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AN EVALUATION OF AND PROJECTS FOR THE HAITIAN COASTAL TRANSPORT SECTOR */

*/ Provisional text, subject to changes in substance and style.

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CONTENTS

PREFACE

In an effort to provide certain guidelines to assist both the Haitian public and private sectors in undertaking projects which might contribute to the establishment of a modern coastal fleet as well as related marine industries, CEPAL's Transport and Communications Division, in response to a request by the Latin American Institute for Economic and Social Planning (ILPES) and as part of the project entitled "Fortalecimiento del sistema de planificación y proyectos del Gobierno de Haití" (ATN/SF-1729-HA), began an evaluation of Haitian maritime coastal transport systems. This evaluation is divided into three stages: (1) the collection of information, (2) its analysis and publication, and (3) the presentation of indicated projects to the Government of Haiti for subsequent submission to appropriate lending institutions and technical assistance sources.

During the information gathering stage, the following organizations and persons made important contributions:

Autorité Portuaire Nationale (APN) - Messrs. Policard, Foucauld and Maxime;
Direction de Promotion des Projects (DPP) - Messrs. Duperval, Hypolite, Métellus and Terra Reyes, and
Service Autonome des Transports (SAT) - Messrs. Le Blanc, Gabriel and Warren.

/I. INTRODUCTION

I. INTRODUCTION

The significance of transport to a country lies fundamentally in the fact that mobility and accessibility are essential to the achievement of nearly every aspect of economic growth. For example, transport plays a pivotal role in creating an environment in which land may be made more productive, mineral resources might be exploited and industries established. While the provision of adequate transport services is not capable by itself of promoting economic growth, it can be said that such growth will not be achieved without transport. As a result, transport is clearly a factor of fundamental importance in all commercial activity and an essential key to economic growth.

While transport systems and related inputs from lending insitutions and technical assistance sources can assist economic activities of developing countries, their impact should not be overstated. Obviously, some transport investment which provides access to an area is indispensable and once established and used productively will have important locational attractions. Nonetheless, there is no evidence that endowing a country with highway, water and rail transport systems ensures that new industrial or agricultural activity will result. It should be understood that transport capacity, loans and technical assistance are permissive -they provide a means by which a dynamic situation or sector may grow and can reinforce motivations that already exist; however, they cannot create such situations or motivations.

In the elaboration of projects it must be recognized that the choice among alternative transport systems fundamentally affects and in part determines a country's development path and its strategy for economic growth. For example, a project for the construction of coastal ports, while seeking to provide maritime transport services between such ports and central or international ports, might be justified only if an adequate feeder road system connecting each coastal port with its respective hinterland were constructed simultaneously. In this sense it is interesting to note that the national transport study for Haiti,1/ which was carried out in the period 1975-1977, recommended that for a mountainous developing country which has an ample coast line and numerous protected anchorages, priority should be given to coastal maritime transport services and ports, and to an adequate system

1/ Berger, Luis, National Transport Study, 1977.

/of feeder

of feeder roads to support them. As a result, the Government of Haiti adopted these recommendations and, with financing from the World Bank, has undertaken a modernization programme of selected cabotage ports as an alternative to more costly road transport.2/

In an effort to continue the initiative begun by the national transport study and to determine means by which the coastal maritime transport system of Haiti might play a more active role in the achievement of national economic growth goals, the World Bank financed the preparation of a two-phase study entitled the "Coastal Shipping Development Study".3/ This study was completed in 1980 and concluded that, inter alia, "Upgrading of the coastal shipping system by converting the current fleet to a fleet of modern, safe insurable vessels is economically feasible".4/ As a result, this document seeks to build upon the conclusions of the aforementioned studies by means of an evaluation of priority coastal transport areas and the elaboration of related projects.

2/ World Bank, Staff Appraisal Report, Port Development Project, Haiti, Report No. 3205b-HA, 1981, p. 2.

3/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I and II.

4/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Draft Final Report, 1979, chapter 1, p. 1.

