gas pipeline and no insurmountable technical barriers to tanker transportation. In a situation like this, tankers are almost certainly the transport answer. Securing manpower to fulfil this area, remains a distant dream.

3.8 OFFSHORE GEOPHYSICAL VESSELS.

Two major systems have been developed for the offshore exploration, namely, Marine Geophysical vessels, for reconnaissance exploration, and drilling rigs for a range of offshore water depths and sea conditions. These vessels require marine engineers, with a high degree of intellect and exceptional ability, to operate the sophisticated equipment installed onboard.

In the words of Edgard Driver and H. Sholnick: "geophysical research vessels are the pathfinders in offshore exploration" (1-7). Their role is to gather the data needed to guide the drill to the most favorable sites. Illustrative of the state of the art is figure 3.1 The diagram of the vessel shows the complement of geophysical, geological and geochemical equipment on board, which include the seismic, gravimeter, magnetometer, underwater seep detector, bottom cover, and computer systems. More than fifty senior marine engineers will be required in this single sector before the end of this decade.

Assessing political, economical, and oil prospects in Nigeria Micheal Ridd made the following comments in Lloyd's List of May 14, 1992 :

as a result of fiscal reforms, linked to the implementation of an integrated oil and gas strategy, experts are confident of substantial growth well into the 21st century. Major oil field developments are proceeding rapidly, with such prestigious companies as Mobil, Chevron, Agip and Shell committing huge volumes of capital, well in excess of \$10bn, between now and the end of the decade. Production capacity is again increasing after a year of decline. Nigeria is producing some 2.1m barrels of crude oil per day, production capacity is projected to rise further towards a projected figure of 2.5m barrels per day by the mid 1990s.

The start-up date for the first Liquidified Natural Gas (LNG) project is late 1996, with an estimated construction cost of \$3.7bn. Before then, the oil industry would have expanded. Proven oil reserves, which currently stands at 17bn barrels, are expected to rise to 20bn barrels by 1995, when daily production should have risen to 2.8m barrels compared with 2.1m barrels in 1991.

As I did mention in the previous paragraphs that the space available for the nation's carriers did not expand with our growing trend of the volume of trade. Petroleum export from early 1970s to 1990s is shown in table 3.2

CRUDE PETROLEUM OIL SHIPPED AT ALL NIGERIAN OIL TERMINALS

1970/71 - 1987

Year	Crude Oil Shipped (in tonnes)	Index Number (1970-71 as base)
1970-71	50,169,763	100.0
1771-72	77,946,573	155.4
1972-73	92,430,673	184.2
1973-74	94,717,879	188.8
1974-75	102,375,308	204.1
1975-76	97,037,938	193.4
1976-77	100,313,452	199.4
1977-78	93,648,251	186.7
1978-79	102,371,874	204.1
1979-80	105,032,673	209.4
1980*	68,227,943	126.0
1981	61,153,673	121.9
1982	51,824,276	103.3
1983	59,892,104	119.4

1984	61,703,669	123.0
1985	71,084,559	141.7
1986	65,874,867	131.3
1987	57,193,091	114.0

Table 3.2

Source: Nigerian Ports Authority Statistics Section Lagos.

From the above evidence, it will be seen that as much gas and oil remain to be found under our ocean, as already has been found under dry land. The human factor of training and safety, must be explored.

3.9 NIGERIAN NATIONAL SHIPPING LINE.

The Nigerian National Shipping Line (NNSL), was officially established in 1959. It all started with two ships, later five, and presently, it has thirteen as at March, 1992. The whole fleet are conventional and break bulk types. The initial concern of the NNSL was to give liner services to the Nigerian shippers. The under tonnage of the National fleet has resulted in Nigeria's inability to implement the United Nations Conference Trade and Development (UNCTAD) code of 40: 40: 20 policy.

In the United Kingdom - West African Lines Joint Service (UKWAL), Nigerian cargo accounts for 84 percent of the overall trade. Yet the bulk of the cargo goes to the U-K flag ships. This went to the extent that three U-K companies viz, Elder Demster, Palm and Guinea Gulf were found guilty of abusing their dominant positions in West African trade. They were fined FFr105m (\$18.4m) by the

European commission, (Lloyds List April, 1992).

As pointed out earlier, Nigeria is a great generator of business for liner shipping companies operating in West Africa, even the so called Francophone countries. Nigeria traditionally accounts for about 60 percent of the cargoes carried. Nigeria is country with a big volume of trade, but with insufficient tonnage with her national carrier.

Nigeria is known to be the greatest generator of the seaborne trade in West and Central African sub-Sahara region. In a nutshell, Nigerian international trade in the region accounts for about 60 percent, if not more. Tables 3.3 and 3.4 show Nigeria foreign trade with U-K and the whole world respectively.

The trade between Nigeria and U-K, (according to the British Department of Trade returns):

Commerces total trade in million Naira Nm for 4 years; oil accounts for 97% of exports in 1988.

	1984	1985	1986	1987
Import (c.i.f)	7,200	8,300	6,700	15694
Exports and Re-exports (f.o.b)	8,700	12,600	6,800	29578

Total trade between Nigeria and U-K, (according to British Department of Trade returns, in £1,000 sterling):

	1987	1988	1989	1990
Imports to U-K:	159,386	128,123	129,406	297,436

Exports and re-export from UK:	481,568	330,476	388,777	499,838
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TABLE 3.3

SOURCE: British Department of Trade.

NIGERIAN AND NON-NIGERIAN INTERNATIONAL TRADE IN METRIC
TONNES

	1988	1989	1990
Nigerian cargo	174.3	165.6	175.6
Non-Nigerian cargo	87.5	108.9	85.6
Overall	261.8	264.5	261.2
Nigeria % overall	67%	62.6	67%

TABLE 3.4

SOURCE: UNCTAD Year Book, 1991.

Judging by the available records of Nigerian seaborne trade, it is convincing, that double the existing number of ships, in national the fleet, will be acquired. Therefore, needs for the training of more than 50 engineers for this sector, is going to be eminent.

3.10 NIGERIAN NATIONAL PETROLEUM CORPORATION

Oil was found in Nigeria 1958. The Nigerian National Petroleum Corporation (NNPC) was established in 1957. The company has four cardinal areas to cover under its activities, viz; exploration, refining, production, processing; the Department of marine transportation was also added to it. Unfortunately, the corporation has no tankers.

Crude oil is at present shipped out almost exclusively by foreign oil companies at the rate of 1.5m barrels per day, at the cost of about \$1 a barrel in freight. Official attempts are now under way to stem this flow of foreign exchange. One of the ways to get this done is for the government to implement a 1987 law which obliges the Nigerian Maritime Authority (NMA) to involve indigenous carriers in the transport of 50% of the crude oil.

The only two tankers of 240,000 GRT. and 400,000 DWT, the company owns are being used as storage facilities. Evidence is very strong, that the corporation will soon go into transportation. This single area again, will call for specialized training for engineer officers.

3.11 NIGERIAN PORTS AUTHORITY (NPA)

Nigerian Ports Authority (NPA) was established in early 1960s, so far it controls about 8 container ports. Container traffic levels at the ports controlled by the Nigerian Ports Authority increased significantly in 1991.

According to Lloyd's List, Friday May 15 1992, "the container traffic throughput at the NPA facilities totalled 2.42m tonnes in 1991, up 34.4% over the 1990 level of 1.8m

tonnes, an increase of 31%, while containerise exports rose 43% from 401,000 tonnes to 575,000 tonnes"

NPA ports handle 223,135 tue in 1991, compared with 173,559 tue for the previous 12 months. The Lagos container terminal accounted for more than half the country's box movements. Part of the increase in the NPA container volumes is accounted for by the inclusion of the Lagos ro-ro port for the time.

In many ways, the take over of the ro-ro operation at the Tin Can Island was the main development in Nigerian Ports industry. NPA management is looking to tackle its manpower problems by zoning the Ports under its control and employing the services of the foreign partners to assist in the maintenance of plant and equipment in these ports. This is a typical situation where services of well trained could have been utilised. See table 3.5 for the Container traffic in the ports within the NPA controlled.

PORT	1990			1991		
	Import	Export	Total	Import	Export	Total
Lagos	53,803	33,523	87,326	62078	52920	114998
Tin Can Island	28,846	21,638	50,484	17,829	13,574	31,403
Lagos ro-ro port.	-	-	-	17,339	15,808	33,146
Kirikri	2,389	2,945	5,334	2,672	4,386	7,058
Port- Harcourt	4,406	4,045	8,451	5,722	5,090	10,812

Port- Harcourt (B)	4,458	4,581	9039	5,355	4,894	10,249
Onne Fed. Terminal	4,525	4,592	9,117	4,197	4,654	8,851
Calabar	670	154	824	451	296	747
Warri	1,174	1,810	2,984	3,904	1,967	5,871
<hr/>						
TOTAL	100,271	73,288	173,559	119,547	103588	223135

Table 3.5 Throughout of Container Traffic (teu) at Nigerian Ports Authority (NPA). Import and Export 1990-
Source: Nigerian Ports Authority Lagos.

3.12 THE PRIVATE SECTOR

The Indigenization decree number 4 of 1972 reserves certain rights in shipping policy for Nigerians. This was reinforced by the Nigerian National Maritime Authority decree number 10.

The Nigerian National Maritime Authority has so far granted National carrier status to the following indigenous companies: African Ocean Lines, Bulkship Nigeria Limited, Niger Brass Shipping company and Nigerian Green Lines. The National Maritime Authority may grant national carrier status to the company if:

- Nigerian individuals or enterprises are fully owned by Nigerian individuals who have at least 60 percent of its equity shares and the company is registered in Nigeria.

- the vessel is owned by the company operating on the deep sea and on the Nigerian coastal or inland waterways;
- the head office of the company is located in Nigeria and its management and control is directed from its Nigerian head office;
- the company owns at least one ocean going vessel of not less than 5,000 net registered tonnage;
- the terms and conditions of the employment of the seafarers engaged by the company are in conformity with Nigerian Laws and accepted by the international rules and standards;
- the vessels of the company are registered in the Nigerian Register of Ships and the vessels satisfy all conditions stipulated in the Nigerian Merchant Shipping Acts of 1962 as amended; and
- 100 percent of the crews and at least 75 percent of the shipboard officers including captain and chief officers and wherever possible chief engineers, are Nigerians.

Putting together, man power demand in the private sector may equally pose a serious threat, to implementation of the lofty and noble ideas of the indigenization policy.

3.13 TRAINING INSTITUTIONS.

The teaching subjects, such as automation, electronics, Electrical machines, computer engineering, engine and bridge simulation training et al, requires lecturers with outstanding ability and qualification and additionally, seagoing experience.

The question now is, who will be the trainers, and how will they complement their academic degrees with industrial experience and professional qualifications. To address this question, lecturers must regularly update their knowledge through research and contacts with industries. Since this sector is worst hit by the shortage, special fund should be created to take care of the situation.

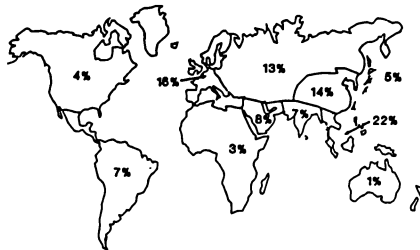
3.14 CONCLUSION.

