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Report on

Ship and Boat Building and Repair

West Africa

United Nations Industrial Development Organisation

Vienna

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/UNIDO publ/. /Expert report/ on /shipbuilding/ and relevant /maintenance and repair/ in /West Africa/ — covers (1) current activity in twenty countries (2) levels and /choice of technology/ in ship and boatbuilding and repair; vessel design (3) /infrastructure/; /development potential/, for /shipyard/s servicing vessels of various sizes. /Recommendations/, /statistics/. Additional references: /fishing vessels/, /economic aspects/. /Restricted/.

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

VIENNA

REPORT ON

SHIP AND BOAT BUILDING AND REPAIR

WEST AFRICA

A & P Appledore Limited

26 February 1988

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1: INTRODUCTION

1.1 Background

This report has been prepared by A & P Appledore at the request of UNIDO. The report supplements a series of technical meetings held in Accra, Ghana, during December 1987. The conclusions and recommendations of those meetings are included in this report.

The terms of reference for this report are as follows:

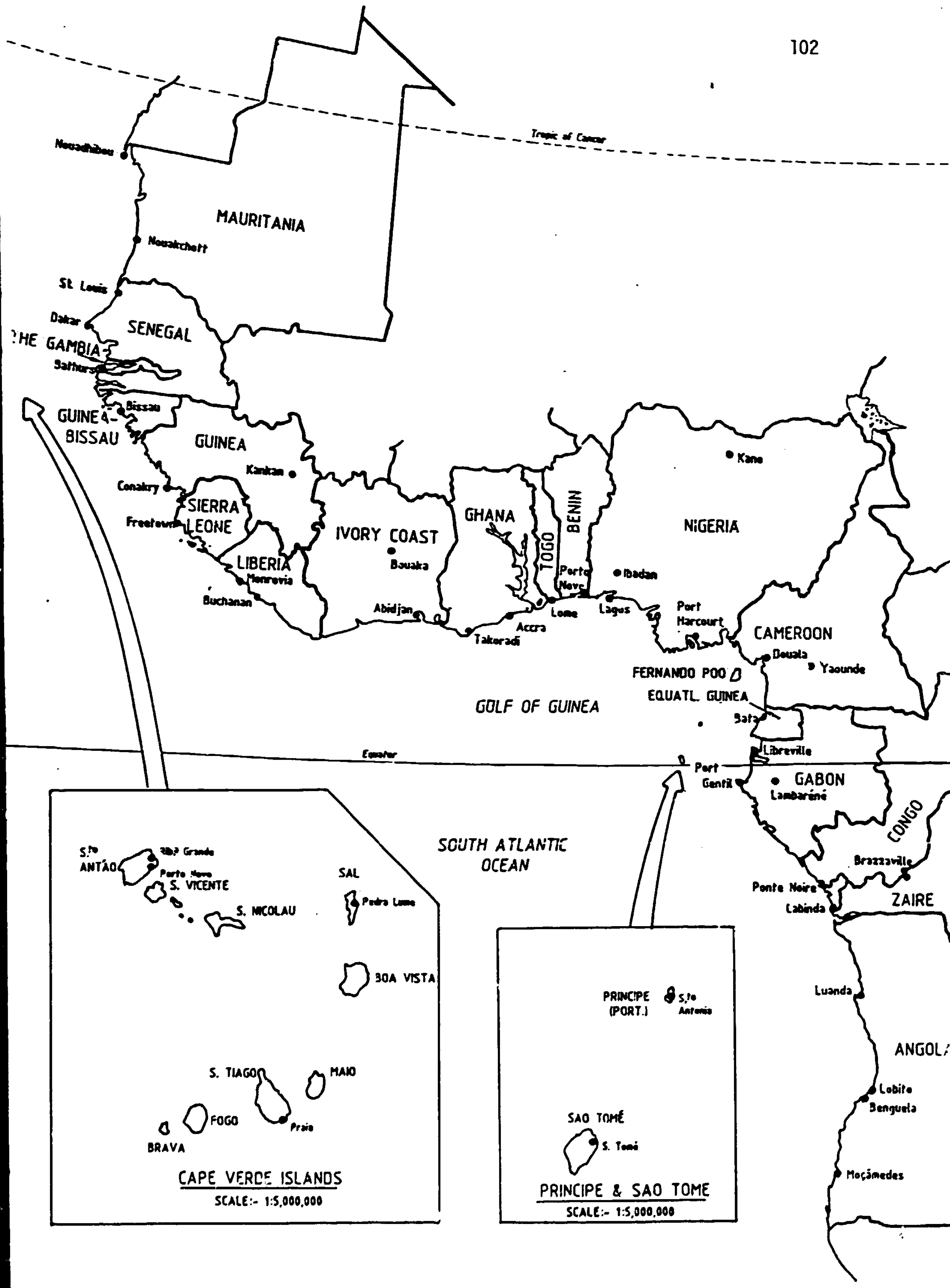
"Prepare a report on boatbuilding ard boatrepair activities by reviewing the latest technologies and evaluating the infrastructure situation in different countries of the region (West Africa) and the existing boat fleets and estimated production of the volume of boat repair work by country. Draw conclusions and make recommendations for short-term and medium-term action. In accordance with the attached outline, to be submitted in English, in ten typed copies, length approximately 80 pages (double-spaced)."

The area covered by this report is shown on the Map in Figure 1.1.

In order to carry out the review, the industry was initially categorised as building or repair, and small ships or boats. At the meetings in Accra it was considered by the delegates that the topics of large ship building and repair should also be addressed.

Building and repair are therefore reviewed for:

- large ship building and repair;
- small ship building and repair;
- boat building and repair.



WEST AFRICAN COAST

SCALE:- 1:20,000,000

Figure 1.1

1.2 Summary

This chapter outlines the background to and purpose of the report. The main conclusions are also summarised.

Chapter Two provides a brief assessment of the existing situation in West Africa on a country by country basis. The existing fleets and facilities for building and repair are noted. The size, age and origin of the fleets of large and small ships operating in the region are detailed in Appendices 1, 2 and 3. The current facilities for building and repair are listed in Appendix 4.

Chapter Three describes some important aspects of shipbuilding and repair technology. The emphasis in modern shipyards is on organisation. Sophisticated equipment is seen as far less significant in achieving effective production. Aspects of ship design are also considered, particularly how it can be integrated with production to take account of methods and materials All three sectors are considered in these respects.

Chapter Four refers briefly to the interaction between shipbuilding and its infrastructure, and identifies some important aspects of the regional infrastructure. This topic is an important element of, and is discussed in some of the papers presented at Accra. Training and manpower issues emerge as the most significant.

Chapter Five suggests some possibilities for development, notably in the fishing sector. For larger vessels, the possibilities are reduced and a need for regional cooperation emerges. Shiprepair and some small shipbuilding are possibilities.

Chapter Six states the main conclusions and recommendations. These are summarised in the next section (1.3).

1.3 Main Conclusions and Recommendations

There is a relatively large marine industry in West Africa, and many people depend on it from local fishermen to large ship operators. Most large and small ships are imported and are frequently repaired abroad. There is an ageing fleet, so an increase in building and repair activity is expected. An opportunity exists to develop the local industry with respect to building and repair of small ships. There is also an opportunity to increase the volume of local repair activity for larger vessels. It is not believed feasible to consider local construction of large vessels.

The small craft, such as workboats, are also mainly imported and an opportunity exists in this sector to develop more local construction and repair.

In order for the opportunities to be seized, a good level of regional cooperation will be needed, since it is expected that the developments would only occur in selected sites, probably building on existing facilities. The developments would therefore be regional as well as local.

The artisanal, mainly fishing, activity relies on numerous local, traditional builders. There is a major need to improve both designs and production methods. This need should be met by assistance with development, which would give a major benefit to the region.

The main recommendations, from the technical meetings in Accra and of this report, can be summarised:

- there should be further studies to identify precisely the market, existing facilities, training and other needs.

- from this a regional development plan for ship building and repair should be prepared.

- fishing boat design and production should be reviewed and a pilot study to assess the most suitable should be carried out.

2: REVIEW OF CURRENT ACTIVITY

2.1 Introduction

A brief review has been carried out of current activity in the various countries of the region. The review looks at three categories of activity:

- large scale shipbuilding and repair;
- small shipbuilding and repair;
- boat building and repair.

Large scale shipbuilding is limited to a few countries and companies. These have to compete in the international market to a large extent.

Small shipbuilding and repair includes boat building on an industrial scale. It competes with imports for production of workboats, fishing vessels, tugs, etc.

Boat building is essentially artisanal and almost exclusively devoted to support of fishing activities. In terms of numbers of vessels and people, fishing is the dominant activity which creates a demand for boat building and repair, and for small shipbuilding.

The review is presented in subsequent paragraphs of this Chapter on a country by country basis and is based on available published data. To this extent, it may well be incomplete and this has led to one of the key recommendations (see Chapter 1).

The appendices to this report list the various nations' fleets by principal types and identify the main shipbuilding and repairing activities.

2.2 Mauritania

The main component of the Mauritanian fleet is fishing vessels. The 1986 figures record 69 vessels, plus 1 factory vessel under Mauritanian flag. Apart from these, there are only 3 vessels which fall into the first 2 sectors as identified above. There are existing projects to extend local fishing capacity. Currently, exploitation of the good fishing grounds is largely by foreign fleets.

The two largest supplies of vessels to Mauritania are Spain and Japan. Most, if not all, vessels are imported.

There are no shipbuilding or repairing facilities to support the ships which operate in Mauritanian waters. No published information has been identified describing artisanal fishing activities or other small boats, but these are believed to be similar to those in other countries of the region.

2.3 Senegal

The fleet in Senegal is also dominated by fishing vessels. Around 130 trawlers, averaging 250 tons gross, were listed for 1986. Other vessels number 10, including ferries, oil tankers and tugs. Most of the vessels are between 10 and 20 years old. They are mainly French-built. However, two small vessels were built locally. It is reasonable to assume that a significant replacement or major overhaul programme will be required over the next few years.

There are significant facilities at Dakar. These include docks and slipways with capacities up to 25,000 tons dwt for large vessels. There is also a slipway for small ships up to 73 metres in length, and a shiplift. No detailed information is available but the facilities are all believed to be serviceable.

The two main enterprises record manpower for shiprepair of about 1,000 personnel in total. Current activity levels are now known, but there is clearly considerable potential.

In the artisanal sector, it is recorded that these were approximately 9,000 pirogues (small fishing canoes) in 1985. About 50% of these are fitted with motors and there are development projects planned to increase this proportion.