II. HAITIAN COASTAL TRANSPORT

For many Haitians the coastal fleet has been the traditional lifeline which ensures mobility for themselves and their goods. This is particularly true of the island districts of Ile de la Tortue, Ile de la Gonave, Les Cayemites and Ile-à-Vache, where coastal vessels are the only means of transport. The Government of Haiti has recognized the important role the coastal fleet plays not only in the economy but also in providing means by which such islands and other isolated areas of that country might communicate among themselves as well as with the rest of the world.5/

The attraction of coastal transport lies in the fact that waterways are provided by nature and capital investments may be limited to the cost of construction and maintenance of port facilities. Further, due to the energy-efficient nature of water transport systems they have experienced dramatic growth rates in recent years. France has been in the forefront in promoting waterway use and has produced statistics to show the energy savings possible from this means of transport. For example, it was found that a self-propelled barge can move one metric ton of cargo 500 kilometres with 5 litres of fuel; an electric train can haul the same load 333 kilometres; a tractor-trailer unit 100; and an aircraft 6.6.6/ Similarly, water transport has the lowest power requirements per ton-mile -i.e., one horsepower moves 150 kilogrammes by road, 500 kilogrammes by rail and 4 000 kilogrammes on water.7/ Thus, water transport is universally recognized as the lowest-cost means for many classes of goods, over both long and short distances.

Since coastal vessels are the most inexpensive means of transport in Haiti, they are of particular importance to the poorest sections of the rural population. As a result, even minor improvements in the coastal fleet, navigational aids and boatbuilding facilities may have a considerable effect in terms of income and living standards of such rural areas.

While there are many aspects of the Haitian coastal transport environment which should be given careful study when formulating a growth strategy for that sector, some of the more important are (a) fleet characteristics and (b) coastal transport services.

5/ Annuaire, Autorité Portuaire Nationale, 1980-1981, p. 150.

6/ Container News, August 1980, p. 10.

7/ Economic and Social Commission for Asia and the Pacific, Inland Water Transport (E/ESCAP/STC.1/9), 1977, p. 62.

/(a) Fleet

(a) Fleet characteristics

Varying estimates concerning the number of vessels engaged in the Haitian coastal trade have been made.8/ Nonetheless, data gathered by the National Port Authority (APN) indicates that there are 418 vessels active in coastal trades, of which 403 are sailboats and 15 motorboats. The size of these vessels varies from approximately one dwt for the smallest sailboat to 550 dwt for the largest motorboat.9/

The Coastal Shipping Development Study 10/ indicates that in Haiti during 1978 there were eight sailing and two motor vessels under construction. If this information is a correct indication of the number of new vessels incorporated into the coastal fleet each year, the average age of such fleet would be

$$\frac{\text{418 vessels}}{\text{10 vessels constructed each year}} = \text{41.8 years}$$

It should be understood that vessels under normal operating conditions, whether of steel or wood construction, have neither physical nor economic lifetimes for such an extended period of time. It would then be reasonable to assume that, during 1978, more vessels than the number reported were either imported to or constructed in Haiti and incorporated into the coastal fleet.

While there is a lack of data concerning the year of construction for the entire coastal fleet, such data are available for those vessels which have motors for propulsion. In this sense it is interesting to note that the average age of the nine wood-hull motor vessels is 13.6 years and 26 years for five of the six steel-hull motor vessels.11/ Except for these six motor vessels, the entire coastal fleet is constructed of wood at local artisan boatbuilding facilities. While wooden boats which are well constructed and maintained can have a useful life of up to 35 years, the large majority of Haitian coastal vessels are neither constructed nor maintained to attain such a life expectancy. In fact, it has been found that the average useful life of these vessels is approximately 12 years.12/

8/ See, for example, Buckley, James C., Inc., Coastal Shipping Development Study, Phase II, 1980, chapter II, pp. 16-17.

9/ Annuaire, Autorité Portuaire Nationale, 1980-1981, pp. 148, 152.

10/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Preliminary Report, Appendix C, p. 1.

11/ Annuaire, Autorité Portuaire Nationale, 1980-1981, p. 152.

12/ Berger, Luis, National Transport Study, 1977, Appendix 8B, table 8E-3, et seq.

/Although coastal

Although coastal vessel owners and operators might be reluctant to improve current wood boatbuilding techniques or change to a more appropriate technology, as such improvements and change would involve compliance with recognized constructio standards and therefore increase vessel acquisition costs, it should be understood that the annual return on investment for the Haitian coastal fleet has been estimate from 44% to 138% for sailing vessels without and with auxiliary motors trading between Port-au-Prince and Pestel/Conrail, and 94% for large motor vessels trading between Port-au-Prince and Jérémie.13/ These estimates would seem to indicate that all coastal vessel operators earn a substantial rate of return on their investments. Nonetheless, the coastal service between isolated communities has traditionally been provided by small sailing vessels responding to sporadic transport demands. Due to the wide variation in demand, long port stays and low-value of cargoes carried, it is necessary to recognize that the majority of these vessels earn only a marginal or very limited return on investment. As a result, the costs for modernization of small sailing vessels, particularly with reference to quality of service and safety, must be within the financial resources of vessel owners.