In spite of the apparent national need for trained Marine engineers, the government and many companies have failed to provide much encouragement. Both sectors need to recognize and react to the challenge by working with the Maritime Academy and professional societies toward solutions. The initiative probably must be taken by the latter two groups. The federal is the largest single employer of technical personnel. Despite protestations in support of technological excellence, however, the government has yet to take the lead in promoting continuing education and training among its own engineers or those of its major contractors. Both attitudes of the federal government and that of the professional Union can probably be best described as being neglect.

Area like dock yards which are the life blood of the shipping industry have a teething problems of manpower shortage. Niger Dock, which started operation in 1986 had a turnover in 1990 of Naira20m (\$2.12m). It is to be upgraded into a ship building yard capable of constructing vessels up to 1,000 dwt before the end of 1992. According to its project director, Namdi Dzobia, Nigerdock has already constructed a passenger ferry, but its main operations involve the repair of vessels owned by the NNSL, the Nigerian Ports Authority (NPA) and Mobil.

The Ship construction sector is seasonably oriented or dependent on economic factors, beyond direct control of the industry. Conversely, marine engineering orientation requires a certain basic, well-trained labour force which is available to serve Nigerians and, if required, international demands. However, it takes time to train a "front loaded" marine engineer, so that if economy improves they can be found just any where.

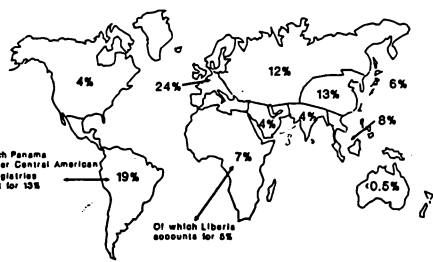
Regulatory and Safety Administrations are yet to get sufficient manpower for their activities. To speak frankly, a country which has maritime interests is manifested by a marine industrial base by the nine sectors outlined above, consequently, it requires fairly centralized marine training to ensure a stable, well trained personnel base to meet its own and its international commitments and obligations.



Total world seafaring supply = 1.2 million in 1990

Fig. 3.1 Supply of seafarers.

source: ICS/BIMCO



Of which Panama and other Central American open registries account for 13%

Of which Liberia accounts for 6%

Total world demand for seafarers in 1990 is estimated at 1.06 million

Fig. 3.2 Demand of Seafarers.

(Courtesy of Bimco/ISC).

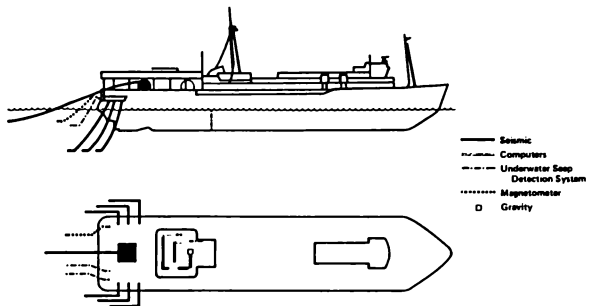


Fig. 3.3 Geophysical Research Vessels.
 Source: Gerard Mangrove. Future of Gas and Oil.

CHAPTER IV

MARINE ENGINEERING EDUCATION AND TRAINING.

4.1 INTRODUCTION.

As pointed out in chapter two, technical education came into thinking of Nigerian government between late fifties and sixties. By 1900, colonial government existed almost exclusively to guarantee the repatriation of profits from commercial venture to England. Maritime education including the curriculum was left in the hands of the missionary societies.

The "Tuskegee philosophy", (237) developed by Booker Washington (ibid), was exported to Nigeria. A curriculum was to be designed for vocational training. The curriculum was designed to foster a differentiated educational system, that is one to train African leaders, the other for masses. This curriculum model was based on the premise that African would forever doom to backwardness of rural servitude, while a privilege few would be trained to administrate and conduct the business of the colonist. Therefore, nothing was done about MET, nor Marine engineering in particular.

4.2 HISTORICAL BACKGROUND: 1978-1988

Maritime Academy of Nigeria Oron, Akwa Ibom State, was established in October 6 1979. But Babangida's Administration in April 22 1988, promulgated the Maritime Academy Degree as contained in the Federal Government gazette number 27 of 1978, volume 75. This instrument then changed the name of the institution from the Nautical College to the Maritime Academy of Nigeria Oron.

4.3 LOCATION OF THE MARITIME ACADEMY

The Maritime Academy of Nigeria is sited in ancient town of Oron. Oron is a boarder town between Nigeria and Western Cameroon. It is of one the two busiest fish market town after Port Harcourt in Nigeria. Oron can be reached by air, road and water, it is also a gate way to the ancient town of Calabar the capital of Cross River State of Nigeria.

4.4 ORGANIZATION STRUCTURE

The Academy is under the federal Ministry of Transport. From the inception, the affairs and policies affecting the destiny of the premier institution were directed by the ministry. It was in 1988 that the so-called autonomy was granted to the institution, since then it took nearly two years before the governing council was appointed. The policy making and management now rest with the governing Council of the Academy.

The day to day administration of the institution is done by the full-time rector, who is assisted by the vice rector. The Registrar and the Bursar are also key officers of the Academy, students' supervision and orderliness is assured by the Regimental unit of the Academy. See fig. 4.1. The Organization Chart.

MISSION - To train young men as officers in the Nigerian Merchant Marine and as leaders in the Maritime industry.

4.5 THE OBJECTIVES OF THE ACADEMY

- To admit and train the various levels of personnel required for running and operating ship of the Merchant navy;
- To train technical manpower for Ports Marine Engineering, Workshop, piloting and navigation, Marine Insurance, Hydrography and related services;
- To provide such other forms of instruction as the Academy may from time to time decide to undertake.

4.6 THE POWERS OF THE ACADEMY

- "To provide courses of Instruction and training;
- In marine technology, including marine Engineering, Navigation, Applied Marine Sciences, Shipping Business and the management thereof and any other courses as may be approved by the council from time to time;
- In maritime sciences related to the needs and development of Nigeria in areas associated with Maritime Affairs; and
- In applied research in Maritime Technology and related activities.
- To arrange conferences and seminars;
- To encourage and promote in-service training and study groups;

- To hold examinations and grant or award diplomas and other distinctions to persons who have pursued course of study approved by the council and have satisfied such other requirements as the council may lay down;
- To demand and receive from any student or from other person attending the Academy for the purpose of instruction for such fees as the council may, with the prior approval of the Minister, from time to time, determine,
- To hold public lectures and undertake printing, publishing and bookselling;
- To make gift for any charitable purpose;
- To undertake any other activity appropriate a Maritime Academy of the highest standard".

4.7 EXISTING MARINE ENGINEERING CURRICULUM

Maritime Academy of Nigeria provides four and half years academic programme leading to the class two certificate of competency (foreign going). From the Maritime Academy's brochure, the curriculum is sub-divided into 5 parts and spread over four and half years. This means that each part constitutes one academic year duration (i.e approx. 9 months), followed by 2 months industrial Training Programme. Every Academy year is further broken into 3 modular terms.

The Education and Training period of 4 1/2 years comprises of four phases:

Phase 1a -The first two years, comprises four semester of
basic academic and professional studies.

Phase 1b- 6 months of industrial training in marine or
mechanical workshops and dockyards.

PHASE 2 - 18 months sea training.

PHASE 3 - 20 weeks mandatory and preparatory courses, before proceeding for the certificate of competency examination. This arrangement is shown in fig.4.2

The curriculum for the basic studies at the Maritime Academy Nigeria covers courses required for the certification of marine engineers in accordance with the International Convention on the Standards of Training and Certification and Watchkeeping for Seafarers (STCW 1978).

4.8 CORE SUBJECTS AREA

The composition of the engineering core subjects are as follows:

- Control engineering;
- Electronic
- Electrotechnology
- Engineering drawing
- Fluid Mechanics
- Internal Combustion engines
- Naval Architecture
- Steam engines
- Strength of material
- Theory of machines
- Thermodynamics

The curriculum structure for the academic study and practical training for the above course is subdivided into five parts and spread over 4 1/2 years. As pointed out earlier, each part is for one academic year duration, followed by a 2-month Summer Industrial Training Programme. One academic year is further broken up into three modular terms.

The subjects to be studied for each part of the programme are given below, followed by a detailed outline of the modular courses for parts I, II, and III.

Course subjects	Total Hours	NO. of Terms								
		1	2	3	4	5	6	7	8	9
Mathematics	28	6	6	6	6	-	-	-	-	-
Physics	12	-	4	4	4	-	-	-	-	-
Chemistry	9	5	4	-	-	-	-	-	-	-
Communications	6	-	4	2	-	-	-	-	-	-
Liberal Studies	6	4	-	-	2	-	-	-	-	-
Naval Science	3	3	-	-	-	-	-	-	-	-
Fluid Mechanics	6	-	-	-	-	-	-	-	-	-
Theory Machines	12	-	-	-	-	6	7	-	-	-
Steght.of Mats.	12	-	-	-	-	-	6	6	-	-
Thermodynamics	12	-	-	-	-	5	6	-	-	-
Elect.Technology	12	-	-	-	-	6	6	-	-	-
Engin. Knowledge	18	-	-	6	6	6	-	-	-	-
Humanities	12	-	-	-	-	-	-	4	8	-
Control Engineering	6	-	-	-	-	-	-	6	-	-
Theo.& Constr.	18	-	-	-	6	4	4	4	-	-
Knowelge	6	-	-	4	-	-	2	-	-	-
Engin.Drawing/Design	30	4	4	4	4	4	4	2	2	2
Boat Work	12	4	4	4	-	-	-	-	-	-
Workshop Practice	36	4	4	4	4	4	4	4	4	4
Project/Elective	10	-	-	-	-	-	-	4	10	-

Total practical (vocational) Training for Engineers:

- (i) In the Academy Workshop from term 1 to 9 - 360
- (ii) On National Flag vessel un the summer between term 3 and 4

COURSE STRUCTURE IN THE SCHOOL OF MARINE ENGINEERING

Term I (OCT.-DEC.)					Term 2 (JAN.-MAR)				
Subject Descript.	Hrs/Week				Subject Descript.	Hrs/week			
	L	P	T	Total		L	P	T	Total
Maths.I	4	-	2	6	Maths.II	4	-	2	6
Chemistry	3	2	-	5	Phys. I	3	1	-	4
Lib.Stud.	4	-	-	4	Comm.	4	-	-	4
Boat Work	-	4	-	4	Boat Work	-	4	-	4
W/S Pract.-	4	-	-	4	W/S Pract.-	1	3	-	4
Naval Sci	-	4	-	4	Engr.Draw.	4	-	-	4
Term Hrs/wk.	30			27	Total Term Hrs/wk.	26			

FIRST SUMMER VACATION (JULY TO SEPTEMBER)

Cadets will be required to make a short voyage of 2 months duration on National Flag Ships. During this period they receive practical training on various aspects of Running and Maintenance of Marine Machinery.