There is a boatyard at M'Balling which may be expanded to meet a development programme. However, there is a shortage of adequate facilities for this sector of the industry.

2.4 The Gambia

Only five vessels are recorded in the first two sectors. These are two fishing vessels, a tug, a dredger and a dry cargo vessel.

There is a single slipway, capable of taking vesssels up to 550 dwt for repair. This is sited at Banjul. It is reported as being under restoration. Up to 150 people are employed for general repair work to vessels in the second sector.

With respect to fishing activities, it is noted that there is considerable potential, but catches landed locally are actually declining. No information on artisanal fishing, or its supporting boat building and repair activities is available. It is assumed to be non-industrial, using traditional methods, as is the case in other countries.

2.5 Guinea-Bissau

A total of 17 vessels, mainly fishing and small general cargo ships, are recorded. Most of the vessels are relatively new, built mainly in Eastern Europe or in the Netherlands.

There are limited facilities for hull and machinery repairs at the Port of Bissau. No docks or slipways are recorded.

There is no information on the third sector, artisanal fishing and related boat building.

2.6 Guinea

The fleet has 6 large trawlers, together with a number of harbour craft and dry cargo ships. There are 19 vessels in total, built mainly in Western Europe.

The main facilities for ship repair at at Conakry and comprise a slipway of 120m length, capable of lifting a vessel of 1,000 tons and a small floating dock capable of servicing harbour craft.

The port is capable of accepting vessels up to 25,000 grt and has a turnover in 1986 of nearly 5 million tons. This implies a large potential market for shiprepair.

In addition to the trawlers, the fishing industry has around 2,300 artisanal boats. There are good fishing grounds but most of the catches are made by foreign trawlers licensed to fish in the area.

There are no significant or semi-industrial facilities for boat building or repair.

2.7 Sierra Leone

Sierra Leone has a fleet of 29 vessels, including 17 trawlers and 6 ferries. Most of the vessels are 10 or 15 years old and the main builders were USA and Japan. None were built locally.

For maintenance, there is a slip of 500 tons capacity, with a maximum length of 158 metres. There is also a small shiplift. No data is available on the numbers employed. The shiplift is intended to service some new, steel-built trawlers.

In the artisanal sector, there has been work to upgrade the quality of boats. These are mainly dug-outs, using traditional techniques. There are a few planked boats. No information on the total number of such vessels is available.

There are no significant boat building facilities.

2.8 Liberia

The Liberian fleet is nominally one of the world's largest. However, the true (beneficial) owner of most of the vessels is actually overseas. The local fleet, mainly tugs, has about 50 vessels below 500 grt.

To service the fleet, there are only limited facilities. There is a drydock at Monrovia with a length of 42.7 metres.

There is another small repair yard with a floating dock but this is currently out of commission. There are plans to re-activate this facility.

There is little information on the fishing industry. There are no large trawlers, so the industry is basically artisanal. There are some steel vessels but no adequate repair facilities.

2.9 Cote d'Ivoire

The total fleet size is around 58 ships, including 35 trawlers. These are mainly 20 years old and a replacement programme may be needed. Various other types of vesssel, the largest being general cargo ships, are represented in the fleet.

France, followed by the Netherlands, is the main supplier of vessels. Three of the small vessels were built locally.

There are significant repair facilities at Abidjan, including three floating docks. Two of these are suitable for smaller ships, but the largest can take ocean-going vessels of up to 10,800 tons and 170 metres in length.

There are also three slipways over 100 metres in length. There are, in addition, three smaller slipways (with a maximum capacity of 300 tons) at Ebrie Lagoon.

All types of repairs can be carried out. There is, however, no data on the numbers employed or the skills available.

Information on the fishing industry at the artisanal level, and its supporting boatbuilding activities, is very limited.

2.10 Ghana

The Ghanain fleet is one of the largest in the region, with respect to true ownership. There are 137 vessels, of which 98 are fishing vessels. There are also a number of general cargo ships and tugs. Most of the small vessels are 20 or more years old.

To maintain the fleet there is a slip of 600 tons capacity, situated at Takoradi. This is suitable for small vessels, up to 39.6 metres long by 9.75 metres beam. There is also a small drydock which may not be operational.

There is also a larger facility at Tema. This has a slipway of 150 tons capacity and two drydocks, the larger of which can take vessels up to 50,000 tons deadweight. The heaviest crane lift is 60 tons. The facility at Tema can provide a wide range of repair services. There is limited shipbuilding on an industrial scale at Tema.

There are some small steel craft which were imported in kit form and assembled locally. The small boats are traditionally dug-outs, in common with the whole West African region. In recent years outboard motors have replaced oars or sails for propulsion. There have been a number of planked boats built with both inboard and outboard motors.

There are a number of boatyards, in addition to artisanal building, located at:

- Sekondi - up to 35 ft boats
- Tema - up to 150 ft boats
- Mumford - small boats

Smaller boatyards (seven in number) are located around the country and there are numbers of individual boatbuilders. Methods are largely traditional and labour-intensive.

2.11 Togo

The fleet in Togo consists of five general cargo ships, two tugs and three large trawlers. These are relatively new vessels supplied by France, the Federal Republic of Germany and Italy.

There are no facilities to repair large or small vessels. Work is normally carried out in Abidjan, on the Ivory Coast. There are no shipbuilding facilities, the fishing and other vessels having been built in Western Europe.

There is no published information on the artisanal fleets, or the facilities for their construction and maintenance.

2.12 Benin

Benin has a fleet of 15 vessels, mainly built in Western Europe. The largest number are fishing vessels of around 130 grt. There are two cargo vessels of around 6,000 dwt.

As with Togo, all of the vessels are built and repaired overseas. Half of the vessels are over twenty years old, so a replacement programme may be needed soon.

There is no substantial data on the small craft and artisanal fishing in Benin. It is assumed to be in a similar state to the other nations; that is, there are mainly single entrepreneurs or small primitive boatyards engaged in production and repair of traditional small craft.

2.13 Nigeria

With the exception of Liberia, Nigeria has the largest fleet in the region. There are 206 vessels, of which the largest single group are 98 fishing vessels. There are also 40 general cargo ships and 15 oil tankers. Of the total, 167 are below 500 grt. These include all the fishing vessels, plus tugs and miscellaneous small ships.

For the size of fleet there are relatively sparse facilities. No industrial-scale shipbuilding is undertaken. For shiprepair there are slipways at Burutu and Lagos.

At Burutu vessels up to 37 metres in length and up to 600 tons can be slipped. There are four slipways in total. At Lagos there are two slipways with a maximum lift of 500 tons and two mechanical lift docks with a maximum lift of 190 tons. There is also a graving dock which is not yet operational. The repair work is limited in scale, and also can only be carried out on the smaller vessels.

Small craft are produced on an industrial basis at Warri, where there is a new, covered facility for workboats up to 15 metres in length. Typical products will be launches and landing craft. The facility has 3,000 square metres of covered workshop.

There is also a small amount of steel boatbuilding at Warii, and some building of platforms for oil exploration.

There are other small, industrial boatbuilders and repairers in Nigeria, but the majority of the many small vessels which are in use have been imported in recent years. There is little information on the small, locally built fishing boats.

2.14 <u>Cameroun</u>

There is a fleet of 49 vessels, the majority of which are trawlers and shrimp boats averaging 160 tons grt. These are mainly over 20 years old, with a few about 10 years old. The vessels were built in various countries, with France and the USA predominating.

At Douala there are two old floating docks of 1,000 and 500 tons capacity. These are to be supplemented by a new, West German-built floating dock which has recently arrived. This is capable of lifting most of the vessels operating in the West African region. This dock will be supported by new workshops and equipment, and will represent a significant development in the shiprepairing capability of the West African region.

Although Cameroun has a better-developed infrastructure than most countries in the region, it has very limited facilities for small shipbuilding or repair. There are believed to be some plans to begin steel boatbuilding.

In the artisanal sector there are some 4,000 fishing canoes. To support these there are no industrial or semi-industrial facilities, and the methods in use are very much traditional, in common with the other nations in the region.

2.15 Equatorial Guinea

Only two large ships, one general cargo and one passenger cargo are recorded. There are no shipbuilding or repair facilities. No small shipbuilding or repair facilities are available.

In the artisanal sector there are a number of pirogues, but these are built and maintained locally, in primitive facilities. (See also Sao Tome).

2.16 Gabon

There are 23 vessels of various types, the largest numbers being of fishing vessels and small passenger ferries. There are one-third over 20 years old and one-third 10 to 20 years old.

France has been the largest single supplier. No vessels have been built locally.

There is a 300 ton slip at Cap Lopez, which is available for limited repair work on the smaller vessels. A particular need for training has been identified. The ability to carry out some repair work on the National Fleet is a desirable development.

There are four small private boatyards building in wood and GRP. These are in the early stages of development. This is being done in cooperation with foreign partners. At present many of the local vessels are repaired in Cameroun.

There is limited information on the artisanal sector. There are, however, no semi-industrial facilities, canoes being built locally using traditional materials and methods.

2.17 Congo

The Congolese fleet consists of 21 vessels; 18 fishing vessels and 3 tugs. The vessels are largely French built. Half of them are 20 years or more old.

There is a single, 600 ton capacity slipway at Pointe Noire. Most types of repairs on small vessels can be undertaken.

There is limited information on the workboat and artisanal sectors. However, it is undoubtedly the case that a need exists for improved facilities and support for boatbuilding and repair.

2.18 Zaire

Zaire has 31 vessels in its fleet. Half of these are fishing vessels, the rest include general cargo, tugs and dredgers. The smaller vessels are mainly around 20 years old or more. The vessels have been built in various East and West European countries. Only one has been built locally.

For shiprepair, there are two small floating docks at Boma. These both have a lifting capacity of 800 tons, with a maximum vessel length of around 70 metres. There are limited facilities to carry out repair and maintenance activities.

The river transport sector has also been specifically identified as of great importance to Zaire. Inland waters have not been specifically identified for other countries but, in areas where road and rail links are often limited, it should form a component of any further studies.

There is limited information on the artisanal sector but, in common with other countries, there is a need for improvement in the support facilities.

2.19 Angola

The Angolan fleet is one of the largest fleets in the West African Region. It consists of 100 vessels, including 65 fishing vessels, 20 general cargo ships and various other types.

The vessels have been built in many countries, with Spain being the largest single supplier, providing 35 of the fishing vessels. The fleet is relatively new, with most of the smaller vessels in particular being less than 10 years old.

Angola has a number of facilities for shiprepair. These support the smaller vessels in the fleet.