As motor vessels with steel hulls are normally imported used and enter the Haitian coastal trade late in their economic lives, they were probably constructed according to the standards of a marine classification society. These vessels are utilized in those trades which demand regular vessel frequencies, due to the types, values and quantities of cargoes offered for transport. On the other hand, the wooden sailing vessels of the coastal fleet normally transport cargoes such as salt, firewood and charcoal which, due to their low-values and non-perishable nature, do not require a similar vessel frequency. These cargoes have few handling and storage requirements and can absorb only minimal freights before rendering them uneconomic for transport.

Based upon the nature of the trade in which coastal sailing vessels operate, they are largely constructed by their owners or at artisan facilities without utilizing modern wood boatbuilding techniques and equipment. For example, since vessel ribs and planks are only rough-cut by hand tools, the necessary close fitting of hull joints and subsequent caulking to ensure watertightness is made extremely

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13/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Preliminary Report, 1979, Appendix C, pp. 44, 48.

/difficult if

difficult if not impossible. As a result, these vessels may easily have an average replacement lifetime of approximately 12 years.

While Haitian domestic cargo movements are principally effected by land transport, i.e., trucks and buses known locally as "tap-tap", the coastal fleet accounts for 18% of all freight revenue, 29% of the ton-kilometres for cargoes and about 10% of the passenger movements.14/ One can only imagine what these percentages would be if the coastal transport industry could reach its full economic potential. The principal obstacles for achievement of such potential are of both an institutional and physical nature. For example, the unsafe conditions for most of the coastal fleet are due to primitive boatbuilding techniques and the almost total lack of adequate facilities for vessel construction and maintenance. This in turn creates a situation in which such vessels and their cargoes are uninsurable. While improvement of currently employed boatbuilding techniques or adoption of a new vessel construction technology might seem to rectify this situation, such is not entirely the case. Since vessel and cargo insurance policy premiums are based upon the global risks encountered, other areas such as improvement of navigational aids and training programmes for vessel captains and crews would also be required to reduce premium costs to an acceptable commercial level.

The coastal transport and boatbuilding industries are predominantly private sector undertakings. Modernization of these industries would involve the elaboration of modern vessel designs, technical assistance to the boatbuilding sector to improve existing woodworking techniques and/or utilize another technology such as ferrocement,15/ and establishment of supportive financial institutions capable of promoting viable economic enterprises. In this sense, the basic need of the Haitian coastal transport industry is to evaluate which boatbuilding technology or technologies can be employed not only to improve the fleet and the quality of its service but also to reduce the outflow of scarce foreign exchange, create sources of employment and utilize locally available materials in the construction of vessels

(b) Coastal transport services

While motor vessels normally provide a more regular service than that of sailboats, it should be understood that actual arrival and departure times for both are determined by cargo and passenger demand. In this sense, then, there are no

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14/ Berger, Luis, National Transport Study, 1977, Vol. II, chapter 4, p. 5.

15/ See annex 1 for a more complete explanation of ferrocement as a boatbuilding material.

/established service

established service schedules. Nonetheless, most coastal vessels operate on a cycle which corresponds to local market activities.

Although there are many aspects of the Haitian coastal transport environment which should be given careful study when selecting vessel types for the coastal fleet, some of the more important are (a) what cargoes and volumes of such cargoes are to be transported, (b) what are the normal shipping units -break-bulk, palletized, bulk agricultural and mineral products, refrigerated and non-refrigerated containers, indivisible odd-sized units, etc.- of the cargoes to be transported, (c) what port facilities are available, and (d) what complementary land transport services are available?.