TERM THREE					TERM FOUR				
Subject Descript.	Hours/Week				Subjects Descript.	Hours/Week			
	L	P	T	Total		L	P	T	Total
Mathematics	4	-	2	6	Mathematics	4	-	2	6
Physics	3	1	-	4	Physics	3	1	-	4
Communs.	2	-	-	2	Liberal Studies	2	-	-	2

MarineEngin.6	- - 6	Fluid Mechanics	4 - 2 6
Engin.Draw.	- 4 - 4	National Knowled.	4 - - 4
Boatwork	- 4 - 4	Engin.Drawing	1/2 3 1/2 4
M/B Pract.1/2	3 1/2 4	Workshop Pract.1/2	3 1/2 4

Term hrs/Wk	30	Total	TERM Hrs/Wk	30
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TERM FIVE

TERM SIX

Subject	Hours/Week	Subject	Hours/Week
Descript.	-----	Descript.	-----
	L P T Total		L P T Total
Mathematics	3 - 1 4	Theory of Mach.	4 1 1 6
Thermodyna.	4 1 1 6	Strength of Mats.	4 1/2 1/2 6
Marine Engin.	5 1 - 6	Electro. Tech.	4 1 1 6
Ship Theory	3 1 2 6	Theory of mach.	4 1 1 6
Construction	3 - 1 4	Construction	3 - 1 4
Engin.Draw.	1/2 3 1/2 4	Engin.Drawing	1/2 3 1/2 4
Workshop pract.	4 - 4	Workshop Pract.	- 4 - 4

TERM SEVEN

TERM EIGHT

(October to Dec.)

(Jan. to March)

Subjects	Hours/Week	Hours/Week	
Description	-----	-----	
	L P T Total	L P T Total	
Theory of Mach.	4 1 1 6	Electro.Tech.	4 1 1 6
Strength of			
Materials	4 - 2 6	Engin. Econ.	4 - - 4
Thermodynamics	4 1 1 6	Control Engin.	4 1 1 6
Marine Engin.	5 1 - 6	Ship Theo. &	
		Construction	3 - 1 4

Engin. Design	1	1	-	2	Engin. Design	1	1-2
Workshop Pract.	1/2	3	1/2	-	4	Workshop Pract.	1/2 3 1/2 4
						Design Project	- - - 4
Total Term Hours/Week				30	Total Term Hours/Wk.		30

TERM NINE
(April to June)

Course Subjects	Hours/Week			
	Description	L	P	T
Maritime business	4	-	-	4
4 Personnel Management	4	-	-	4
Ship Theory	3-	1	-	4
Nautical Knowledge	1	1	2	4
Engineering Design 1	1	2	4	6
Workshop Practice	1/2	3	1/2	4
Design Project/Elective	2	-	1	3
Total Term Hours/Week 29				

KEY: L - Lecture Hour

P - practical

T - Tutorial

4.9 MANDATORY COURSES

This is the final stage of the programme and is always given in the Arab Transport Maritime Academy Egypt. The approved subjects within Mandatory courses are:

FA 01 First Aid: 20 total hours

FF 020 Fire Fighting: 30 total hours

PS 030 Personal Survival: 30 total hours

As stated earlier the Mandatory courses are done in AMTA in Egypt, however, arrangement has reached an advanced stage for the courses to be conducted in Nigeria, before the end of 1992/93 academic year.

4.10 LEADERSHIP/PHYSICAL EDUCATION TRAINING

The leadership and physical education play decisive roles in education and training of cadets in the curriculum. This is seen as means to implement the whole training processes, through discipline and loyalty. Hence, the institution is a para-military.

The Regiment is led by a senior naval officer, assisted by junior naval personnels of the commandant. This system helps to set a high standards of personal appearance, conduct, team work and leadership that are in keeping with the finest tradition of the seagoing service. As some of us are familiar, regimental system is a process which assists in developing the leadership potential of cadets through:

- Ability to perform well under variable conditions
- Obedience and prompt response to instructions
- Pride in oneself and in one's profession
- Know of one's professional duties
- An unyielding sense of duty
- Military bearing and pride of one's personal appearance
- Physical fitness and mental adjustment
- An ability to work with other people
- An understanding of positive leadership skills.

The Regimental system is also a means through which upper midshipmen practice leadership through interpersonal skill example. It is the goal of the regimental system to develop leadership trails in upperclass cadets that will enable them lead other cadets through positive motivation. In keeping with this objective, the Regimental system assist the cadets in developing:

- concern and interest in the development of junior ones
- Professional knowledge and skill
- The techniques of firm but considerable leader
- Sound experience in teaching and counselling.

4.11 FACILITIES

The Maritime Academy has the following facilities :

- 1 A training ship
- 2 2 stand by generating plant
- 3 36 class rooms (including lab.)
- 4 2 technical drawing rooms
- 5 2 radar simulators
- 6 1 engine room workshop
- 7 1 engine room simulator
- 8 1 workshop for Lathe, Welding and forge machines
- 9 1 library
- 10 2 sports ground
- 11 1 accommodation for 200 students
- 12 2 restaurant
- 13 1 students' common room for with bar
- 14 1 typing pool office.

4.12 TEACHING STAFF

This area has been the major problem that plagued the 14-year old institution. Frankly, this has also been the most neglected sector right from the inception of the Academy. The staff strength of the engineering faculty as at now stands at:

Lectures - 2 (full time)

Assistant lecturer - 2 (full time)

Senior instructors - 2 (full time)

Part time lecturers- 2

TOTAL - 8

1.13 THE WEAKNESS OF CURRICULUM

Broadly, before an attempt is made to assess the success or failure, its merits and its drawback, its pluses and its minuses. We need evaluation as limit to an assessment of the outcomes of this curriculum, or, even more narrowly do an appraisal of the extent to which it had been successfully delivered. And how much it has solved the Maritime goals of the nation and meeting the IMD requirements on Standard of Training Certification and Watchkeeping for Seafarers.

There have been no worked out plan for the training and retraining of teaching staff. The curriculum has stagnated for more than a decade without a single review, and there is no prescribed means to evaluate it. On this point, Kelly made the following observations:

developments in evaluation theory in recent years have shown the evaluative process within education to be a highly sophisticated and complex matter.

He has, among other things, revealed the need for evaluation to be seen as part of the process of the curriculum change or development from the very onset. The current curriculum lacks a mean of constant feed back of understandings to inform the process of revising, modifying, adapting and indeed, restructuring, the original plans to reflect the experience of attempting to implement them.

4.14 ENEMY OF COMPETITION

Few desperate Nigerians have tried to give different reasons why the Academy remains so long without enough teaching staff. Out of desperation they complained about the sitting of the Academy of at Oron. For those who were honest enough, they talked about poor salary structure, that they should be paid the previous salaries they earned while working 24 hours onboard ship.

Some of these are people who were trained with the public fund. Obviously, the salary is poor, but this is a global problem in class room situations, the story is the same world-wide. At least a college professor in Nigeria earns same salary as his director-general counterpart in the Ministry. Generally, the salary structure in tertiary institutions in Nigeria is far more better than in the civil service.

What I will try to avoid is building bridges between what I said in the previous chapters and what I have written recently. Some foreign experts were seconded by the International Maritime Organization (IMO), to the Academy the same Nigerians Seafarers intimidated the said experts, and they left without replacement. From the author personal experience an average Nigerian seafarer finds it extremely very inconvenience to work with academicians. Whereas in Europe, America and Japan the University lecturers and maritime experts are working hand in hand to promote maritime education programmes in their Academies.

There is an obvious basic hypothesis that whatever

interferes with the competitive process is bad. There is seemingly, however, an implicit view that these things might have hit the cadets harder than they did to the image of the Academy. The classical example of this assertion is a case of Dr E. Emmah, a veteran Naval Architect and a Consultant. He came in briefly as a partimer, but rendered invaluable services within a very short time. At the end, he was badly treated and he left, since 1989 that he left, the subject has remained without qualified lecturer to teach it.

As Benard Crossland, (5) pointed out, " It should no longer be possible to have people who are proud of their ignorance of Mathematics, Science and technology" The acceptance of broad based education for the Academy would impose considerable strains on our maritime education system, which is even now suffering from a chronic shortage of lecturers in relevant subjects. There is no alternative to paying the going rate if we are to overcome this shortage, even if this has to be achieved by a scarcity award on top of normal teachers' scale. What is important is that people must be patriotic, most probably those who were trained with public fund.

4.15 ADMISSION

Generally, admission to the Academy is by competitive entrance examinations. Academy admits 40 - 50 students a year, but admission is strictly based on the qualifications of the applicant and is granted without regard to ethnic, religion and state of origin. Successful applicants should meet the requirement for the admission as stated below:

The applicants must be high school graduates or holder of a high school equivalent certificates, preferably West African School Examinations Certificate (WAEC), or GCE "O"

level. The following courses are the minimum required for admission without exception:

Mathematics - credit or distinction

English Language - credit or distinction

Physics - credit or distinction and

Chemistry - credit or distinction

The entry level has been raised since 1989 with abolition of the remedial programme.

Additionally, applicants must be medically fit to withstand the strenuous training and exercises. It should be borne in mind that the entry qualifications for the Maritime Academy in Nigeria is the same as University.

4.16 MARINE ENGINEERING CURRICULUM IN RIVERS STATE

UNIVERSITY PORT HARCOURT

The Marine Engineering Department offers a 5 years programme leading to bachelor of Technology degree in Marine engineering. The first two years of the 5-year programme are devoted to advanced courses in basic science and fundamental engineering concept. Lectures, tutorials and laboratory work are routed in broad-based, strong scientific background to enable the students to acquire the necessary skill in analyzing and solving complex engineering problems.

The minimum duration of the B.Tech. programme in marine Engineering is five years (10 semesters) comprising both classroom lecture and supervised industrial work experience scheme period. Nine semesters of course work are spent in the University made up of two semester in each of years I,

II, III, and V and the first semester of year IV.

The long vacation periods of 3 months at the end of each year of years II and III are spent in shore-based establishments. A 6- months sea-training period from the end of the first semester of year IV is spent on board sea-going or coastal vessels owned by shipping, fishing or oil-rig servicing companies.

4.17 PROGRAMME STRUCTURE

The programme and the summarised versions of the syllabus are under Faculty courses. Some of the courses are Faculty courses while others are Departmental courses. The courses are common engineering courses taken by all students studying in the Faculty.

4.18 FORMAT FOR COURSE NUMBERING

A. Faculty courses

The Faculty courses are numbered according to the senate curriculum and Instruction committee recommendation on course numeration. The course numbers start with FEC followed by (3) digits:

- i) the first letter indicates (F)acult
- ii) the second letter indicates (E)ngineering, and
- iii) the third letter indicates (C)ommon courses
- iv) the first digit indicates course level;

i.e. 0 - Diploma courses

- 1 - first year B.Tech. course
- 2 - second year B.Tech. course
- 3 - third year B.Tech. course
- 4 - fourth year B.Tech. course
- 5 - fifth year B.Tech. course
- 6 - first year M.Tech. course
- 7 - second year M.Tech. course

v) the second digit indicates the Department the particular course:

- 1 - Chemical/Petro-chemical Engineering Department
- 2 - Civil Engineering Department
- 3 - Electrical Engineering Department
- 4 - Marine Engineering Department and
- 5 - Mechanical Engineering Department.

vi) the third digit indicates the subsequent number of common course offered by the particular department.

In view of the above format, the numeration of the common courses are as follows:

- (a) Courses to offered by the Mechanical Engineering Department:

FEC 250 Engineering Drawing I
FEC 251 Engineering Drawing II
FEC 252 Applied Mechanics I
FEC 253 Thermodynamics I
FEC 254 Workshop Technology I
FEC 255 Workshop Technology II
FEC 256 Materials Science
FEC 257 Introduction to Engineering practice.

b) Courses to be offered by Civil Engineering Department

FEC 120 Technical Drawing I
FEC 121 Technical Drawing II
FEC 222 Strength of Materials I
FEC 223 Fluid Mechanics I.

c) Courses to be offered by Electrical Engineering Department:

FEC 230 Electrical Technology.