At Lobito there are four slipways with a capacity of 1,500 tons. Vessels up to 75 metres in length can be slipped. There is also a floating dock (built in 1967) which can lift a vessel of 2,200 tons.

At Luanda there are two slipways with a 500 ton capacity. These have a restriction on ship breadth of 6.25 metres. Other small slipways are located at Mocamedes, Porto Alexandre and Soyo.

There has been some development in recent years in the small vessel sector. There are a number of small boatyards, mainly at Luanda. These specialise variously in wood and steel. There is some construction, but mainly repair work is carried out. The facilities available are small and limited in capacity. Much of the equipment is old. There is a need for an enhanced technical capability.

2.20 Cap Verde

There is a fleet of some 25 vessels belonging to the Cap Verde Republic. These are mainly small general cargo ships, with a few fishing vessels and other small ships.

There are several repair facilities. At St Vincent there is a shiplift of 2,800 tons capacity, with up to six berths available for shiprepair. There are adequate workshops to provide a range of repair capability.

There are also two slipways with a lifting capacity of 250 tons.

For smaller vessels there is a boatyard which can produce vessels up to 16 metres long (in wood or GRP) as well as carrying out repairs. There is a need to strengthen the local capability, to improve both fishing and inter-island communication.

There are currently around 50 boats in semi-industrial fishing all of which are old.

There is also a large artisanal sector. An estimated 1,200 canoes, up to 6 metres long, are in use; less than half are motorised. The boats are built on the beaches, using some imported wood.

Improvements to the fishing boats, and to their support facilities, are badly needed.

2.21 Sao Tome and Principe

The fleet consists of only two fishing vessels and one general cargo ship. There are no facilities available for shipbuilding or repair.

In addition to the two large trawlers there are seven smaller vessels (around 15 metres long) in the semi-industrial fishing sector.

In the artisanal sector, there are around 1,500 canoes (generally between 5 and 10 metres in length). None (or very few) of these are motorised.

There is an unused dockyard at Neves which it may be possible to re-commission. It would require a significant training effort and some new workshops and equipment.

3: TECHNOLOGY

A: INTRODUCTION

3.1 Levels of Technology

This chapter reviews the technology of shipbuilding and shiprepair. It is necessary to review the technology in the context of the three sectors which have been identified. These are:

- Large scale shipbuilding and repair, which is essentially international in character. It is industrial in technology.

- Small shipbuilding and repair, which is serving local markets but has to compete with imports. It is industrial or semi-industrial.

- Boatbuilding and repair, which is primarily artisanal in character.

Each sector will need a different approach, a different level of technology and a different mix of labour and capital. As a starting point, it is possible to consider the appropriate level of technology for each case.

Four levels can be identified. These refer to the general status of development and apply to all three sectors. These represent shipyards in different stages of development, with different volumes of production and with different labour costs. In general, the higher the labour cost and volume of production, the higher the desirable level of technology.

Level 1 - The Basic Technology Shipyard

This shipyard contains basic production facilities, including several inclined berths for hull construction. The following features typify the level of technology.

- Relatively low capital investment.
- Large workforce to achieve output.
- Unsophisticated equipment.
- Traditional shipbuilding methods.
- Small structural units.
- Large proportion of manhours expended in the open on inclined berths.
- Vessels outfitted principally after launch.
- Low level of organisation.
- High level of shipbuilding skills.

- In production in a shorter period than the higher technology yards.

- Flexibility in product mix.

- Difficult to significantly change technological base.

Level 2 - The Medium Technology Shipyard

This is a more modern shipyard and would probably have two or three inclined berths or simple ship transfer system. The following features typify the level of technology:

- Higher capital investment to improve productivity and reduce size of workforce.
- Some modern equipment and handling systems.
- Batch production techniques in some outfit shops.
- Larger structural units to reduce manhours on the berths.
- Partial outfitting and painting of structuralunits before erection.
- Some block assembly.
- Output two to three vessels per berth per year.
- Better quality of work.
- Vessels launched in a more complete condition than in the basic technology yard.
- Improved working environment, giving increased attractiveness for the workforce.

Level 3 - The High Technology Shipyard

This is a modern shipyard in the world wide sense and would incorporate a relatively advanced ship production system. Hull construction would probably take place in a single dock or on a flat berth with a sophisticated transfer system, such as a shiplift. The following features typify the level of technology:

- High capital investment.
- Good manpower productivity.
- Modern equipment in all main areas.
- Advanced production techniques.
- Mechanised production in many steelworking areas.
- Flow line or large batch production and modular construction in outfitting.
- Large "natural" structural units for fast erection at low manhour expenditure.
- Majority of manhours expended in good working environment.
- Multi stage hull construction.

- Substantial outfitting and painting of structural units before erection.

- Substantial outfitting and painting of vessels before launch.

- Good working conditions throughout the snipyard.

Level 4 - The "High Plus" Technology Shipyard

This shipyard would be highly advanced and would have a unique ship production system. Hull construction would take place largely under cover. The following features typify the level of technology:

- Very high capital investment.
- Best available equipment.
- Highly mechanised subassembly and assembly lines.
- Extensive modular construction in outfitting.
- Large "natural" structural units for fast erection at minimum manhour expenditure.
- Large majority of manhours expended under cover.
- Multi stage hull construction in one dock.
- Vessels undocked virtually complete.
- High level of environmental protection.

- Excellent working conditions.
- Small, highly productive, workforce.
- High degree of organisation.

3.2 Historical Perspective

The first shipyard was no more than a sloping beach, down which a completed vessel could readily be launched into the water. Choice of site was dictated by the proximity of suitable materials, usually wood.

The situation did not change substantially for many years. Although the size and complexity of ships increased, the basic requirements remained the same. The details of the technology employed also changed, although it remained until the twentieth century essentially a manual operation. During this century, and particularly in the last thirty years, shipbuilding technology has developed rapidly. The main characteristics of these are shown in the outlines of the four levels of technology.

Many shipyards have elements of different levels of technology, reflecting the process of change and development over time. The successive levels are associated with several driving forces:

- an increased level of throughput.
- greater specialisation of ship types produced.
- increased level of investment to offset high labour costs.

It is characteristic of shipbuilding technology that it is relatively easy to transfer, even at the advanced levels. For example, countries such as Korea and Brazil have become leading nations, because they have been able to use relatively advanced technology alongside a labour cost advantage over traditional shipbuilding nations.

In many ways small shipyards have not shown the same degree of development as those of larger size. This is for a number of reasons:

- the market for small vessels is more fragmented and localised.
- there is less money available for investment, because of the small scale of operations.
- the opportunities for series production are often less.

There are relatively few examples of advanced technology small shipyards. In the market conditions which exist, the opportunities for investment to create advanced small shipyards are very limited. It is therefore appropriate to consider how low cost technology may be adapted for efficient production in small shipyards.

Boatbuilding and repair has remained at the most basic level. There are some advanced technology boatyards in developed nations, which reflect the high labour cost and volume of production. In these, hundreds of boats may be built annually using industrial, flow-line methods.

3.3 Conflicting Requirements from Technology

The overall development of shipbuilding technology has been associated with three trends:

- towards high volume production, in order to justify investment.

- towards a limited range of vessel types.

- towards high capital investment and automation in order to offset labour cost.

In general, high efficiency of production has been associated with high volume and high investment. A need has been identified to develop technology which will allow high efficiency at low or medium volumes and without large investment.

The traditional basic technology shipyard has low efficiency, because of the piece by piece construction techniques and lengthy cycle of construction. It can only achieve high volume by multiple berths, which result in extra investment and large volumes of work in progress. It is a model which is not viable in current economic conditions, and represents a situation of stagnation.

The intermediate levels of technology represent the historical movement from the previous situation, and are a response to economic pressures. They require significant investment to achieve their greater efficiency.

The high level of technology is only viable at high rates of production, and is very capital intensive.

With respect to labour, the low technology is associated with high levels of skill, representing years of training and experience. Increasing levels of technology move from craft orientation to lower levels of skill for most of the workforce. The skill is substituted by equipment. There is also a requirement for more formal organisation and control, to replace elements of craft skill and also to manage the faster rates of production.

The challenge is to develop a technology which meets the conflicting requirements of:

- acceptable efficiency.
- low or medium production rates.
- minimum investment.

3.4 Industrial and National Objectives

Apart from cost effective shipbuilding, there may be additional objectives. Among common reasons for developing shipbuilding and repairing, whether on a small or large scale, are:

- creating employment - shipbuilding at all levels of technology is a labour intensive industry and creating jobs can be relatively cheap.

- reducing imports - as an easy industry to enter, local production of ships is a good way to achieve this objective.

- improving transport or other marine activities - investing in shipbuilding may be the means of stimulating other industrial activities.

In addition to these objectives, which may modify the absolute requirement to be cost effective, there are some overriding objectives which must be met to make a shipbuilding operation viable.

It is in the first place essential to be able to produce ships to programme. Reliability of delivery is the first essential of any shipbuilding enterprise. It is not important whether the timescale is long or short, but meeting the delivery target is the means to build confidence in potential customers. It is secondly important to meet budgetary objectives. Again, whether or not the enterprise is intended to be profitable does not matter, but once a budget has been set it should be maintained.

Finally, the time and budget targets should represent the best obtainable.

B: SHIPBUILDING AND REPAIR

3.5 Ship Design

It has been traditional to regard the design and production of a ship as two separate processes. The responsibility of the designer has been seen as the development of a design that will satisfy the needs of operation, while the producer has been required to make whatever vessel emerged from the design process. In the increasingly competitive climate of current shipbuilding, this separation is increasingly inappropriate. Those organisations which are competitive have increasingly adopted a policy of integrating design and production.

The key element of design for production is that the designer should take account of available production processes in preparing his design. This requirement is of importance whether the production facility under consideration is an advanced, highly automated shipyard, or one which is extremely basic in character. Whatever level of technology is available, its operation will be enhanced if the vessels to be built have been designed with its particular production characteristics in mind.

The need for design for production arises largely from changes in production. Traditional long construction cycles, with sequential outfitting, have been replaced by a demand for the shortest possible building time. This has resulted in a need for technical information in a form suited to production and in a sequence closely geared to the production schedule. It is therefore clearly essential for the designer and producer to work closely together.

In the traditional design process the vessel is designed as a series of systems, each of which is created independently of the others. The various systems are created sequentially, that is the steel structure will be developed in terms of shell plating, frames and so on, followed by the various outfitting systems. These will each be created with reference to the steel but not to each other. Although considerable detail is included in the drawings of the systems, it is essentially pictorial. It does not provide sufficient information to allow the elements of the systems to be produced efficiently.