The Haitian coastal trade structure may be characterized in general terms by dependence on a limited range of agricultural and mineral products in movement from outlying areas to central markets, and on limited amounts of capital and consumer goods as return cargoes. While each of these groups of products -agricultural, mineral and manufactured- may be transported by specialized vessels, the limited volumes involved and the seasonal changes in the tonnages of such cargoes discourage capital investments in specialized vessels and related port facilities. Further, although each of these groups of products is normally presented in different shipping units (bulk, bags, boxes and barrels), they are of sufficiently small size and low weight that coastal vessels are loaded and discharged manually by stevedores. This latter aspect is of paramount importance, as low-cost stevedores at cabotage ports make expensive cargo handling equipment unnecessary. For example, in 1975 the International Development Association initiated a pilot project for improvement of three coastal ports of key importance to the growth of coastal trade.16/ It should be highlighted that neither this project nor a subsequent project for similar improvements to eight additional cabotage ports contemplate the use of cargo handling equipment for loading and discharging coastal vessels.

It must be understood that the coastal fleet provides a service which responds to the transport needs of various sectors of the Haitian economy. As a result, the freight rates quoted by owners and operators of coastal vessels reflect the characteristics of the normal shipping units and hence the need for cargo handling

16/ International Development Association, Fourth Highway Project, Credit 556-HA, 1975.

/equipment. For

equipment. For example, freight rates for lumber are quoted by the lot; charcoal, flour and cemet by the sack; manufactured goods such as soap and bottled drinks by the case; petroleum products by the barrel; and cane alcohol and salt by the ton, even though transported in barrels and sacks, respectively.17/ As can be seen, the normal shipping units for the coastal fleet are small individual packages which generally permit manual loading and discharge of vessels thereby obviating the need for cargo handling equipment.

Many coastal vessels load cargoes as they are received from individual shippers and deliver cargoes to consignees in the same manner. This practice is the result of small cargo units being delivered by individual shippers, flexible sailing schedules and the lack of warehouses at cabotage ports. If shippers and consignees were provided warehouses with adequate security at such ports, cargoes could be delivered to appropriate authorities for carriage prior to vessel arrival thereby permitting coastal vessels to observe fixed sailing schedules. Similarly, coastal vessels would be permitted to immediately discharge cargoes for storage in such warehouses without the time-consuming process of making delivery to each consignee. While secured warehouses at cabotage ports would permit an increased level of utilization of the coastal fleet, other services such as dredging, docking tugs, refuelling facilities, food, water and electricity, as well as restoration of piers and navigational aids, could also play a decisive role.

As water transport is limited to routes that nature has provided, complementar land transport services are normally required. In practice, virtually all cargoes transported by the Haitian coastal fleet require initial and final non-water movements of 5 to 10 kilometres from the point of origin to the nearest port and from the port where the cargo is discharged to its final destination.18/ Consequently, water transport services are a composite of basic facilities and operating equipment for both water and land transport. It should be understood that the land transport segment may be satisfied by either an adequate system of all weather gravel feeder roads or a modern system of highways and paved secondary roads depending on the volumes, types and values of goods in movement as well as geographical and topographic conditions encountered. Where the volumes of goods

17/ Berger, Luis, National Transport Study, 1977, Vol. III, chapter 8, p. 17.

18/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase II, 1980, chapter V, p. 156.

/are limited

are limited and of low value, an adequate system of feeder roads would seem to merit further investigation.

While truck transport does provide a more flexible and often quicker service than the coastal fleet, the utilization of land transport systems for Haiti would require a never ending outflow of foreign exchange not only for equipment and materials to build roads but also for trucks, spare parts and petroleum products. On the other hand, as coastal shipping has lower capital and operating costs than road transport and due to the energy-efficient nature of coastal vessels, utilization of a modern coastal fleet in conjunction with an adequate feeder road system could substantially reduce the outflow of Haitian foreign exchange.

In many developing countries there is at times a combination of traditional and modern transport. The metropolitan areas of such countries are normally served by modern air, land and ocean transport systems. However, in rural areas of these countries traditional methods such as the donkey, animal carts, and the jugs, trays and baskets carried on human heads are extensively employed. Like other developing countries, Haiti is heavily dependent on such traditional methods. For example, in 1977 it was estimated that nearly 300 000 tons annually are carried to market by human bearers and animals.19/ As a result, the spectrum of transport modes utilized in Haiti ranges from head and animal porterage to modern jet aircraft and from canoes to containers.