B. Departmental courses to offered by Mechanical Engineering Department.

The courses listed in the following group of subjects are taken by the Marine Engineering students. The courses number start with MEC, indicating (M)echanical (E)ngineering (C)ourses, followed by 3 digits which have the following conotation:

i) the digit first indicates the year in which courses are offered;

ii) the second digit indicates the course group; the following groups are employed;

Group 1 : Applied Mechanics and Design

Group 2 : Thermal Engineering

Group 3 : Fluid Mechanics

Group 4 : Strength of Materials

Group 5 : Materials Science

Group 6 : Production Engineering

Group 7 : Industrial Engineering

iii) the third digit indicates number of courses within the group.

4.19 GROUPS OF SUBJECTS

GROUP NO. GROUP TITLE/COURSE

1. APPLIED MECHANICS AND DESIGN

MEC 310 Applied Mechanics II

MEC 311 Mechanics of Machines

MEC 312 Mechanical Engineering Design I

MEC 313 Mechanical Engineering Design II

MEC Mechanical Vibration

2. THERMAL ENGINEERING

MEC 320 Thermodynamics II

MEC 522 Thermodynamics III

5. FLUID MECHANICS

MEC 330 Fluid Mechanics II

4. STRENGTH OF MATERIALS

MEC 340 Strength of Material II

5. MATERIAL SCIENCE

MEC 350 Metallurgy I

6. PRODUCTION ENGINEERING

MEC 255 Workshop Technology II

7. INDUSTRIAL ENGINEERING

MEC 370 Economics for Engineers

MEC 571 Engineering Management

C. Departmental Courses to be offered by Electrical

Engineering Department

EEE 320 Electronics Instrumentation

EEE 375 Marine Electrical Technology.

D. Marine Engineering Courses

The course numbers start with MAR indicating (MAR)ine Engineering courses followed by three digits which have the following connotations:

- i) the first digit indicates the year in which the course is offered:

- ii) the second digit indicates the course group; the following groups are employed:

Group 1 : Ship Power Plants

Group 2 : Naval Architecture

Group 3 : Ship Building

Group 4 : Ship Auxiliary Systems

Group 5 : Ship Automation

Group 6 : Nautical Science

Group 7 : General Marine Engineering.

iii) the third digit indicates the number within the same group.

GROUP NO.	GROUP TITLE/COURSE	YEAR SEMESTER
1.	SHIP POWER PLANTS	
	MAR 410 Marine Diesel Engine I	IV - 1
	MAR 411 Ship Power Plants I	IV - 1
	MAR 412 Engines and power plants	IV - 1
	MAR 413 Marine Steam and Gas Turbines	IV - 1
	MAR 514 Marine Diesel Engine II	V - 1
	MAR 515 Ship power Plants II	V - 1
	MAR 516 Running and Maintenance of Ship Power Plants	v - 2

2. NAVAL ARCHITECTURE

MAR 420 Naval Architecture I	IV - 1
MAR 521 Naval Architecture II	V - 1
MAR 522 Naval Architecture III	V - 2
MAR 523 Ship Propulsion	V - 1

3. SHIP BUILDING

MAR 430 Ship Structures	IV - 1
MAR 431 Ship Strength	IV - 1
MAR 432 Ship-Yard Technology I	IV - 1
MAR 533 Shipyard Technology II	V - 1
MAR 534 Ship Design I	V - 2
MAR 536 Ship Design II	V - 2
Ship Design Construction	V - 2

4. SHIP AUXILIARY SYSTEMS

MAR 441 Marine Auxiliary Machinery	IV - 1
MAR 442 Heat Transfer	IV - 1
MAR 543 Refrigeration and Air-Conditioning	IV - 1

5. SHIP AUTOMATION

6. NAUTICAL SCIENCE

MAR 360 Navigation and Meteorology

III - 2

6. GENERAL MARINE ENGINEERING

MAR 570 Marine Operations

IV - 1

MAR 571 Project

V

4.20 CONCLUSION

The Engineering curricula in the Maritime Academy has stagnated for nearly 14 years without a single review. As we are aware shipping is a dynamic activity, which is under constant pressure to change. Most of human factors cited in Marine accidents were related to a lack of experience with the onboard technology. Failure to use available equipments, inadequate numbers of qualified personnel, inability to operate highly automated systems. Properly functioning equipment is not the major problem, having crews who are able to make use of such equipment may be the heart of the matter.

Today, more sophisticated equipment is being developed to further aid the Mariner. Often such equipment is installed even before it is required by regulations. Creating the impression that all possible measures to provide for safety of the vessel have been implemented.

Additionally, steering systems have been greatly improved subsequently to the Amoco Cadiz casualty. Redundant power units and duplicate Control systems with associated failure alarm system to lessen the likelihood that casualty will

result from the loss of steering control.

Ships are changing in sizes and shapes to take advantage of the advanced technology. It then means that the training of the Marine Engineer must be developed correspondingly with time. This means updating instructional material, which will involve reducing subjects of less significance to make way for subjects of increasing values in the current Maritime technologies.

In part of shortage of qualified lecturers, what this implies is that there must be all-out effort on the part of the authorities to motivate and induce the needed lecturers. To solve this problem, the authorities must be prepared to attract well qualified technical and maritime lecturers by placing them on salaries comparable with those of their colleagues in business and industry in order to keep them in teaching.

We should also remember that, our competitor countries are Ghana, Ivory Coast, Egypt, Britain, France to mention just are a few. The Britain which we copied the present curriculum from has since moved away from rigidity to some thing flexible and new.

Nigeria must understand therefore, recognize the instrument of the current policies and note some of the inadequacies in the current curriculum. Our Shipping industry must reflect the technology of the 1990s. We have to understand that Nigerian engineer is going to compete with European, Japanese, and American engineers. On the light of this, our system have to be restructured to reflect the global aspirations.

MARITIME ACADEMY OF NIGERIA ORGANIZATION CHART

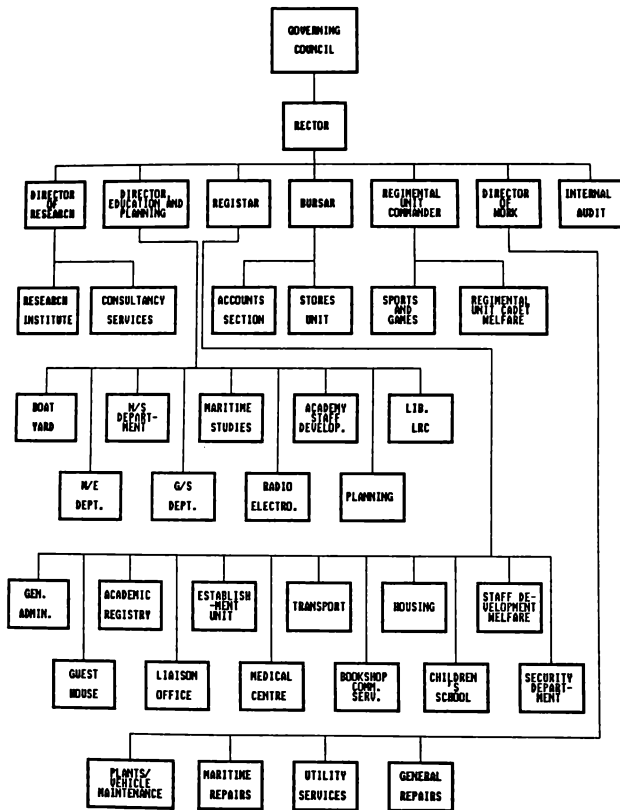
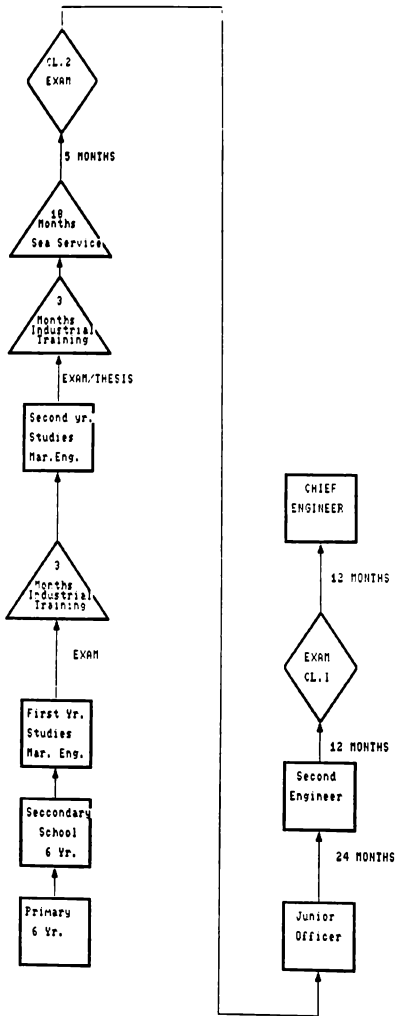


Fig. 4.1 Organization Chart: MAN - Oron



CHAPTER V

PROPOSED CURRICULUM DESIGN AND DEVELOPMENT

5.1 Introduction

The term "Curriculum" has a wide variety of definitions. The Latin root for the word "Curriculum" means "race course". presently, there is no commonly accepted definition for the term. The definition varies with the concepts that a researcher or practitioner uses in his or her curricula thinking and work. .

Goodson (39) defined curriculum as follows:

- A general over-all plan of the content or specific materials of instruction that the school should offer the student by way of qualifying him for graduation or certification or for entrance into a professional or vocational field (Goodson, 1966, p. 29).

By contrast, many curriculum writers have developed curriculum designs which have deliberately focussed on process skills. The major thesis of this approach is that there are skills that students should learn that are not only useful in learning specific competencies within the school curriculum but will be useful in none-school related contexts, and helpful in future learning situations.

Among the type of processes that have served as organizers for curricula are problem solving, social processes, and valuing processes. Advocates of process oriented curricula have argued the following to support their views:

- Since the most significant goal of the school is the development of life long learning skills and interests

central;

- the curriculum should be planned and organized so as to have maximum carry-over into life processes and skills; greater carry-over is likely to be when the curriculum design directly reflects these processes and skills;
- the process of valueing and other processes having a high effective element can be taught as well as essentially cognitive skills; the former should be as well represented in the curriculum as the latter.

(Saylor and Alexander 1974 p. 227)

5.2 THE NEW CURRICULUM

The principal aim of the new curriculum is that of educating the cadets generally, while simultaneously providing professional competence in marine engineering and naval architecture. To this end the curriculum is designed to be of such depth and quality that all cadets would be fully prepared to enter directly the practice of their profession or go straight into graduate studies and research.

The content of the new programme is made to develop the cadet's capability for independent study and original thought as well as to foster those work habits which contribute to professional excellence.

Changes can be rough, and at times turbulent. We simply need to recognize the competitive threat in the global maritime industry, therefore, making the change is inevitable. I know that economy and culture may play their roles, but the latter is dynamic and variable with time.