Because of the level of detail which is achieved, the drawing process takes some considerable time, which delays the start of production. It is then necessary for the production departments, or a local drawing section, to review the drawings, to identify anomalies, avoid interferences between systems and to create additional information to allow the parts to be produced and subsequently assembled together. Further, the traditional system drawing does not include any specific production information. Such aspects as:

- Material Lists
- Assembly Sequences
- Dimensional Control Data

are usually not to be found. Once again, this information has to be created by the production epartment, or by an ancillary drawing/ technical office.

This type of production specific information is necessary for any level of productive efficiency. If a high level of efficiency is sought, then it becomes crucial. In many shipbuilding companies, therefore, an additional design phase has been introduced. This takes a complete design and transforms it into the necessary production information. Each system is overlayed on the others, and on the steelwork. From these "composite" drawings, it is possible to identify and correct interferences and hence create drawings which show all the systems in part of the vessel in their correct relative positions. Once the breakdown of the hull into its erection blocks has been determined, and the installation of the outfit equipment, whether conventionally or as modules, decided, the composite drawings provide the basis for production drawings for each individual unit.

By using the technique described above it is possible to achieve a considerable reduction in the time and manhours required to complete a vessel. There is, however, a drawback and this is that the time taken to design the vessel will be considerably extended. Further, the design will still be system oriented and will have taken little account of the capacity for the production facility in which it is to be built. For example, the lifting capacity in a workshop producing modules cannot be considered until the module has been identified from a composite drawing.

By this time also the relationship between different items of equipment will have been decided on criteria other than what constitutes the most effective module design. The precise location of pipes and other transit systems will be decided system by system. This results in inefficient routings and in more complex pipework than might otherwise be necessary.

There is a need for a fundamental change in the design process, to match the need for changes in production.

The need for the technical function to understand production requirements and for production departments to understand technical procedures and requirements is greater than ever. It will not be possible to achieve the low production cycle times, short delivery times and high productivity unless the technical and production functions work closely together.

The traditional role of the ship designer is the preparation of an overall design of vessel which will have a performance satisfying the owner's operational or functional requirements.

The concept of design for production, however, requires that in satisfying these requirements, the ship designer must also give attention to ease of production. There are thus two major aspects to design, namely, design for performance and design for production. There are other aspects also, including design for overhaul, repair and maintenance.

The overall objective of design for production can be defined as follows:

- "Design to reduce production costs to a minimum, compatible with the requirements of the vessel to fulfil its operational functions with acceptable reliabiity and efficiency".

3.6 Shipbuilding Production Technology

This covers the whole range of shipbuilding activity, both the necessary plant and equipment and the means of organising and controlling its operation. The technology employed is the means of achieving the objectives set for the enterprise.

Consistent Technology

It is believed by many shipbuilders at all levels of size and sophistication that the only thing preventing them from achieving international levels of productivity or reliability is their shipyard equipment. However, good or improved plant and equipment are never the total answer and in many cases are not even initially needed to improve performance.

At least as important as the equipment are the organisation and production methods used in a shipyard. The organisation and methods must always be at least as advanced as the equipment, and often the desired improvement in performance can be achieved solely by improving the organisation and methods, without any significant expenditure on equipment.

The technology needs to be developed from sound principles and applied consistently throughout the shipyard. A collection of random solutions to immediate problems will not produce a significant improvement and may not even solve all the immediate problems.

Shipbuilding Principles

- Solve problems as early as possible. Preferably identify the problems and find the solutions before production starts.

- Do work as early in the production cycle as possible. It is nearly always the case that the earlier the work is done, the easier and more efficient it is. Most of the improvements in production technology result from the application of this principle and not from the high-technology equipment that is the visible change.

- Make work parallel not sequential. By doing two pieces of work simultaneously rather than one after the other, not only is the total time (and hence the build period) reduced, but also anything which makes one piece of work late does not make the other late.

- Reduce or eliminate unnecessary work in production by design improvements. "Design-out" problems so that no solution is needed.

- Employ new technology as the efficiency of the yard makes it economical to do so, in order to make work faster, easier or of better quality.

These principles need to be applied throughout the shipbuilding process.

Planning

Many of the problems encountered by shipbuilders relate to time, such as difficulty in delivering on time, or late delivery of equipment by suppliers. If time were unlimited, many of the problems would not exist, but this is rarely the case and in particular the timing of delivery of a ship is normally of great importance.

So the shipbuilder must maintain control over the timing of events and this must be incorporated into management systems. Just as he must build the ship to the correct shape, he must also build it at the correct time.

In order to control the timing of events, it is necessary to plan when each event should occur and then work to make sure it does occur at the planned time. Thus, the two elements of "time control" are planning and progress monitoring.

There are three basic levels of planning:

- strategic or long-term
- tactical or medium-term
- detail or short-term

In small yards, the first two levels, strategic and tactical, are the most important as they set the framework. Supervisors can then use this framework to work out the detail level for themselves. In extremely small yards (say, under 100 people), planning could be reduced to only the highest strategic level.

The tasks to be carried out at each stage are outlined below:

Strategic Planning

- Decide how the ship will be built and divide the work to be done into "Planning Units" (eg, steelwork unit).

- Using this information, forecasts of timescale and key dates can be made.

- From the build method and timescale, the resources (men, shop area) required over the period of the contract can be identified.

- Identify key dates by which technical information is required.

- Identify key procurement dates for equipment.

The inputs to this stage will be:

- The ship specification.
- Design drawings.
- Manhour estimate.

The key output from this stage will be a Master Schedule, showing major steel and outfit activities.

Tactical Planning

- Identify the work to be done in each "Planning Unit" and divide the work into stages.
- Calculate (or initially estimate from experience) the time required for each stage and generate a simple network for each planning unit.
- From the Master Schedule and the planning unit times, date each stage and look at the workload going through each production process.
- Using this information, refine the resource estimates from the strategic level.
- Check procurement dates against the more detailed schedule. Revise, if required.

Detail Planning

- Identify the work to be done at each stage and the products required.
- Calculate the time required to produce each product.
- Schedule the flow of products through each area of the shop or ship.

Progress Monitoring

Planning is of little use if the plans are not adhered to, and so some form of checking progress is required. Traditional shipyards have used various ways of measuring throughput such as number of plates cut per week, number of tons of steel erected per week, number of pipes installed per week. These all have the inadequacy that knowing the number of plates, pipes, etc, does not demonstrate if these were the correct plates, pipes, etc. Having produced a plan of production, only one question really needs answering - are we on programme?

So the purpose of progress monitoring is to measure whether planned dates were achieved and whether the hours used exceeded the planned hours. In the event that either of these conditions is not met, the immediate aim is to work out how production can quickly get back on to the programme.

Purchasing/Material Control

One obvious requirement for the shipbuilding process is the equipment and materials from which the ship is assembled. The purpose of the purchasing and material control functions is to ensure that the required equipment and materials are available when they are needed by production.

In order to obtain equipment and materials when needed, it is essential to have an accurate knowledge of the lead time for each type of material, so that ordering takes place early enough to ensure the production programme is not delayed. Shipyards which import a significant proportion of their materials need to develop the technique of bulk ordering the majority of equipment and materials at an early stage. Then as the design (and hence material requirements) is refined, a second "topping-up" order can be placed for use later on in the contract.

As the design is refined and production drawings produced, the generation of parts lists must become an integral part of the production information so that all non-stock items are defined early enough. Even stock items should be identified so that reordering can take place before stocks are exhausted.

Production

The development of shipbuilding and repair technology has been along the lines of a steady progression from basic to high technology. It has been led by nations seeking high volumes of production and those compensating for high labour costs. In terms of production hardware, there is relatively little new. Recent developments have been more related to organisation of production and ensuring a complete set of information and materials is available for production. This is perhaps the most important aspect to be considered.

In production, the corresponding need is for organisation of workstations, so that similar items are produced repetitively by a group of workers, with their tools and equipment. The tools and equipment can be specialised and efficiency thereby increased.

3.7 Shiprepair

Shiprepair has many characteristics in common with shipbuilding and much of the discussion above applies equally to both. They key difference is one of timescale. Where shipbuilders work in months and years, shiprepairers work in days and weeks. It is therefore essential to have a high level of organisation, with a well-trained and flexible labour force. This allows a shiprepairer to respond to the short-term, unexpected variations in workload which are normal.

The production technology equipment and plant has also developed. As with shipbuilding, it has been the nations with high labour cost which have led the way. Significant progress has been made towards automating such labour-intensive processes as hull cleaning and painting. Some of the design for production concepts have been applied, so that equipment is removed from the ships to be repaired in a workshop rather than work taking place onboard ship.

However, the application of new technology has been variable. A few large repair yards are equipped with the large cranes and sophisticated equipment associated with high technology. Most have remained at a lower level, and have concentrated their development efforts on organisation and particularly labour flexibility.

C: SMALL SHIPBUILDING AND REPAIR

3.8 Ship Design

The small ship sector provides a huge diversity of designs, from one-off, specialised vessels to series produced fishing vessels and workboats. The larger vessels are generally of steel, but smaller vessels may be of a variety of materials.

The main recent development has been in the increasing use of the concept of design for production. This is of particular importance when the facilities available and the skills to operate those facilities may well be limited. The overall objective of design for production has been identified above (3.5). It to reduce the production cost to a minimum, compatible with the requirements of the vessel to fulfil its operational requirements with acceptable reliability and efficiency. The extension of the design process to include a design for production function has the following primary objectives:

- To produce a design which represents an acceptable compromise between the demands of performance and production and, where appropriate, takes into account the needs of overhaul, repair and maintenance.

- To ensure that all design features are compatible with known characteristics of the shipyard facilities.

- To apply design for production principles and procedures insofar as they are relevant to the particular vessel and to the particular shipyard where the vessel is to be built.

- To coordinate the inter-relationship between the machinery, electrical and outfitting work with the structural work, in order to create a fully integrated design.

It is, of course, vital that design for production effort starts early in the design process. The designer has the greatest influence on the cost of the vessel during the earliest design stages when main materials and equipment and the basic configuration are being decided. The influence he has on cost drops off quite rapidly in the later design stages. Five stages of design can be identified. These are:

- Conceptual
- Preliminary
- Contract
- Transition
- Detail

Conceptual Design

The objective of the conceptual design stage can be stated to be:

- To establish overall features of a design to meet owner or mission requirements.