As many outlying areas of Haiti are unable to offer sufficient cargoes to induce operators of coastal vessels to make more than occasional calls at their ports, these may, in the absence of Government initiatives, lead to a downward spiral of economic activity. The lack of an efficient and regular coastal transport service acts as a disincentive to expand their production of crops for export. Their earnings from exports and their ability to import either remain low or decline. As fewer inward and outward cargoes are offered for transport, fewer vessel calls tend to be made, thereby reinforcing the disincentive. The provision of low-cost, efficient and regular coastal transport services must be viewed as a means by which production in such areas may be stimulated and so lead to more cargoes being offered in due course. Consequently, coastal transport services are a most important developmental tool for assisting the growth of areas served, as well as the Haitian economy as a whole.

19/ Berger, Luis, National Transport Study, Vol. II, chapter 4, p. 7.

As the coastal fleet principally carries mineral and agriculture commodities, the demand for transport services can be expected to increase at the same rate as the growth of production in those areas.20/ While the obvious response to an increase in transport demand would be either to increase the size of vessels or their number, the Haitian coastal transport environment presents many other less-costly alternatives. For example, due to the excessive amount of time coastal vessels spend in port to load and discharge cargoes as well as to receive and delive cargoes directly from or to appropriate persons, a minor reduction in such port time could substantially increase the productivity of the existing fleet, thereby obviating the need for larger or additional vessels.21/

When considering changes to even a relatively simple transport system, it should be understood that such changes can significantly effect existing relationships, patterns of usage and performance. For example, since modern capital-intensive vessels are in useful production only when moving goods towards their destination, all time spent in port due to congestion, weather delays, waiting for cargo and the solution of shore labour problems is non-productive and must be reduced to a minimum.22/ Further, such vessels normally utilize cargo units such as pallets and pre-slinging to speed loading and discharge times and, consequently, require expensive cargo handling equipment -since their weights exceed by many times that which may be handled manually- which is not available at Haitian cabotage ports. As a result, if a decision were made to utilize larger capital-intensive motor vessels in Haitian coastal trades, there would probably be a reduction in vessel frequency at cabotage ports due to the limited amounts of cargo offered for transport. The reduced vessel frequency would provide shippers with an incentive to utilize available land transport systems. This, in turn, would increase the outflow of Haitian foreign exchange for the purchase of additional transport equipment, spare parts and petroleum products to satisfy the increased demand for land transport services. Moreover, a wider utilization of motor instead of

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20/ Ibid., Vol. III, chapter 8, pp. 13-14.

21/ See, for example, Secrétaire d'Etat des Travaux Publics, Transports et Communications, Plan Quinquennal 1976-1981 du Secteur des Transports, 1976, p. 8.

22/ CEPAL, Survey of Hawaiian inter-island maritime transport systems in the light of their significance for Caribbean inter-island transport (E/CEPAL/1085), 1979, p. 2.

/customary sailing

customary sailing vessels in coastal trades would result in higher freight rates to pay for additional vessel acquisition and operating costs, and further increase the outflow of foreign exchange.

While Haiti has no formal maritime training programmes for officers and crew, there exist informal apprenticeship programmes aboard coastal vessels. Nonetheless, as the coastal fleet is composed of 403 sailing and only 15 motor vessels, the amount of on-the-job training which can be carried out aboard those motor vessels is extremely restricted. If the number of motor vessels utilized in coastal trades is to be increased, the establishment of appropriate formal training programmes would appear necessary.

Although the existing coastal fleet provides an adequate quantity of transport services, the quality of such services requires immediate improvement. The major reason for this is that vessels constructed for Haitian coastal trades do not comply in even a minimal way with accepted wood boatbuilding standards and, as a result, create unnecessary risks for vessels, cargoes, passengers and crews. For example, since 1968 over 400 lives have been lost due to coastal vessels sinking within sight of land. 23/

The legal régime which governs Haitian coastal trade is found in Articles 68-88 of the Customs Code (1962). This code reserves the Haitian coastal trade to vessels owned by nationals of that country or corporations in which such nationals have a majority ownership and establishes the requirements for vessel registration, annual inspection, repairs, safety and clearance upon entering and leaving ports. Nonetheless, these regulations are incomplete in many respects. There is no approval required for coastal vessel plans prior to construction. There are no established standards for safety equipment required to be aboard vessels, and no inspections are made to assure serviceability of such equipment. Further, there are no regulations concerning minimum manning requirements for vessels engaged in coastal trades. While an annual inspection is required of all Haitian flag vessels, there are no published regulations or standards for such inspections. Furthermore, the dry dock which could be used to inspect vessels while out of the water is not in service. The lack of vessel regulations such as these has reduced the possibility of

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23/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Preliminary Report, 1979, Appendix C, pp. 7-10.