In Nigeria, marine engineering education developed more as

a professionally oriented subject, while in developed world the emphasis has been on engineering science. In a fast changing maritime technology it is disturbing to see certain things remaining constant when they should not. Training in the world of marine engineering is the case in point.

Considering the state of Nigerian economy and the present dynamic nature of maritime technology, the new training scheme should be able to produce a marine engineer, who should be able to measure up academically and scientifically with his land-based engineers. For example, in Electrical, Mechanical, Aviation and Civil counterparts, to mention just a few. Conversely, such development will remove once and for all cultural stigma associated with the professional certificate without academic degree backing.

It is not always and not only the money which attracts particularly young people to go into certain profession, but the professional pride. Additionally, high reputation enjoyed in the society may make the decision in favour of that very profession. The image of the seagoing professional is badly neglected in Nigeria, compared with his colleague in the Air craft industry. This needs to be polished up with sound academic and professional education.

The author's personal observation in the class room with the cadets, reveals that midshipmen aim toward obtaining bachelor degree that could give them wider job opportunities in their future lives. Technical training alone is not enough. Engineering educators and the society owe it to their students, and to the nation, to help them become not only good engineers but responsible world potential leaders.

At this point, one would like to ask will Nigeria organize creative educational programme to develop the skills and innovative abilities in our marine engineers? Will we at the long run break the traditional pattern by recognizing that education and training of marine engineers is a life long process?

Firstly, we must maintain a balance between fundamentals and specialization. Shakespeare wrote that during a life time, an individual goes through seven ages. But that of an engineer should be something in the neighbourhood five. Similarly, Anthony Giordano, president of American Society of Engineers, 1989-90 disputed that, in their professional lives, engineers pass through certain ages. These ages illustrate the spectrum of values that must be considered in design of a career-long system of engineering training following graduation:

- the age of the application engineer;
- the age of the design engineer;
- the age of the engineer supervisor;
- the age of the engineering manager and
- the age of the engineering vice-president and president.

Generally, the author does not expect new graduates engineers from the Maritime Academy to be seasoned veteran engineers, but we would like the graduates to know at least what engineers do and why. Looking critically at the marine engineering discipline, a discipline can be defined based on what is expected of those trained in that discipline. A list of competencies also serves as a

guideline to the building of an engineering curriculum. Competencies for the marine engineering are classified as those expected to be met by all graduates of the programme.

The late philosopher Sidney Hook (7-9), suggested that among the characteristics all college graduates should have effective communication, knowledge, about the world and humanity, a grasp of physical principles that explains what they observe, and awareness of the function of the society.

Going by these principles, the proposed new curriculum should be able to produce engineers with the following ability:

- Solid fundamental knowledge of engineering sciences;
- Reasonable familiarity with computers, computational techniques, and computational aids;
- Ability to reduce data, concepts, and designs to clear pictorial form;
- Ability to approximate solutions, make reasonable engineering assumptions when required, and produce specific recommendations in determining data;
- A developing sense of engineering ethics and some principles by which moral choices may be made within a professional context;

- Ability to carry design processes from problem definition to solution, including the ability to gather pertinent information and deal with incomplete problem definition and constraints involving esthetics, reliability, economics, politics, ecology, law, sociology, and general safety.

5.3 THREE DIMENSIONS OF THE NEW CURRICULUM

There are three distinct phases at all the real marine engineering student is supposed to pass through to become an acceptable engineer. This is illustrated in figure 5.1

Movement from one phase to the next requires a shift in paradigms. Engineering education should promote this shift, not inhibit it. When an engineer begins his or her education, the emphasis should be placed seriously on the -ics, this means:

- Mathematics;
- Physics
- Mechanics
- Electronics
- Chemiques
- Acoustics

- Elastics

The -ics at the end of each word signifies that the subject is scientific, analytic, synthetic, mathematic and academic. The key characteristic is the absence of concern for human values. No one can be considered a competent engineer who does not have a good grounding in the -ics.

The second phase of development occurs when a student graduates and move into gainful employment, where the key encounter with what I call the -ing phase:

- Operating

- Planning

- Designing

- Creating

- Delivering

- Servicing

- Optimizing

- Scavenging and above all managing.

Because each of the words has a very root, it connotes action. The -ics subjects are concerned with knowing and understanding. The -ing subjects are concerned with doing, or more accurately, with delivering to customers the promises of engineering education and training.

In the -ing phase, engineers are confronted with human values. The matter was put succinctly in 1857 by A.

Wellington, in the Art of Railway Location in the United States:

" It will be well if engineers were less generally thought of, and even defined, as art of operation or constructing. In a certain important sense it is rather the art of not constructing; or, to define it rudely, it is the art of doing well with one dollar".

It is the third phase, the -tion phase, that best prepares engineers to play significant roles in the governance of the systems required to support the society. In this phase engineers deal with society functions and institutions, which include transportation, communication, habitation and environmental protection. It is at this final stage, that human values, in all their complexity play the central role.

5.4 Curriculum for National Aspiration

The proposed new curriculum is intended to take into consideration the new development in the **National economy**. As Nigeria is marching into culturè of ship building and repairs, the new curriculum, by and large must reflect this aspiration. Therefore, areas like **Naval Architecture and Design** must be given top priority in the new curriculum.

Curricula changes dictated by the future trends, as elaborated in the previous section, are more evolutionary than revolutionary. These curricula changes call for addition of many subjects and skills; in view of an already bulging four years curriculum, their incorporation will require fundamental restructuring of the engineering curricula.

To answer future needs, the following changes are suggested

for incorporation into engineering curricula.

Mathematics: The mathematics base in marine engineering education needs to be broadened to emphasize subjects such as numerical methods, approximate methods, finite mathematics, non-linear analysis, asymptotic methods, and mathematical principles of graphics.

This need has been brought about by advances in the engineering Sciences and computer technology. The author feels that these subjects should be part of future engineering education even at the expense of more classical mathematical subjects. Course content must be carefully scrutinized to eliminate less relevant subjects and mathematical rigour where it is not absolutely necessary.

Also to be encouraged is the use of computer software in symbolic algebra and calculus for both teaching mathematics and routine engineering analysis in engineering sciences that enables students to deal with "tougher" problems.

Natural Sciences: There is a fast growing body of knowledge in the natural sciences that engineering student must learn. The present and future technologies will be based on a broader spectrum of scientific subjects and disciplines. In teaching physics and chemistry, emphasis should be placed on this broadening scope of the scientific base, rather than on the standard subjects, some of which are taught in engineering sciences in greater depth and sophistication.

The common denominator of these requirements, together with those aspects of natural sciences that are an indispensable part of the general education of a modern engineer, should form the requirements.

Simulator:

On the present trend, there will be no meaningful training for real sea operation, in the absence of simulator. On the side of simulator training, Warrent Lebeck, (1) of the United Merchant Marine Academy, Kings, New York, made the following observations in the paper he presented to the 7th International Maritime Lecturer Association (IMLA) Conference held in New York 1992:

simulator is a useful tool that can duplicate stressful and critical situations and sharpen our skills to deal with such real emergencies. Simulators can put deck and engineering officers through crises and emergencies that they would be training, including rectification of skills, it has a vital role to play in our efforts to create and maintain a strong competitive American Merchant marine.

(Leback, 1992, pp.1).

We will expect the new curriculum under the new dispensation to produce an engineer who can compute trim and stability, in addition, make reasonable calculations using personal computers (Ibid., p.5). And, we will also need bridge officers who not only can plot a true course. They need to understand and direct the appropriate actions when the bridge-mounted engine console lights up with a plot "hot bearing" or other crucial malfunctions in a readout on one of the dozens of remote sensors. They will have to know because it is likely that there will be no one in the engine room.

The modern ships are becoming Electrical/Electronics oriented owing to a departure from the traditional method to automation. The remote controls, in most cases rely so much on the electronics devices and circuitry.

Engineering Ethics and Humanities: The philosophy of the new syllabi would provide adequately for the study of engineering ethics and good grounding in humanities. Humanity is equally important as professional, many engineering students often wonder why they should be "bothered" with courses other than those professional ones they are admitted to read. Even among the senior academic staff, there are some intellectuals who also question the reason of humanist studies in the institution which, in their opinion should be devoted every bit of their time in attention to professional or technological courses.

What this actually means is that an engineer requires much more than just his engineering or professional knowledge to operate effectively in his society.

An engineer responsible for an organization of say, 30 or more crew members under him is faced with a professional as well as organizational problems. His success in such a task depends on his knowledge and understanding of the simple mechanics of group behaviour just as much as his expert knowledge of engineering.

In his part, the engineer also requires some extra-professional skills in the official or formal medium of expression. He should be able to communicate meaningfully and effectively with the group, more especially if the composition is a multi-ethnic setting.

A chief engineer either afloat or ashore will certainly rely more on communication skill than on his engineering know-how. Any marine engineer officer who is faced with such a challenge, shy away with what can be considered an integral part of his official responsibility, is no more than a "ship mechanic"

In the words of Paulo Freire, every human being no matter how "ignorant" or submerged in the culture of science" he may be, is capable of looking critically at his world in a dialogical encounter with others. Provided with the proper tools for such encounter, he can gradually perceive his personal and social reality.

With reference to the words of Freire, one can advance opinion that it is the humanist studies more than physical science that provide the tools for critical social, economical and political awareness.

Emphatically, the philosophy of the proposed new curricula should look like the pictorial view shown in figure 5.2. From this arrangement, the modern ships' officer is a professional and must understand the procedures and judgements of practice. It is primarily due to the education in fundamentals that enables him to satisfactorily cope with the variety and rapidity of technological change of the modern times. Multipurpose education includes engineering science education.

It has much to do with thinking, and identifying the essence of problems, and choosing logical solutions. Frequently in professional practice, "how you think about what you think about" may be more important than "what you think about".

Navigation: The change of standards in Maritime education training will place more emphasis on navigation. Due to automation, navigation as subject will become more important than ever. Based on the present standard status (1992) which may be characterized by not yet satisfying position determination, Arpa, auto-pilot (course control), Satcom, GMDSS, VTS, are areas which must be fully exploited in the new engineering curriculum, as long as the fully

integrated bridge system is the general and popular concept for today's and tomorrow's ship. All officers, being deck or engine must be able to execute or monitor the navigation process, plan the passage, and assess critical situations. Examples: France, Germany/hamburg/Netherlands.

Computer: A substantial increase of computer-related subjects and skills in the curriculum is needed. These include fluency in computer languages, computer graphics, database management manipulation, familiarity with a standard operating system, text editing, construction and critical of large software packages. Some understanding of hardware elements, and computer controlled processes. The students should learn to apply these skills to solving engineering problems.

Effective data handling requires the capability to use a computer (Garbage in - Garbage out) and data processing techniques (example, filters), to acquire, store, analyze and assess data, and to have a thorough understanding of the controlled process and the ship as a total integrated system.

These changes in professional activities have a strong influence on objectives and contents of engineering training. It is observed that:

- operating systems using electronics technology and man-machine interfaces like keyboards, screens, and software tools, like flow diagrams, icons and menus have become very similar in different applications such as bridge operation, engine room operation, loading office operation and radio operation
- the skill to operate electronics based systems is also desirable in the proposed system.

Automation : No where do the words automation and computer appear in the existing curriculum. There are poliferation of automation processes on the modern ship. They appear in the engine room in bridge control systems, they appear on the bridge in the integrated navigation system, and they appear in cargo operations in such areas as mechanical hatches and automatic warning systems.