The content of the stage can be defined as a series of inputs and outputs. Inputs may be presented in the form of an outline specification, or one may be developed as a basis for the conceptual design. Inputs and outputs are listed below:

Inputs

- Service requirements
- Routes
- Market forecasts
- Technical change

Outputs

- Preliminary general arrangement, midship section
- Preliminary specification
- Preliminary calculations (dimensions, capacities, etc)
- Preliminary body plan

If at this stage a shipbuilder has been identified the following production inputs and outputs are essential:

Production Inputs

- Shipbuilding policy:

  - type plan
  - facility dimensions
  - interim product types

Production Outputs

- Preliminary block breakdown
- Zone identification

Preliminary Design

The objective of preliminary design is to establish the features of a design in sufficient detail to form the basis of a contractual arrangement.

The stage can be defined in terms of a series of inputs and outputs. One major input will be the output from a conceptual design. The main inputs and outputs are listed below:

Inputs	- Conceptual design
	- Functional requirements
	- Regulations
	- Design standards
Production Inputs	- Shipbuilding policy
	- Company standards and industry standards, including: - material sizes - modules - service runs - block sizes

Outputs	-	General arrangement, midship section
-------	-	Specification
	-	Body plan
	-	Ship calculations
	-	Arrangements
	-	Piping diagrams
	-	Electrical load analysis
	-	Plan list
Production Outputs	-	Preliminary build strategy
------------------	-	Equipment identification
	-	Material requirements:
		- quantities
		- long lead items

Contract Design

Contract design follows contract signing and is intended to establish features of a design for the purposes of classification and other approval and material specification. The various inputs and outputs are listed below:

Inputs	- Preliminary design
	- Functional requirements
Production Inputs	- Preliminary build strategy
	- Standards
	- Production processes and facilities
Outputs	- Ship Design:
	- hull form capacities, etc
	- approval drawings, scantling plans
	- Machinery installation arrangements
	- Accommodation design
	- Ship systems design
	- Hull outfitting
Production Outputs	- Contract build strategy
	- Schedules:
	- erection/installation
	- assembly
	- manufacture
	- Purchasing information

Transition Design

Transition design is considered here as a distinct stage, although in some aspects it runs parallel to the functional design process through all the stages.

The objective of transition design is to translate the features of the design from the system orientation, necessary to establish functional performance, to a planning unit orientation, necessary to establish production requirements.

Transition design develops elements of systems into steel and outfit zone composites. It should be based on the spatial analysis of earlier design stages.

However, for effective design for production to take place, production needs and capacities should be highlighted from the earliest stage.

Inputs	- Conceptual design
------	- Preliminary design
	- Contract design
Outputs	- Process analysis
-------	- Interim products
	- Work package information
	- Workstation drawing information

Detail Design

The objective of detail design is to establish the features of the design necessary to allow local purchasing, part manufacturing and subsequent assembly to be carried out.

Detail design is carried out by planning unit, on those elements of the ship which have been developed to the stage where all functional and approval requirements have been satisfied.

It can be defined in terms of inputs and outputs:

Inputs

- Contract design
- Transition design
- Build strategy
- Standards
- Workstation capacities
- Process analysis

Outputs

- Work instructions
- Workstation drawings
- Material lists
- Dimensional requirements

Outfitting

Emphasis is placed on outfitting design for production because, in all but the smallest vessels, outfitting is the operation that causes problems.

At the earliest design stage the division of the hull into units, and the identification of zones for installation, is made. An overall schedule for the building of the vessel is developed. The installation zones can be split into functional spaces, each containing related equipment. These spaces will form the basis of modules or outfit assemblies. Each space or module is designed in detail as a complete entity and the sequence of design is related to the sequence of production.

Outfit Subassemblies

Outfit subassemblies consist of a number of minor assemblies and parts joined together and, like minor assemblies and parts, are categorised by a trade group. They may however involve more than one trade in their production. For example, pipe subassemblies consist of a number of pipe parts or pipe minor assemblies bolted to common steel supports, which will then be installed on an outfit assembly or unit, on a steel unit or block, or on-board the vessel.

Joining the individual pipe parts into a pipe sub-assembly reduces the work content at the installation stage.

Outfit Assemblies

Outfit assemblies are made from a number of subassemblies, minor assemblies and parts. The size and weight of these assemblies are relatively large and require cranes for handling.

These assemblies may then be joined to form larger outfit units or else are inspected, tested and painted and installed on steel panels, blocks or on-board the vessel.

Typical outfit assemblies consist of a steel frame on to which pipes, venting, light supports or lights and cable trays are attached. The two assemblies identified in the figure below are:

- the outfit unit base frame with a pipe subassembly (installation is the framework upside down).

- the outfit unit top frame complete with venting, cable tray and lights.

Outfit Units

Outfit units are large enough to be identified at the earliest design stages and defined in the build strategy document for the vessel.

The work content in the production of an outfit unit warrants independent planning and monitoring, and thus outfit units are also defined as planning units. For outfit units:

- installation on-block or on-board is planned and monitored
- an assembly programme is generated and monitored
- separate drawings are produced

Outfit units are assembled from outfit assemblies, minor assemblies and outfit parts, and are painted, inspected and tested to as great an extent as possible before being considered complete.

Cables are also installed on the unit. If a cable run remains within the boundaries of the outfit unit, it is completed. Where the cable run passes to a further destination remote, it is installed as far as possible and the remaining length of cable is coiled for final pulling and fitting on-board the vessel after the installation of the outfit unit.

Two types of outfit unit are readily identified, equipment modules and pipe banks.

Installation on the Ship

Installation on the ship is planned and monitored by zone.

Zones which contain large or heavy outfit items such as the generators, or outfit units such as equipment modules, are left open for a period to allow the heavy items to be lowered vertically into place by crane (open sky outfitting). The zone can then be closed off by the erection of another unit or block on top. The erection programme is planned to give sufficient time between erection lifts to allow for open sky outfitting.

The designer should be aware of open sky outfit possibilities so that the structural breaks are positioned to best suit the installation requirements.

The positioning of outfit units clear of steel unit butts is also a feature that designers should consider. The unit breakdown is the first production engineering task carried out and will have been established when outfit units and blocks are being identified. The task of identifying outfit units and blocks is carried out by production engineers at the strategic level working with production management and the preliminary and contract design groups.

One important stage is the completion of hot work in a zone (and on the other side of the zone bulkheas or decks). On completion of hot work, final painting can be carried out, the area becomes "clean" and the outfit trades can work in good conditions. This is particularly important for the installation of delicate/sensitive equipment and cabin furnishings.

3.9 Production

The purpose of this section is to identify how, for smaller shipyards, the benefits of high technology can be obtained without the high expenditure associated with it. Efficient, high technology yards are characterised by the high level of organisation of work. These yards recognise that good organisation is required in order to make economic use of the high technology. The key to achieving good productivity without high capital expenditure is to adopt the same organisation of work but without the same capital expenditure on equipment.

The various stages of production are considered below.

Preparation

High technology shipbuilding makes extensive use of computer control for preparation equipment. This requires large investment which may not be available. It is nevertheless true that accurate components are the foundation of any shipbuilding process, and an alternative means must be found.

A number of simple devices are available to replace the manual preparation process. Whilst the accuracy obtainable will not be as good as that produced by computer control, it would be adequate.

The shaped portions of vessel hulls provide the most difficult area in preparation. Selecting a design which reduces the complexity of the components is of major assistance. It will prove possible to use labour-intensive methods, which include an element of trial and error, because preparation is the least costly area in terms of labour. The use of heat-line bending for steel hull plates is one relatively recent development which is very appropriate for small shipbuilders. Correcting problems at later stages is always more costly.

Assembly

It is essential to develop stages of assembly to put together parts prior to work on the shipbuilding berth. This reduces the amount of work carried out on the berth and therefore reduces both the time taken to build a vessel and the hours taken.

For very small vessels, it may be simpler to complete the hull in a single stage (depending also on the material). The assembly process can also be applied to outfitting. In many ways this is one of the most important aspects of technology. It is a matter of organisation, rather than facilities. It requires the minimum invescment, but can provide a considerable return.

A significant assembly operation conventionally requires investment in cranes and buildings. This requirement can be broken down into a number of elements, which are then provided separately:

Weather Protection	-	provided by the building.
Movement	-	achieved by low cost, ground level devices.
Lifting	-	mobile light cranes, small hoists which will cover most lifts.
Manipulating	-	turning over or positioning large assemblies can be achieved by taking the assembly to a fixed device.

By avoiding large cranes supported on building structures, it is possible to provide very simple buildings to provide whatever level of shelter is needed from the weather.

It is important to create workstations which specialise in specific types of work. These workstations can make use of simple, low cost jigs and fairing aids to enhance accuracy.

Ship Construction

This is the most expensive area in terms of manhours. The first essential is therefore to minimise the work done by adopting assembly stages. The construction area also normally requires expensive cranage and this is increased by large assemblies. As with the assembly stage, significant investment can be avoided by identifying each element of the construction operation. Then, the neea is to view each element separately.

If the assemblies are made sufficiently large, then all the major structural work can be completed and the assemblies moved and also joined using ground devices.

For small vessels, mobile cranes are a relatively inexpensive solution to the problem of erecting assemblies.

Tower cranes, as used on building sites, also provide a low cost alternative to conventional shipbuilding cranes. It is important to identify first the most appropriate method of constructing the ship, and then to define a technology to achieve this. It may be acceptable to construct deckhouses and other structures in smaller assemblies, if the main structure is completed in large units.

Outfit Installation

It is generally relatively easy to complete the structure of a vessel, although it may not be done efficiently or to high quality. However, installation of the services and equipment in a vessel is frequently a cause of lateness and over-spending.

Normally, in low technology shipyards, the traditional sequance is followed whereby installation only begins after completion and often launching of the hull. This ensures difficulties. In high technology shipyards, considerable expenditure is made in equipment and organisation to ensure that all installation is completed as early as possible in the shipbuilding cycle.

There are two techniques which can be used to move the work of on-board installation to an earlier, more efficient, stage of production; outfit assemblies and pre-construction installation.

Outfit assemblies consist of outfit items assembled together on their own steel supporting structure. These are constructed separately from the hull steelwork and are installed in the ship, leaving very little completion work on-board. Outfit assemblies can be used throughout the ship, although they are particularly applicable to machinery spaces and other areas with a high density of outfit items.

Installation of outfit items on to steel units before the ship is constructed offers several advantages. The area being outfitted is less congested and, with the unit on the shop floor, access is easier. Often the orientation of a unit will allow work that will be overhead at the ship (eg, deckheads) to be done downhand. Again, this techique can be used throughut the ship, but is particularly applicable to areas of lower outfit density.

Either of these techniques can be adopted by small yards with very little capital expenditure. The key to their successful use lies in the organisation of the work and the production of suitable production information.