The computerized engine room automation system has the following advantages in the modern ship:

- Reduced fuel costs by limiting the usual gradual increase in specific fuel consumption through continous component condition control, proper cylinder balancing and optimal injection and combustion;
- Reduced maintenance costs through extended maintenance intervals by ensuring good operating conditions and by maintenance planning based on accurate information rather than on assumptions and statistics;
- Effective use of maintenance crew;
- Reduced risk of machinery breakdown and consequently "off-hire";
- safety against black-out because of extensive power consumption monitoring;

It has unlimited advantages in the operation of the modern ship.

Engineering Design: The movement toward the sciences in marine engineering training was, however, motivated by what Herbert Simon, (2) of Massachusetts Institute of Technology (MIT), called the "desire of academic respectability". In terms of the prevailing norms of general culture as existing in France, Japan, United States, Netherlands and Germany, Simon said academic respectability calls for such subject matters "that are intellectually tough, analytic, formalizable and teachable".

It is right to say that, engineering design or synthesis is the central theme of the engineering activity. In the existing curriculum, the subject has always been treated as "intellectually soft, intuitive, informal and cookbooky" and was by and large purged from engineering curricula.

The design element of the curriculum urgently needs to be strengthened by adding courses wherever possible on the fundamentals of design. within the generic realm of Computer Aided Design (CAD), major efforts should focus on improving the cadets' understanding of engineering principles, the design process and proper use of the computer in finding optimal solutions to engineering design problems.

English Language: The teaching of technical English should be replaced by the teaching of the English Language. Where necessary more attention should be paid to report analysis.

Communication: Greater emphasis should be placed on improving the written and oral communication skills of students. I will like to suggest that each year stress oral presentation, and at least one course each year have substantial writing requirements and several literature surveys.

Interdisciplinary Exposure: Marine engineering students are handicapped in this regard. Efforts should be made to incorporate elements of interdisciplinary work into the curriculum. One way to approach this problem is by forming small research or project team from different disciplines carrying out or engineering project.

Apparently, the same argument goes for other subjects in the curriculum, they must be reviewed in line with the other courses as the pressure from the high technology continues to influence the maritime industry.

Parallel to these changes, it is suggested that overall course load for the 4 years curriculum should take the following form:

- Mathematics and Natural Sciences - 30 to 35 %
- Engineering Sciences - 35 to 40 %
- Design and Computer technology - 15 to 20 %
- Humanities, Social Sciences,
- English language and communication - 10 %

The pictural view of the above arrangement is illustrated in fig. 5.3.

5.5 COURSE DURATION

Since the traditional 4 - year programme cannot be further stretched, new approaches are required to alleviate the situation. The approaches require significant changes in the philosophy, attitudes, goals, curricula contents and methodology of the Marine Engineering Department. The materials must be simply repacked to achieve economy of

presentation. Marine Engineering also must try to develop intellectual curiosity, creativity and cohesive understanding of the fundamentals of the marine engineering profession.

4 years seem reasonable for the most countries. Duration of theoretical training, total duration of practice before/within theoretical education, total amount of engineering training, supporting and professional syllabi subjects, Certificate(s) of competency, academic degree differ considerably from country to country. Some of the relevant data can be taken from table 5.1:

Country	Entrance Level	Year Educ.	Educational Level	Academic Degree
France	Bacc	P+4	Polytech	Msc/Bsc ?
Holland	11 Y	2+P+1	Polytech	Bsc/Ing
U.K.	12 Y	-	Polytech	-
Ger/Hamburg	12 Y	P+4	Polytech	Ing.
Ger/Flensburg.	12 Y	P+3+1	Polytech	Ing.
USA	12 Y	P+4	Academy	Bsc
Japan	12 Y	4	Univ.?	Bsc

Table 5.1

(Courtesy of 7th IMLA conference, 1992.)

The author assumes that these data might have been updated. As shown in the table, "12 Y indicates entrance requirements for either polytechnic or University, while

"p" stands for practical training.

The significance of the point raised in the above systems are sea time, total duration of theoretical education, for example, Germany, France, United States and Japan use four years. While Netherlands uses three years for theoretical training. Going by the popular standards, the four years duration should be maintained.

5.6 4-YEAR FRONT LOADED

The existing programme in the Academy is Sandwich. On the basis of time, it takes approximately 8 - 10 years, from cadetship to train first class engineer. Considering the level of knowledge, professional and academic achievements, most of the useful time must have been wasted on shipboard training. It is not suggested that we should abandon sea-training. It is the critical link between the classroom and the "real world". The focus of training remains at sea. It is what we teach aboard is becoming the critical question.

In sea training, academic is not emphasized at all. It serves as a background to practical tasks faced by the cadets in the "real world". The advantage of this system is that it is relatively cost-effective, does not require a high level of education for entrants. It provides the industry with a "Captive" work force of trainers. The disadvantages are the system, in general, is based on outdated needs, pre-supposes an on-board training which is not always available. It prescribes high standard, short term modular shore training, which in many states, including Nigeria, is not fully provided.

5.7 MAJOR PROGRAMMES IN THE CURRICULUM

The changing in the seafaring over the past years, have meant that many who do not see themselves remaining at sea need to acquire higher qualifications. It is still, very often, regards any one with more than a handful "GCE" "O" level as being too clever to remain at sea. Nevertheless, seafarers have relatively short career afloat of around seven years at the average.

Moreso, the existing programme in Nigeria and in most countries, do not make provision for the land-based side of the industry. It is on the light of this situation that prompted D. M. Waters, rector World Maritime University - Malmo, to make the following remarks:

In this regard it interesting that - despite the considerable amount of debate currently being generated about the training of the seafarers - so little is said or done in respect of the shore-based positions, traditionally occupied by the ex-seafarers. There are, of course, a few countries where comprehensive University undergraduates Courses in maritime studies prepare students not only for seagoing positions, but also recognize that many of them will progress to managerial positions in the shore-side of the industry. However, the majority of the advanced countries appear to assume that the fleet managers, harbour masters, surveyors, maritime lecturers et al., will continue to be adequately prepared by the education they received for their certificate of the competency followed, hopefully, by extensive seagoing experience (D.M. Waters, 1991, p.4).

Considering the fore-going arguments, it is now suggested the new curriculum be reconstructed into 2 major areas viz,

A. Marine Engineering- Focus on shipboard engineering operations;

B. Naval Architecture - Attention directed towards A, with more emphasis on ship building and construction.

The structure of the degree programme is suggested to take the following arrangement:

PHASE 1: For the first two years, all students from the two major areas take common courses in the following component core areas and also courses from

A. Mathematics- Four courses in calculus (I, II, III,IV)

B. Sciences - Divided into:

i) physics - 4 courses

ii chemistry - 2 courses

C. English - 3 courses

D. Humanities- and Social Sci. - 6 courses

E. Naval Sci.- 4 courses

F. Physical Education/First Aid - 8 courses

G. Computer Science - 2 courses

The first phase will also include workshop technology and greater part of natural, applied, and engineering sciences. Introduction to some aspects of major areas will be included.

Since technical courses often require a sequence of prerequisites, it might be necessary for some engineering science courses to be extended into the second and third year. Each area of specialization would have exact course requirements. Most of the lecture courses would not differ substantially from courses currently taught in bachelors' degree programmes. Except that with strong pre-engineering preparation, the courses should be taught at a higher level and would include more materials.

Phase II

The main theme of phase two will be on major area of specialties and in-dept approach to natural and applied sciences and engineering science. This period will be directed towards land-based and shipboard training, and it should be at the ratio of 1:1 to maintain the equitable balance. Principally, such areas as marine propulsion machinery, automation, electro-technology, electronics, integrated bridge and engine room control system et al. Equal amount of time should also be spent in the shipyard.

Phase III

This period will be the final phase of the programme. Here it will be mainly focused on deeper approach to the professional training and intellectual training. Additionally, the training must meet the following requirements:

Training to meet STCW provision, as contained in articles:

- X and regulations 1 - 4 of the convention;
- Training to meet the STCW Convention requirements

broadened to include non-STCW courses:

- Training to meet the STCW Convention requirements and expanded to enable candidates who wish to continue after bachelor degree and Certificate Competence respectively to continue to pursue higher degree.

The proposed restructuring degree programme is illustrated in tables, 5.1, for general Courses, table 5.2, for Naval Architecture and table 5.3 for Marine Engineering ship operation.

Restructuring Programmes for Bachelor Degree in Naval Architecture and Marine Engineering

COMMON: For the first two years, all students irrespective of the Department, must successfully achieve a minimum mastery level in the common subject areas. The maximum great point average must not be below 2.00 GPA, in each of the courses. However, if particular courses are not relevant to the student's need, they may be waived:

- Mathematics
- Phys.I, Elem. Mech & II
- Chemistry I & II
- Data processing (basic)
- Automation
- Engineering graphics
- Strength of materials

- Introduction to Engr. Design
- Ship operation system
- Navigation
- Workshop Tech./practice
- Naval Arch. and propulsion
- Electrical Machinery
- Electronics / digital
- Solid / Fluid Mechanics
- Safety
- Computer programming
- Physical Education
- Seamanship
- Engr. Ethics
- Engr. Sci., Elective
- Engr.Man.Proc.
- Engine Simulator

Table 5.1 Common Curriculum

CURRICULUM FOR NAVAL ARCHITECTURE

SEMESTER I			SEMESTER II		
Subject	SEM hrs.	Classs hrs.	subject	SEM hrs	Class hrs.
English/Comm.	2	2	Mar.Engr.II	3	3
Chem. I	2 1/2	3	Calculus II	4	4
Calculus I	4	4	Comp.Program.	3	4
Engr.Draw.	3 1/2	6	Applied Chem.II	3	3
Naval Arch.	1 1/2	2	Physics II	3	4
Mar.Engr.	1 1/2	2	Elective	3	3
Physics I	4	4			
	-----			19	21
	19	23			

It is obligatory that at the end of every semester the student must complete two months practical work.

SEMESTER III

SEMESTER IV

Subjects	SEM hrs.	Class hrs.	Subjects	SEM hrs.	Class hrs.
Elective II	3	3	Calculus IV	4	4
Calculus III	3	3	Literature	3	3
Engr. Analy.	2	2 1/2	Phy. IV	3	4
Material Science	4	5	Fluid Mech.	3	3
Strenght of Mat.	4	4	Thermo.	3	3
Physics III	3	3			
				16	17
	19	20 1/2			

Successful completion of two months practical work is required.

SEMESTER V

SEMESTER VI

Subject	SEM	Class	Subject	SEM	Class
	hrs.	hrs.		hrs.	hrs.
- Economics	3	3	Ethic & Pol.	3	3
- Probabli.			Modern Phys.	2	2
& Rand.Pro.	3	3	Naval Arch IV	4	4
Mach.Design	2	2	Engr.Lab.	2 1/2	4
Electro-Tech.	3	4	Naval Arch.	4	4
Marine Engr.	3	3	Elect.Engr.	3	4
Naval Arch.	2	2	Thesis	-	2
Thesis	-	1			
				21 1 /2	24
	16	18			

SEMESTER VII			SEMESTER VIII		
Subject	SEM hrs.	Class hrs.	Subject	SEM hrs.	Class hrs.
Ethics & profession	3	3	Naval Arch.IX (ship design)	3 1/2	6
Communcation	2	2	Naval Arch.X (propell.design)	3	3
Sh.Vibra.	3	3	Mar.Engr. VI (Steam plants).	4 1/2	5
Naval.Arch.	4	7	Thesis		2
Mar.Engr.V (Design)	4 1/2	5	Seminar	3	2
Thesis	2 1/2	5			
	18	25		17	21

Table 5.2 Naval Architecture Curriculum.

MARINE ENGINEERING CURRICULUM

SEMESTER I			SEMESTER II		
Subject	SEM hrs.	Class hrs.	Subject	SEM hrs.	Class hrs.
English/ Comm.	2	2	Mar.Engr.II	3	3
Calculus	4	4	Calculus	4	4
Ship System	3	4	Chemistry	3	3
Physics	4	4	Comp.Prog.	3	4
Chemistry	2	3	Physics	3	4
Naval Arch.	2	3	Engr.Design	1	1
Mar.Engr.I	1	2	Elective	3	3
		-----			-----
		18	22		
				20	22

SEMESTER III			SEMESTER IV		
Subject	SEM hrs.	Class hrs.	Subject	SEM hrs.	Class hrs.
Elective II	3	3	Literature	3	3
Calculus	3	3	Calculus	4	4
Elect,Engr.	3	4	Humanity	3	3
Thermo.	3	3	Material		
P/E	1	1	Strenght	3	3
Mar.Design	3	3	Workshop	1	2
Engr.Man.proc.	1	1	P/E	1	1
		-----	Elect.Mach.3		4
		17	18		
				18	20

The Summer sea term of 4 credits hours must be maintained.

SEMESTER VII			SEMESTER VIII			
Subject	SEM	Class	Subject	SEM	Class	
	hrs.	hrs.			hrs.	hrs.
Humanity	3	3	Humanity	3	3	
Naval Arch.	3	3	Engr.Econs.	3	4	
Engr.Design	4	5	Mar. Law	2	4	
Automation	3	3	Pern.Mangt.	3	3	
Navigation	3	3	Engr.Design	3	5	
Materials			Engr.Analy.	3	3	
Strenght	1	2	Thesis	2	2	
-----				19	24	
		17			19	

Table 5.3 Marine Engineering Curriculum.

5.8 CERTIFICATION

A question frequently asked is what are the personnel requirement for a ship and what standards the personnel should be trained?

The obvious answer to this question is that a ship should carry sufficient crew to enable it safely navigate the oceans, without accident or loss to the crew, cargo itself and without damage to the environment. 85 % of marine accidents have been attributed to the human errors, and lacked proper training.

RECOMMENDATION

With the high level of professional and academic standards proposed in this dissertation only three levels of certificates are recommended. These are third class, second class and first class (all unlimited).

5.9 Examination

After four years of studies, with more than six months of accumulative sea-service training, class three engineer officer certificate should be given to the student after oral examination.

For the class two certificate, for the second engineer (unlimited 750 - 3000 kw), the candidate should have a minimum of 12 months approved sea-training and 8 weeks simulator training as engineer Watchkeeping officer. Three out of the 12 months must have been on ship above 3000 kw.

Chief engineer (unlimited). Any person seeking for examination at this stage should have a minimum of 15 months approved sea training and 8 weeks simulator training as second engineer and 4 months out of 15 must have been on ship above 3000 kw.

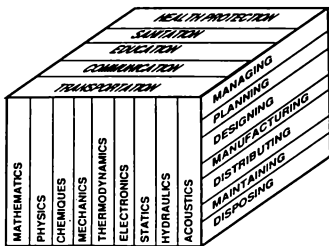
Simulator training is regarded by the author as integral part of sea training. This approach has since been adopted by France, which maritime training system is one of the best the world.

5.10 CRASH PROGRAMME

This is a short term arrangement, under this condition University graduate engineers in Mechanical and Electrical engineering, are admitted for short courses. The duration of such courses should be lasting between 3-4 months in the Academy, before a prolonged sea - service is embarked upon. This proposal if given a chance can go a long way to alleviate our manpower problems.

The Flow chart of the entire training Scheme proposed in this dissertation is shown in figure 5.4. Diagram A, shows programme for Engineering graduates, B illustrates programme for Naval Architecture and C, indicates Marine engineering scheme.

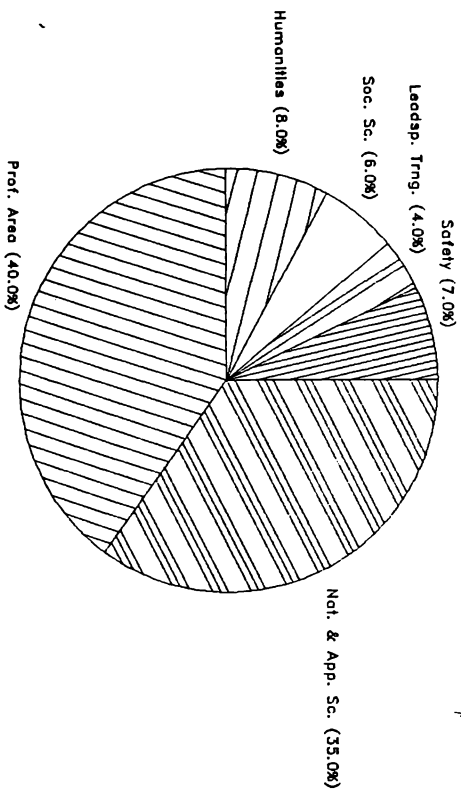
Three Facets of an Engineering Career



■ The *-ics* face is academic in outlook and marks the start of the profession. The *-ing* face is the "doing" face. The *-tion* face is concerned with the functions of society. Each face is orthogonal to the others in spirit, style, and values.

Fig. 5.1 Three Distinct Phases of Engineers.
(Courtesy of Engineers Education).

Fig. 5.2 Philosophical view of the Curriculum



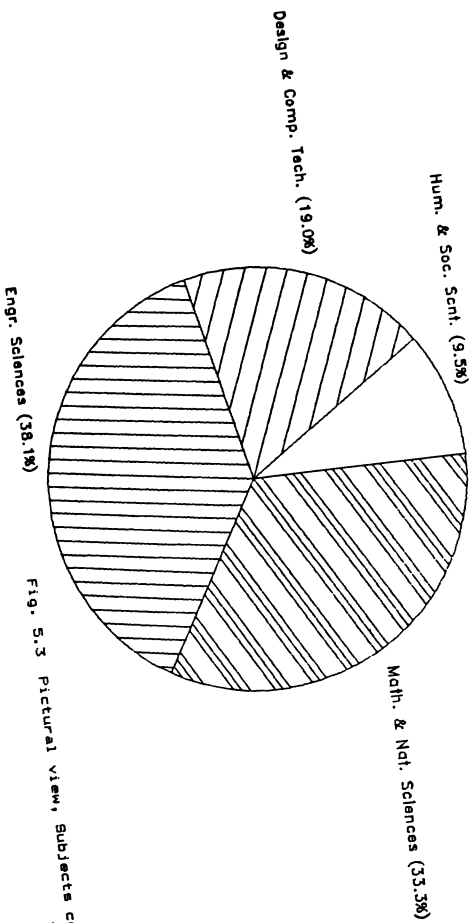


Fig. 5.3 Pictorial view, Subjects combination

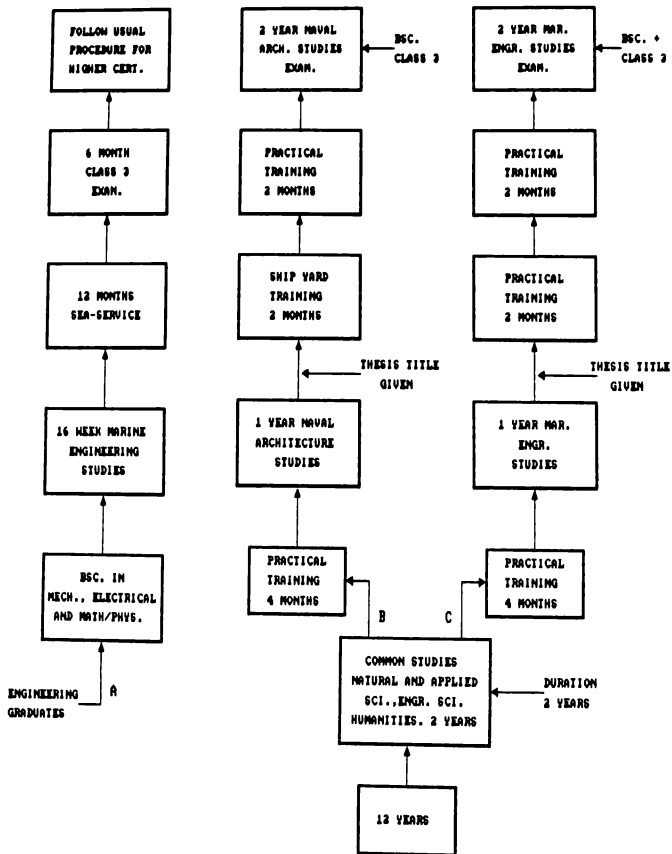


FIG. 5.4 PROPOSED RESTRUCTURING PROGRAMME

CHAPTER VI

RECOMMENDATIONS AND CONCLUSION

Introduction: The decline in number of Nigerian flag ships and jobs for Nigerian Seafarers has seriously reduced the support of our land-based marine industry. Also the training Scheme and the teaching staff, has been something of a serious threat to the Shipping industry in Nigeria. It is this unusual turn of events that has prompted me to propose a new approach to Marine engineering education in Nigeria. I believe that the opportunity has offered itself to remedy the deficiencies in the existing system, and to adopt a front loaded system into future. However, in doing so, we must maintain whatever is good about the present sandwich system and be flexible enough to allow for changes and innovations that will take place in the industry.

In assessing deficiencies, I noted an overburdened curriculum; insufficient integration of both early natural sciences, engineering sciences, Mathematics and problem-solving orientation. This limited cadets' appreciation of the diversity of subjects engineers need to cover; insufficient integration of engineering with non-engineering aspects of communications, business, technology, policy, arts and sciences; and virtually no exposure to the culture and practice of lifelong learning.

RECOMMENDATION

My assessment led me to conclude that pressure on the curriculum required the educational experience to be significantly restructured, and this restructuring should focus on the lower division. Such a focus would also become a driving force for changes in the rest of the curriculum. This paper, therefore, recommends retaining and strengthening elements of Mathematics,

engineering sciences, natural sciences, and fundamental concepts of engineering analysis and design.

Additionally, it is also suggested that, however, more emphasis should be placed on synthesis and maintenance of depth and strength in technical subject matter; stronger emphasis on non-technical education to develop historical and societal perspectives; development of management skills.

While I acknowledge the inter-dependence of theory and practice, the focus of my analysis is the curriculum in action. This stance reflects my own experience as a long time teacher of engineering technology for nearly two decades, and which has given me an opportunity to share in the development of a curriculum. As a maritime teacher, my function here is to critically examine curriculum theory and practice in the light of each other. It has been a hard decision, in which theory has been forged on the anvil of practice. My approach is analytical, the aim here is a ratio of 1:1 for theory and practice.

The 4 - year cannot be further stretched, new approach are required to alleviate the situation. These approaches require significant changes in the philosophy, attitudes, goals, curricula content, and methodology of marine Engineering Department. The material must be simply repacked to achieve economy of presentation.