Launching and Recovery

There are a variety of different launch methods available today, and the choice of the most suitable launch method for vessels to be constructed must be made. The decision depends on a number of factors, the main ones being as follows:

- Level of technology adopted in the yard.
- Range and size of vessels to be built or repaired.
- Capital cost of the development of the launch facilities.
- Maintenance of the launch facilities.
- Ease of the launch operation.
- Cost of the launch operation.

The first decision is whether to have a dynamic launch or a controlled launch.

Dynamic launches, where the ship is released to slide into the water on angled ways, are of course well proven, being the traditional method for launching of vessels. The vessel may be launched end on, ie, on the longitudinal axis of the ship, or sideways. Although the former is more common, side launching is well established, particularly in the USA.

In end launching the ways on which the vessel slides during launch must extend well into the water so as to ensure a good depth of water over the end of the ways. Because the vessel is built on a declivity (typically 1:20) it may be necessary to build up the berth well above the level of the rest of the site. The construction of part of the berth below sea level presents the same problems as dry dock construction and is expensive.

Side launching allows the ship to be built horizontally, parallel to the quay, and involves less capital cost. There is, however, an element of risk with side launching, more so than with end launching. Because of the problems of dynamic stability, some heavier outfit items must often be left off until after launch. The vessel is always subject to a considerable shock loading. Side launching can be summarised as being a useful and cheap launching method for smaller vessels.

Both side and end launching are uncontrolled procedures and it is often preferred to use a controlled launch to reduce risks of damage. This reduces the skill levels needed, but introduces capital expenditure and a need for maintenance. It does provide the possibility of recovering ships from the water for repair.

Floating out of a dry dock is the simplest procedure but is usually associated with the highest initial cost.

The marine railway has advantages of simplicity but can be complex and costly to maintain.

A purpose-built, heavy lift trailer offers greater flexibility than other end launching methods. It can be used for vessels up to about 500 tonnes, although at these weights the towing vehicle can be expensive.

Shiplifts are very popular and, where significant repair work is carried out, can be cost-effective. However, the installation cost is relatively high.

Using a drydock or pontoon is a more complex procedure, although the benefits of having several repair berths, as with a shiplift, exist. It is a structure whose construction should be within the capacity of a shipyard.

The choice of method is very dependent on local circumstances. It is important that a detailed analysis is carried out, and that all possible methods are considered, only being eliminated on economic or technical feasibility grounds.

3.10 Shiprepair

Small ship repair has the same characteristics as large ship repair. The requirements for organisation and labour flexibility are even greater.

Much of the low-cost technology, which can be applied in small ship building, is also applicable to ship repair.

The business is very labour-intensive and, given the essential requirements of a repair berth or dock and a few basic pieces of equipment, success will depend very much on how well the labour force has been organised and trained.

D: BOATBUILDING AND REPAIR

3.11 Vessel Design

Fishing Boats

The existing designs of fishing boats generally available in West Africa have a number of drawbacks in operation and construction. It is essential that the boat designs are reviewed. Considerable theoretical and practical work has been carried out into suitable designs of fishing boats for rural and developing communities. Work has also been carried out on alternative low cost materials, in particular on using indigenous materials where possible.

The traditional dugouts are still to be found, although to some extent they have been replaced by planked vessels. However, some of these are heavy and newer designs with lighter planking or plywood may be more appropriate.

The older, round-hull designs have to some extent been replaced by hard chine hulls. These are easier to produce from the point of view of both speed and cost.

Timber has been the traditional boatbuilding material since time immemorial, and this is what is still used. There are several hardwoods in the country's forests but the two proven species acceptable for boatbuilding are IROKO and OPEPE.

Opepe is one of the hardest woods known and is used for making railway sleepers. In boatbuilding, it is used for the underwater portion of the vessel because of its hardness, its imperviousness to water and the extra advantage that it is very toxic to torredo worms, commonly known as marine borers.

Iroko is used above water because of its ability to withstand weathering. It is able to withstand the long periods of the high temperature and heavy tropical rainfall. Vessels meant for fresh water operations are often completely built with Iroko.

A range of materials can be used for hull construction. All have advantages and disadvantages for various vessel types. The main materials are:

- steel
- wood
- fibre reinforced plastics (FRP)
- aluminium
- ferro-cement

At present, all the small fishing boats and launches are made of wood. Some of the workboats and other craft are FRP and large vessels are of steel construction. There are a few cement boats.

Steel

For future development, it is almost inevitable that steel will be used for vessels longer than around 20 metres. It is the usual material for such vessels and normally gives both technical and cost advantages. This would have to be reviewed in the light of the import cost of steel.

Wood

Wood is the traditional material and is used for fishing boats in particular. It is not cheap and no longer always readily available in the types needed for boatbuilding. In some countries much of the suitable wood has to be imported. Alternatives to the traditional heavy planking is the use of plywood, which can be supplied locally.

Fibre Reinforced Plastics

Fibre reinforced plastics have been used for relatively large military vessels, but would generally be used as a substitute for wood on smaller craft. The advantages of FRP are:

- lightness
- lack of maintenance requirements
- ease of repairs

It is expensive but is used in some local boatyards. As a material it is easy to work. Once a suitable mould has been made production of hulls is routine. One drawback is the generation of fumes during lay-up and curing but good ventilation can overcome this. The temperature and humidity conditions at various seasons would need to be determined to be certain of satisfactory curing.

A new method of hull construction promises to bring the benefits of GRP or advanced composites without the costly and time consuming business of making plugs and moulds.

In building a hull on the system the basic shape is defined by a series of GRP battens laid longitudinally over station moulds, which can be plywood profiles braced together. If lofting has been done right the battens lie in fair curves over the station moulds creating the outline of the inverted hull. Over the battens is laid a special glass reinforcement ready wetted-out with resin. One or more layers of reinforcement can then be added to give a thin shell. To obtain a good surface finish some filler must then be applied, filling the weave of the glass reinforcement and also fairing any areas where the glass has run in flats between battens.

At this stage the hull is thin but surprisingly rigid, certainly more rigid than a half-finished GRP sandwich, and can safely be turned over and the station moulds removed from inside.

In the basic system the I section battens stand proud on the inside, and to enable subsequent reinforcement to be added small wedges of polyurethane foam are tucked along the sides of each batten. Layers of resin and glass can then be placed inside the hull, working as if it were a normal female moulding, until the desired thickness and strength has been achieved.

A hull built in this way can be considered as a longitudinally stiffened shell, and the first boats to be built have used this technique. The system has now been refined to one in which the GRP battens are still the basis of the structure but end up forming shear webs in a true sandwich construction. This particular variation seems to have many merits, either for the strong structure needed for workboats or for exceptionally light and sophisticated structures such as racing yachts.

Aluminium

Aluminium is very light and therefore is excellent for small vessels with high payload requirements. Its common application is in small, fast warships and patrol craft. It is, however, an expensive material and for this reason it is unlikely to figure heavily in any boat or shipbuilding programme for the area.

A method has recently been reported in which aluminium is used to produce a stressed skin vessel. This then only requires simple transverse framing. The method generally simplifies the construction technique and reduces the necessary skill levels.

3.12 Building and Repair

Small vessel construction requires relatively few facilities. The basic requirements are:

- access to water for launch and recovery.

- environmental protection, probably only a roof for wood construction.

- secure storage for materials.

- all necessary jigs and fixtures for the production method and material selected.

- all necessary tools and equipment.

As with larger-scale shipbuilding, the organisation of the work should be a priority. The ability to collect the right materials and information for a task is paramount.

An adequate supply of trained labour is also a prerequisite for successful operation. Currently, most fishing canoe production is by local boatbuilders using local materials and traditional techniques.

4: INFRASTRUCTURE

4.1 Significance

Shipbuilding and repair is an industry which is noted for generating many more jobs than are directly involved. In broad terms three jobs in support industry may be created, for every one in the shipyard. These include materials supply, sub-contract engineering, temporary labour supply, plus service industries to support the community.

Conversely, if the infrastructure of support industry is not available, a shipyard will be more difficult to create. If materials cannot be obtained locally, or if labour cannot be trained, then operation of any shipyard will be more difficult.

Any intention to develop an aspect of the ship or boat building industry will require a feasibility study to establish the market for products, the methods to be adopted, the design and the labour requirements. These will be analysed to determine the financial viability of the scheme. Alongside the study, a review of the infrastructure should be made. The scope and size of the review would depend on the development scheme itself.

The infrastructure is essential to any marine activity.

4.2 Existing Infrastructure

The infrastructure was a significant topic in the meetings held in Accra in December 1987, and reference is made to the various papers presented and the discussions which followed. The main item requiring urgent attention which emerged from the meeting was training. It is apparent that there is a need for more skilled personnel, at all levels and in all sectors. That is not to say that high levels of skill do not already exist, but that there are insufficient personnel available to realise the full potential of the industry in West Africa.

In the artisanal sector there is a need to teach new techniques and methods to the existing craftsmen. This may involve the use of new materials, or the implementation of new designs which will provide more efficient vessels. The current, traditional methods generate small requirements for infrastructure. Changes in the vessels, and in their methods of construction, will create a need for an improved infrastructure, for example, to ensure a steady supply of materials. This aspect will require further study to establish precise requirements.

Because of the fragmented nature of this sector, further study is also essential to establishthe size of the training requirement and the most appropriate means of supplying the training. It will need to be localised, to ensure a widespread use, but will not have to be so dispersed as to reduce its effectiveness.

In the small and large ship sectors there are a number of existing establishments which can form the nucleus for expansion. Rather than try to create new centres, it will be far better to build on the existing infrastructure to provide an additional training capacity. This will require some regional cooperation. The larger establishments will provide the best potential for the creation of new training centres.

At present much of the equipment for locally built vessels does, and would, require to be imported. A study is needed to reveal where local supplies could be fostered. Again, a regional approach should be adopted to provide reasonable volumes of production and to avoid destructive fragmentation of the industries.

5: POSSIBILITIES FOR DEVELOPMENT OF SHIPBUILDING, SHIPREPAIRING, BOATBUILDING AND BOATREPAIRING IN WEST AFRICA

5.1 Scale of the Industry

This report has highlighted the size of the marine activity in West Africa. It is a substantial industry in all three sectors.

By far the largest numbers of people are involved in the artisanal sector. It has not been possible to identify the total, because of absence of statistics, but the number of canoes and other small boats is in tens of thousands. Hundreds of thousands of people are involved in fishing and related activities.

The small boat sector is smaller in number but there are still substantial numbers of fishing vessels, harbour craft and workboats. Most of these vessels are built overseas and imported.

Several of the countries in the region have a substantial fleet of ocean-going ships.

There is a relatively small involvement in building or repairing these. Almost all new ships are imported, and in addition many repairs are carried out overseas. Nevertheless there are a few shiprepair yards which carry out significant work.

The age of the fleets in the small and large ship sectors is high. Many vessels are over 20 years old and are candidates for replacement.

5.2 General Possibilities

Given the large scale of the various marine activities in the West African region, there are almost unlimited possibilities for development and expansion of boat and ship building and maintenance. This is true of the three sectors which have been considered in this report.

However, the possibilities will in reality be limited by practical considerations such as:

- limitations on investment capital;
- limitations on availability of adequately trained personnel;
- limitations on general infrastructure and supplies of materials and services;
- competition from other potential investment areas.

Although the overall scale of marine activity is large, it is fragmented. Each country, with one or two exceptions, has only a small fleet. Therefore it is not feasible for each nation to develop a complete range of shipbuilding and repairing services. Rather, it may be better to build on existing capabilities and to take a regional view. Thus different nations could concentrate on different aspects of the industry.

Perhaps the artisanal fishing sector is the exception. Almost every country in West Africa would benefit from a significant upgrading of the vessels employed.

Each sector is discussed in the subsequent paragraphs of this chapter.

5.3 Large Ship Building and Repair

Large-scale ship construction offers the least possibilities for development. There is a massive over-capacity in shipbuilding on a world-wide basis, and this situation is likely to remain for some years. There is also a high capital cost associated with new shipbuilding facilities, even if the level of technology is geared to a low throughput and to low labour rates. It would be necessary to import much of the equipment and materials. In all probability the cost of importing new vessels would be lower than the cost of building them locally. The cost of imported materials, both for shipbuilding facilities and for ships, is likely to exceed the cost of importing ships.

Although it is unlikely that ship construction would be economically viable, it may be desirable from the point of view of job creation and industrial development. This is a possibility that is more feasible for small ships.

Ship repair is also in a depressed state over the world. However, there are more genuine possibilities for the West African region, for several important reasons:

- The industry already exists.

- There are several large-scale facilities in the region. (These have been described in Chapter 2 and are summarised in Appendix 4).

- Investment costs are much lower than for ship construction.

- The existing, locally-owned fleets provide a potential base-load of work. Some developments are already taking place, notably in Cameroun which has acquired a new dry dock. The region could support more than one large facility, provided good cooperation can be achieved between the different countries.

The recommendations of this report include the need for a more detailed study of the local fleets, the vessels calling at West African ports and the existing facilities. This could be an essential prerequisite to any development plans.

5.4 Small Ship Building and Repair

This sector is also depressed in world-wide terms. However, the market for small vessels is typically much more localised. Such factors as the cost of delivery voyages, the cost of far-distant supervision and consideration of local conditions are much more significant. The capital cost of a new facility is much lower.

For these reasons, the possibility of constructing new small vessels in West Africa is much greater than that of building large ships. There is also a significant demand, both actual and potential, for small vessels. This is particularly the case for fishing vessels, since:

- there are excellent local fishing grounds.
- there are many local trawlers, of which most are old (see Appdendix 2).
- there is both a new and replacement market.

It therefore can be concluded that there are excellent possibilities to establish one or more regional shipyards to produce small ships, particularly fishing vessels. The most suitable location would depend on a number of factors. These include:

- regional cooperation, to share opportunities for building and for materials and services.
- actual demand, based on a new market survey (see Recommendations).
- the availability of existing facilities as a basis for development.

Shiprepair for the small ship sector appears to be already established in a number of countries. This situation has been described in Chapter 2 and a list of the known operational facilities is presented in Appendix 4.

Nevertheless, there are undoubtedly still possibilities for further development because of the numbers of vessels.

5.5 Boat Building and Repair

This is the largest sector in terms of numbers of vessels and people. Most of the vessels are fishing canoes, but there are also many workboats and other small craft.

For the fishing vessels, there is an undoubted need to develop and improve. Some aid projects have been carried out to do so. The possibilties of doing so may be limited because the fishing boats are based (and generally built) locally, so the activities are small scale and are dispersed. Improvements are needed in the design of the boats and in the facilities to build and repair them. The possibility of using non-traditional materials should also be considered.

This suggests semi-industrial facilities, supplying boats to a larger area than at present. Such an operation would be easier to manage than assistance to scattered local builders. However, it could have undesirable effects on the local economic infrastructure.

For the workboats, the possibilities for more semi-industrial facilities are greater. There is a demand for a variety of small craft and many are now imported. Local building would reduce import costs and assist the local economy. It would be essential to prepare carefully, to develop or obtain designs suited to locally available materials and methods.

6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This report has reviewed the current West African ship and boatbuilding and repairing industry. The report has been prepared following a meeting in Accra, Ghana, sponsored by UNIDO. The meeting was held from in December 1987. For completeness the conclusions and recommendations of this meeting are summarised as part of this chapter.

In addition, overall conclusions and recommendations, based on the results of the studies carried out, are presented.

6.2 Report of the Technical Sessions of the Meeting

Each participant presented a country paper highlighting the situation in his country and the problems faced by the boatbuilding and repair industry. The participants also agreed to extend the scope of the workshop to large scale shipbuilding and repair, as these were considered important to many participating countries.

The discussions which followed the country papers threw up the following points which were considered the important issues concerning all participating countries:

1: The urgent need for the training of personnel at all levels in the industry.

2: The need, which applies to many of the participating countries, and which was brought to the attention of the meeting by the Secretary - Industry, Science and Technology of the Government of Ghana, for the upgrading of the traditional dugout canoe.

3: The benefits of regional cooperation in the industry in all aspects, including training, exchange of information and marketing.

4: Examination of alternative materials for boatbuilding in the sub-region.

5: The need to make a sectoral study of the industry.

6: Establishment and implementation of standards for boat construction, especially from the point of view of safety.

7: Development of infrastructural facilities, such as harbours, for countries that lack them.

8: The need to reverse the trend of West African countries repairing their ships in Europe and to use facilities available in West Africa.

9: More seminars of this type to develop greater acquaintance and awareness of one another and their problems.

10: Rationalisation of shipyard/boatyard facilities in the sub-region.

11: The need for the introduction of computers into the industry for functions such as design, estimating, costing, invoicing, etc.

6.3 Recommendations of the Technical Sessions

1: Manpower Development

To request the assistance of UNIDO to conduct a Manpower Survey in all countries of the sub-region to ascertain manpower needs, available training facilities and training requirements, with a view to drafting an action plan including the possible need of a regional UNIDO Training Centre.

2: Regional Cooperation

a) To form a Regional Association of Shipbuilders and Repairers, encompassing the small and large scale sectors of the industry with the assistance of UNIDO. This association would meet annually in the first instance and once in two years thereafter.

b) In pursuance of the above, each country to form a National Association from which delegates would be nominated to the Regional Association.

c) By the end of the Workshop, a date and venue to be decided by the participants for the inaugural meeting of the Regional Association under UNIDO sponsorship.

3: Market and Facility Survey in the Region

To be included in the UNIDO sponsored manpower survey of recommendation 1.

4: The Application of Computers

UNIDO assistance to introduce computers in shipyards and boatyards of the region as needed.

5: The Dugout Canoe

Giving particular attention to the request of the Secretary - Industry, Science and Technology, of the Government of Ghana the session discussed this issue at length and recommends the following:

- The dugout canoe with outboard motor should be replaced by a planked boat with an inboard diesel engine.

- In order to encourage traditional fishermen to adopt the new type, the Government must take necessary measures which may include subsidies to fishermen buying the boats or boatbuilders building them.

6.4 Overall Conclusions

The research carried out for this report has led to a number of conclusions. The marine industry in West Africa is large, and is of major importance to the people living on the coast. Fishing is particularly significant since the rich fishing grounds in the region provide a valuable source of protein. There is a need to improve the ability to catch fish, and a key contribution to this will be an improvement in the design and construction of small fishing boats. There is a need to review the design, materials and construction methods for the fishing boats.

The marine industry has an important part to play in creating employment possibilities. Considering the boat building (other than fishing canoes) and small ship building sectors, most of the vessels currently in use are imported. There are a few facilities in the Region, but they have a limited impact. Most of the vessels are also repaired overseas. There is a need to review the existing situation in more depth, to establish a number of points:

- the current and potential market for new vessels;
- the market for repairing vessels;
- where these activities currently take place;
- the capacity of existing West African facilities to supply some of the market requirements;

- the obstacles to development, including lack of manpower, materials, etc;

- the ways in which the obstacles could be overcome.

It is a conclusion of this report that the West African nations do have an opportunity in the small ship and boat sectors.

Large scale ship repair offers some opportunity, but on a limited scale. Because the industry world-wide is suffering from overcapacity and excess competition, it is not a time for others to join the industry. However, there are a few facilities in West Africa already, and some developments are taking place. The conclusion is that these existing facilities should be supported by the region as a whole, so that they can gain a significant share of the repair market. Suitable offset arrangements would be needed to do so. From a regional viewpoint, the existence of a number of flourishing shipyards would provide a training ground for others as an assistance to setting up newer shipyards on a smaller scale.

Shipbuilding, finally, offers the least opportunity. Although the regional demand for ships could support local facilities, in reality the current prices for ships are so low as to make the proposition uneconomic.

6.5 Recommendations

The recommendations of the UNIDO sponsored meeting in Accra are endorsed. From the conclusions reached, this report recommends the following actions:

a) Carry out a detailed review of vessels trading to West Africa, and their ownership, to establish the potential market for West African participation in ship building and repair.

b) Carry out a detailed review of the small vessels operating in West Africa, and their source, to establish the potential for West African participation in the small ship and boat building and repair market.

c) Carry out a detailed review of the existing facilities in West Africa, to establish their capacity and capabilities.

d) Set up a Regional Association to promote cooperation and explore ways of supporting local industry.

e) Carry out a detailed review of the available manpower and training facilities, to establish the need for development.

f) On the basis of the reviews, prepare an overall Regional Development Plan, to establish how the industries will develop in future.

g) Carry out a review of existing fishing boat designs in use in the region, identify alternatives, taking into account different materials, and prepare a pilot study to evaluate boats and recommend a choice of designs.