The Engineering Department must try to develop intellectual curiosity, creativity, and cohesive understanding of the fundamentals of the marine engineering profession.

RECOMMENDATION

In the light of the disadvantages associated with the existing sandwich programme, I recommend the abolition of

the present sandwich system. This should be replaced with one-tier system of 4 years academic degree programme, leading to bachelor of science (Bsc), in marine Engineering, Naval Architecture and 3rd Class certificate of competency. The programme will include a period of guided sea-training. The entry qualification will be General Certificate Education GCE "A" level certificate or its equivalent.

IMPLEMENTATION

To speed up the process of the degree programme, it is suggested that the Authorities of the Maritime Academy in collaboration with the Federal Ministry of Transport, should open discussion with the River State University, Port Harcourt. Such discussion should centre on modalities for immediate affiliation. The allegiance will permit the Academy to go under the umbrella of the University Accreditation to award the degree, until the time it could do it alone.

The choice of the River State University, Port Harcourt, is based on proximity to the Academy, its long standing recognition by the International Maritime Organization (IMO), and the Institute of Marine Engineers London.

There is a substantial flow of seafarers from the developing countries to ships owned and managed from the developed world. In recognition of the situation, some shipowners' associations from Europe, Scandinavia and Japan have entered into agreement with the seafarers unions in the Philippines, Indonesia and India on salary structure for their seamen. In some cases assistance is offered for the training of the seafarers. Such agreed assistance has been rendered to the training institutions and some ship management companies. For this reason, the standard of

training provided should be acceptable to the international shipping community.

The proposed new programme is designed to produce an officer who is scientifically sound, and professionally good enough to do the work of a 3rd engineer immediately after graduation.

FUNDING FOR THE SHORTAGES

The federal government alone cannot give enough fund to meet the needs of all its para-statal today in the present world of accelerating marine technology and tougher competition.

Recommendation

If essential training in marine engineering sector is to meet its real needs, both in terms of quality and quantity, it is recommended that the government, shipowners and the Union make choice between two main options:

- Bring in new, more rigorous rules designed to meet current and future training needs;
- Introduce a levy/grant system to all marine related industry in Nigeria to pay toward training.

As said earlier, the present method of funding and encouraging training has great limitations and hardly adequate for an institution which is changing beyond recognition. One gets worried about the attitudes of the private companies which are doing nothing and, like vultures, are just waiting to make lucrative offers to

the trainee to entice them away while not spending a dollar on their training.

For foreign - going service, the shipowners should play greater overall role by, for example, paying one third of the general training fund. No organization within the industry should be exempted from the levy.

On the broader scale, industry, government and the University should collaborate effectively in research through consortia. In such alignment, the research body receives fund from both government and industry to support practical research of values to the industry.

SOLUTIONS TO MANPOWER SHORTAGE

The skill shortages are badly affecting all sectors of the marine industry in Nigeria. This is a symptom of failure of government, Shipowners and industry itself to invest in its future manpower needs. However, merely pouring more resources into training and buying unrelated equipment is not the whole answer, they must be backed up with changes in attitude. The old pattern would not do. Something much more flexible to meet the immediate needs is required.

Recommendation (general)

To arrest the present situation generally in all sectors of marine economy of the nation, it is suggested that government should organize crash pre-sea training programmes for the holders of the following academic degree:

- Bsc.- Mechanical Engineering;

- Bsc.- Elect/Electronics Engineering;

- Bsc.- Maths/Physics.

These candidates spend about one semester of 16 weeks in the Academy, this period should include simulator training. Later on, they go on sea-service for one year. On return, they go to the Academy for 6 months duration, for third class engineer officer examination and Certification. There after, the trainee follows the laid down policy and procedures for getting higher certificates.

The idea of putting Bsc. engineering graduates through an accelerated cadet programme at the Maritime Academy should be considered as a priority.

TEACHING STAFF

As in all training situations, the ability, co-operation, skills and dedications of the teachers are the key components in the transfer of knowledge and skills to those being trained. In attempting this analysis I have come to the following conclusion that the current curriculum lacks means of evaluation, feed back and implementation. The teachers who were supposed to be key figures in the process of curriculum implementation were not considered. The welfare of teachers as well as the training to cope with ever increasing new technologies in the industry was not important to the administration. There will be no curricula if there were no teachers to interpret and execute them.

Recommendation

In view of the multi-functional roles of the teachers in transfer of knowledge, not even in the ordinary school system but in the sophisticated and complicated marine

Engineering setting. I recommend the following for immediate implementation to attract right calibre of maritime teachers into the institution:

- Remedial measures should be taken by the government to improve lecturers' salaries generally and to adjust them periodically. Salary level, comparable to other professionals with similar qualifications, corresponding to knowledge and competence in teaching, should be considered as one of the keys to retention of qualified teachers in the profession;
- Government should consider "scarcity award" to maritime lecturers. Period of training, hazard and harsh environment associated with the maritime profession, should be a determining factor for such award;
- A programme should be worked out which allows senior engineers to accept full-time teaching or research position at the Academy while remaining on the payroll, as a last assignment before retiring;
- Special funds should be provided to the Academy to encourage experimentation and establishment of new programmes and curricula that will lead to improved industrial competitiveness between the industry and the academy.
- A professional approach to teaching should be seen in the same way as a professional approach to law, medicine, or engineering. It is not enough for a lecturer to be an exceptional Seafarer, advocate, or designer. He or she must be a distinguished

- Entry into the teaching profession should be maintained at a high level in order to avoid a decline in the quality of education;
- Teachers need to be, or to become, committed to any planned change if it is to work. The motivation of teachers to make it work is crucial, because any change as far-reaching as the implementation requires that they be prepared to put in it more extra work;
- Involve individual departments in curriculum development and review every two years;
- Encourage curriculum communication with other sister Academies world-wide;
- The rector should spend time visiting teachers in the classroom;
- As the change will be based on the school and implemented not from above, teachers should be involved in the process of installing and implementing new programmes;
- The Academy should promote good interaction with the Accreditation Board, such as National Board of Technical Education (NBTE), the National Science Association of Nigeria and other appropriate agencies to advance issues important to engineering education and training.
- The Nigerian Society of engineers should talk straight to the government, arousing sympathy for the engineering education. Most specially in marine engineering which seems to be operating outside the

national educational system.

- Many objectives should be drawn on students education and their level of training by systematic qualification upgrading of the teaching staff including their sea going experience

As the technology becomes more important in National life, we must educate the supporting structures of the society especially government about the potential impacts and importance of technological change. For example, the engineering society should be able to tell Federal government to borrow lead from Japan's situation. Japan spends just 1 % on defence, thereby making enough funds available for engineering and research.

Implementation

It is worth repeating that non-implementable programmes probably do more harm than good when they are attempted. The most responsible action may be to reject certain innovations which are bound to fail and work earnestly at those which have a chance to succeed.

In other words, change is not a fully predictable process. The answer is found not by seeking ready - made guidelines, but by struggling to understand and modify events and processes which are intrinsically complicated, difficult to pin down. Some of the ways in which we should attempt to effect the change include:

- Hiring or promoting new teachers who possess conceptual abilities, and who will in turn develop them in others;
- Adding training in the processes of implementation to in-service workshops and other project training

activities directed at programme change;

- Adding courses in the theory of practice of change to pre-service programmes for lecturers, rector and other administrators.

CONCLUSION

The need for adequate training has again been highlighted by Lloyd's Register, whose latest casualty statistics show that 258 vessels of 1.5m gt. were totally lost during 1991, the highest total since 1986. It marked an increase of 422,000 gt. on the previous year. More than 1,200 people died in these losses, although structural or other technical failures may have played an important part, as well as human error through fatigue, inadequate training is recognised as the major contributing factor.

A maritime nation like Nigeria cannot prosper without good shipping. We are in danger of ignoring that simple truth. For some time now shipping in general, and the Merchant Navy in particular, has not had a high priority, except in a crisis. For example, that of River Quorra's accident in 1988 in which many Nigerians were killed and goods and property worth million of dollars perished. That is something we may all come to regret.

Many highly placed Nigerians do not know that nearly 98 % of our foreign trade is sea-borne. It has been so many years back and will continue to be so for foreseeable future.

Generally, there is nothing more gratifying than being able to make changes in the important issue that affect the lives of hundreds of thousands or millions of people. I will like to conclude with what American poet Ralph Waldo

Emerson wrote more than a century ago, "What lies behind us and what lies before us are small matters compared with what lies within us". It is only through dedication and commitment that we will accomplish impossible tasks. Let us join to shape the future.

BIBLIOGRAPHY

1. Anarah, H. Development of Maritime Education in Nigeria. World Maritime Univ., Malmo, 1985.
2. Akinsoji, O. The Training of Manpower in the Marine Fishing industry of Nigeria. W.M.Univ.Malmo,1985.
3. Allan, Pepper. On Training Needs - Management the Training and Development. Aldershort, England,1984.
4. Agbakoba, E. Education and Training for the Maritime Industry. Asso. of Master Seminar. Lagos,1991.
5. Bryan, H. "Marine Engineering and the Microprocessor". Institute of Mar.Engineers. 1985.
6. Brodefors and Rinman. The Commercial History of Shipping. Rinman and Linden AB, Gortenberg, 1983.
7. Cranch, T. Edmund. "An Overview and Assessment" Engineering Education 62 1990.
8. Fafunwa, A.B. History of Nigerian Education. Carton Press, Lagos, 1997
9. Flensburg Polytechnic. Marine Engineering Curriculum. Flensburg, Germany 1991.
10. Greg, Keansley. On Validity of Training and Technology. Addison Wesley Publishing Coy., 1984.
11. Hunter, Brain. The Statesman's Year Book. Macmillian Press Ltd., London 1991.

12. International Labour Organization. Monographs of
Seafarer's Vocational Training. Geneva, 1967.
13. Ikejiani, O. Education in Nigeria. New York, 1965.
14. John, Matthew. Curriculum Exposed.
David Fulton Publishing Ltd., London Wc 13, 1989.
15. Kelly, A.V. The National Curriculum. A critical
Review. Paul Chapman Publishing Ltd., London, 1990.
16. Mbanefo, L.N. Nigerian Shipping Law.
Professional Book Limited, Lagos, 1983
17. Moloney, S. "African Lines pledge support for UKWAL"
Lloyd List. 6 May, 1992.
18. McMasters, J. and Ford, S. "An Industry View of
Design Education" Engineering Education 62, 1987.
19. Nigerian Shipper's Council. What and Why Wherefore.
Victoria Island Lagos, 1987.
20. Mangrove, Gerard. Future of Gas and Oil.
Van Nostrand, Melbourne , Australia, 1983.
21. Nwaogugu, A.c. " Why Humanities and Social Sciences"
An address to incoming students of the College of
Technology, Oweri - Nigeria, 1982/83 during
Orientation Week.
22. Ozoro, Obase. Manpower for Scientific and
Technological Development
De-Shine Intern. Publishing Coy. Lagos, 1982.

23. River State Univ. Marine Engineering Curriculum
Port Harcourt - Nigeria, 1991.
24. State Univ. of New York. Marine Engineering Curriculum. King points, New York, 1992.
25. Waters, D.M. "Sustainable Development and Future Marine Education and Training". Paper presented Law of the Sea Conference, Malmo, 1991.