APPENDICES

Appendix 1

WEST AFRICAN FLEETS

Flag	No	Total GRT	Fishing	General Cargo	Harbour
Angola	100	92,285	65	21	8
Benin	15	4,887	10	2	3
Cameroun	49	76,660	36	6	7
Cap Verde	25	14,095	3	2	15
Congo	21	8,458	18	-	3
Cote d'Ivoire	58	120,679	35	10	6
Equatorial Guinea	2	6,412	-	1	-
Gabon	23	97,967	8	4	3
Gambia	6	2,588	2	1	-
Ghana	137	165,644	98	17	13
Guinea	19	7,179	6	1	7
Guinea-Bissau	17	4,070	6	5	1
Liberia	1,658	52,649,444	-	249	45
Mauritania	73	22,752	69	1	-
Nigeria	206	563,912	98	40	20
Sao Tome	3	1,488	2	1	-
Senegal	148	50,429	130	8	4
Sierra Leone	29	6,979	17	-	5
Togo	11	54,882	3	5	2
Zaire	31	65,833	14	5	9

Appendix 2

WEST AFRICAN FLEETS

AGE OF VESSELS - SMALL SHIPS

	Below 2,500 dwt				
	Year of Build				
Flag	pre 1965	1966-70	1971-75	1976-80	1981 on
Angola	6	6	3	18	52
Benin	7	2	1	1	3
Cameroun	20	0	5	14	1
Cap Verde*					
Congo	11	1	1	0	5
Cote d'Ivoire	24	9	3	1	2
Equatorial Guinea*					
Gabon	8	2	3	2	4
Gambia	0	1	0	1	3
Ghana	33	20	30	6	5
Guinea	4	8	0	2	2
Guinea-Bissau	4	0	2	8	1
Liberia	7	5	16	11	3
Mauritania	5	22	28	4	15
Nigeria	27	17	20	33	70
Sao Tome*					
Senegal	61	32	28	8	2
Sierra Leone	3	3	7	3	12
Togo	1	0	0	2	2
Zaire	10	4	2	2	0
Total	231	132	149	116	182

* No Data

Appendix 3

WEST AFRICAN FLEETS

VESSELS BELOW 2,500 dwt - COUNTRY OF BUILD

	Angola	Benin	Cameroun	Congo	Gabon	Gambia	Ghana	Guinea-Bissau	Guinea	Cote d'Ivoire	Liberia	Mauritania	Nigeria	Cap Verde	Senegal	Sierra Leone	Togo	Zaire	Total
Angola	8	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	9
Benin	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Cameroun	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Congo	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Gabon	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Gambia	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	0
Ghana	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	0
Guinea-Bissau	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	0
Guinea	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	0
Cote d'Ivoire	-	-	-	-	1	-	-	-	-	3	-	-	-	-	-	-	-	-	4
Liberia	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	0
Mauritania	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	0
Nigeria	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	0
Cap Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	0
Senegal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Sierra Leone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	0
Togo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	0
Zaire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Austria	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Belgium	-	-	2	-	-	-	-	-	-	3	-	-	1	-	5	-	-	9	20
Brazil	12	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Canary Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Denmark	-	-	5	-	-	2	1	1	-	-	2	1	1	2	-	1	-	-	16
Finland	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
France	-	8	14	14	11	-	5	-	1	18	-	6	2	-	70	-	1	-	150
United Kingdom	-	-	1	-	1	1	9	-	-	1	-	-	19	5	2	2	-	-	41
German Democratic Rep	-	-	-	-	-	-	-	2	-	-	-	-	3	2	-	-	-	-	7
German Federal Rep	-	3	2	-	-	1	7	-	7	4	13	-	13	5	10	4	2	3	74
Greece	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2
Hong Kong	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Hungary	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Italy	9	3	-	-	-	-	-	-	-	-	-	-	3	-	1	-	2	3	21
Japan	-	-	-	-	1	-	50	-	2	2	-	34	15	-	12	5	-	-	121
Korea (South)	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	-	-	5
Mexico	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3
Norway	-	-	-	-	1	-	3	1	2	1	1	-	3	1	1	-	-	-	14
Netherlands	5	-	3	-	2	-	6	9	2	6	7	5	30	2	5	1	-	-	83
Poland	-	-	-	-	-	-	3	-	1	-	-	-	4	-	-	-	-	-	8
Portugal	6	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	9
Singapore	-	-	-	-	-	-	2	-	1	-	1	-	1	-	-	-	-	-	5
Spain	35	-	2	-	2	-	-	-	-	-	2	27	18	-	13	-	-	1	100
Sweden	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2
USA	2	-	11	-	-	-	5	-	-	-	13	-	46	-	4	11	-	1	93
USSR	8	-	-	-	-	-	-	2	-	-	-	-	-	-	5	-	-	-	15
Yugoslavia	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Total	85	14	40	18	19	5	94	15	16	39	42	74	167	21	131	28	5	18	831

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
ANGOLA			
Lobito			
Slipway No 1	170.00	1,500	Covered building slipway. Can take ships of not more than 66m in length and 3m draught. One 12.5 ton, one 10 ton, one 5 ton and one 3 ton travelling cranes.
Slipway No 2	170.00	1,500	Can take ships of not more than 66m in length and 4.20m draught. One 15 ton travelling gantry crane.
Slipway No 3	203.00	1,500	Can take ships of not more than 75m in length and 5.20m draught. One 50 ton travelling gantry crane.
Slipway No 4	170.00	1,500	Covered repair slipway. Can take ships of not more than 66m in length and 3m draught. Three 10 ton and one 3 ton travelling cranes.
Floating Dock	110.00	2,200	Built 1967.
Luanda			
Slipway	152.39	500	Breadth 6.10m.
Slipway	149.95	500	Breadth 6.10m.
Mocamedes			
Slipway	50.00	-	
Slipway	30.00	-	

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
Porto Alexandre			
Slipway	30.00	-	
Slipway	30.00	-	
Soyo			
Slipway	176.01	-	Breadth 6.25m.
BENIN			
Cotonou			
-	-	-	Limited repair facilities available.
CAMEROUN REPUBLIC			
Douala			
Floating Dock I	-	1,000	Built 1905.
Floating Dock II	-	500	Built 1979.

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
CAPE VERDE REPUBLIC			
St Vincent			
Slipway No 1 (Repairs)	125.88	250	Maximum deadweight capacity is 250 tonnes.
Slipway No 2 (Repairs)	156.05	250	Maximum deadweight capacity is 470 tonnes.
Patent Slip	95.00	2,800	Ship dimensions: Length OA 110.00m. Breadth 16.00m. Max draught (aft) 5.0m. Max deadweight capacity 6,500 tonnes.
CONGO, REPUBLIC OF			
Pointe Noire			
Slipway	34.94	600	Maximum breadth 15.45m. Maximum draught 5m.
GABON			
Cap Lopez			
Slipway	-	300	Facilities for limited hull and machinery repairs.
GAMBIA (THE)			
BANJUL - River Gambia			
Slipway	128.62	406	May not be operational.

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
GHANA			
Takoradi			
Slipway (Repairs)	173.73	500 bottom cradle 400 top cradles	For ships of not more than 39.62m in length and 9.75m beam. Inclination 1 in 20. There is one main centre cradle and the upper section can be used to accommodate two vessels, one on each side of the centre cradle.
Dry Dock (Repairs)	38.10	-	
Tema			
Dry Dock No 1 (Repairs)	274.40	-	One 60 ton and one 20 ton travelling cranes. Maximum deadweight capacity is 50,000 tons.
Dry Dock No 2 (Repairs)	106.70	-	Maximum deadweight capacity is 2,000 tons.
Slipway No 2 (Repairs)	39.31	-	Maximum deadweight capacity is 150 tons.
GUINEA (PORTUGUESE)			
Bissau			
-	-	-	Limited hull and machinery repairs undertaken.

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
GUINEA, REPUBLIC OF			
Conakry			
Slipway	121.91	305	
Floating Dock	-	-	
IVORY COAST			
Abidjan (Banco Bay)			
Floating Dock	83.51	2,200	
Floating Dock	40.48	610	
Floating Dock No 3	176.50	10,800	Built 1981. Height of keel blocks 1.20m. Two 7.5 tonne cranes.
Slipway	124.96	30	)
Slipway	140.20	305	)Cradle is adjustable
Slipway	160.01	244	)
(Ebrie Lagoon)			
Slipway	-	150	
Slipway	-	100	
Slipway	-	300	

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
LIBERIA			
Monrovia			
Dry Dock	42.67	-	Private Dock.
NIGERIA			
Burutu			
Slipways Nos 1 & 2 (Repairs)	199.33	610	)Nos 2 and 3 slipways have lifting capacities of 100 and 30 tons respectively.)Maximum size of ships handled on slipways is 73.14m and about 600 tons deadweight.
Slipways Nos 3 & 4 (Repairs)	137.15	407	)One 25 ton crane, and one 5 ton crane for heavy lifts only at no 4 slipway.
Lagos (Apapa)			
Slipway (Repairs)	91.43	500	Electrically operated.
Mechanical Lift Dock (Repairs)	-	102	Under repair.
Mechanical Lift Dock (Repairs)	30.00	190	Maximum width 13m. Maximum draught 4.50m.
Slipway (Repairs)	-	200	Extreme length of vessel 42.70m. Maximum draught alongside 2.50m. One 250 ton Goliath crane.
Graving Dock	-	-	
Port Harcourt (Choba)			
Slipway (Repairs)	60.00	2,000	Air and electric current supply 165 ton crane on yard. One 20 ton tower crane on slip water.

Appendix 4

WEST AFRICAN FLEETS

CURRENTLY AVAILABLE SHIPBUILDING AND REPAIR FACILITIES

COUNTRY Port Type of Installation	Capacity Length (m)	 Tons	Notes
Warri			
Slipway	42.67	203	Side slip for 45.72m craft. Maximum width 7m.
SENEGAL			
Dakar			
Dry Dock (Repairs)	188.00	-	This Dock can be divided into two sections, one 68m long and the other 118m. Merchant ships are admitted when the dock is not required for naval purposes. Maximum permitted load on the keel blocks is 25 kg/cm2. Width of blocks, 0.40m. Space between blocks, 0.60m.
Floating Dock	-	60,000	
Slipway (Repairs)	50.00	500	Breadth 14.63m.
Slipway (Repairs)	73.15	1,016	Breadth 14.63m. Private use only.
Mechanical Lift Dock	64.00	1,200	Takes 4 ships together. Length of tracks, one 30m, one 40m and two 60m.
SIERRA LEONE			
Freetown			
Clinetown Slipway (Repairs)	158.50	600	

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COUNTRY Port Type of Installation	Capacity Length (m)	Tons	Notes
ZAIRE, REPUBLIC OF			
Boma			
Floating Dock (Repairs)	82.88	2,540	Built 1925. Lengthened 1977. One 1 ton electric crane.
Floating Dock (Repairs)	65.00	1,524	One 3 ton crane.

7: REVISIONS

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