/constructing and

constructing and maintaining vessels in class, and has restricted the insurability of risks for coastal vessels and their cargoes. In turn, these circumstances restrict the availability of capital for financing the construction and purchase of appropriate vessels.24/

It should be recognized that there exists an interdependence between the coastal transport administrative infrastructure, the coastal fleet and cabotage ports and, as a result, benefits obtainable for the entire coastal transport system. For example, possible benefits from vessel construction standards will be lessened to the extent that corresponding improvements are not made to boatbuilders' financial and technical capabilities so that such standards might be attained. Further, the greater or lesser efficiency of the coastal transport system influences and is influenced by the costs and efficiencies of land transport. Consequently, support for the Haitian coastal fleet should include not only standards for construction, repair, safety, inspection and certification of vessels but also monetary and fiscal support such as loans and reduced taxes for the financially weak but operationally competent in order that vessels may be constructed and acquired.

Another important reason for the lack of quality in coastal transport services is the absence of training programmes for captains and crews. While coastal fleet captains and crews have many years of on-the-job experience which, for this profession, can be obtained in no other way, this experience has created many accepted practices which involve great risks. For example, almost no coastal vessels utilize load lines; such lines are placed on the hull of a vessel to indicate the maximum depths to which it may be loaded for various oceans and seasons. While these load lines might reduce the cargoes a vessel can transport, their purpose is to create a factor of safety for vessels, cargoes, passengers and crews so that all may survive if adverse conditions are encountered. Since the majority of coastal fleet captains and crews received their training on vessels without load lines, thereby precluding a fixed standard from which they might determine the correct amounts of cargoes to be carried, the overloading of vessels has become an accepted practice and, hence, does not appear to create any undue risks.

A final reason for the lack of quality in coastal transport services is the almost total absence of lifesaving equipment. To correct this situation, responsible agencies of the Haitian Government should give careful study to both existing

24/ Ibid., Phase II, 1980, chapter VIII, pp. 88-89.

international rules for lifesaving equipment and the requirements of Haitian coastal transport in order to promulgate appropriate regulations. As the usefulness of cold-water exposure suits, high-capacity radios and survival rations becomes questionable in warm tropical waters with vessels always in sight of land, it would appear prudent that requirements for lifesaving equipment should be promulgated which take into account the unique nature and environment of Haitian coastal transport. It might be found that, for example, low-cost radio transmitters using the citizen's band, and life jackets for all passengers and crew could provide a reasonable level of safety and at the same time not overburden vessel owners with unnecessary costs.

The aforementioned areas -boatbuilding standards, captain and crew training programmes and lifesaving equipment- require immediate attention to improve the quality of coastal transport services. While each of these areas would appear to involve only the coastal transport physical infrastructure, such is not the case. In each area rules must be prepared, promulgated and enforced; that is, captains and crews must be taught operating procedures which ensure vessel, cargo and passenger safety; boatbuilding enterprises must understand and apply appropriate standards to the construction and repair of coastal vessels; and standards for lifesaving equipment must be established. As can be seen, each area requires a strong institutional response not only to prepare and promulgate rules and regulations but also to ensure their effective application.

III. A GROWTH STRATEGY FOR THE HAITIAN MARITIME TRANSPORT SECTOR

Although Haiti is recognized as one of the poorest countries in the world with an annual per capita income of US$ 260.00,25/ it nonetheless has unique advantages for the development of not only its coastal fleet but also certain aspect of its maritime sector. Some of the more important of these advantages are (a) distance to the sea for Haitian productive centres, (b) proximity of Haiti to the United States of America, (c) low wage rates for skilled workers, (d) a disciplined and dexterous labour force, and (e) a liberal framework for capital investments.

As Haiti has an extensive coast line, numerous natural anchorages and ports, and the majority of its agricultural and incipient industrial centres within 40 kilometres of such coast line, these physical endowments can greatly assist in the achievement of national economic goals. For example, due to the cost-efficient nature of coastal transport, it can provide an incentive for marginally profitable agricultural products to be moved to other more favourable markets. Further, if coastal transport services are provided on a regular basis, farmers would have an incentive to change from subsistence production -i.e., the size and diversity of crops determined by their own individual needs- to a more market oriented production.

While Haiti is quite close to the United States, such proximity does not seem to create any special advantages for the development of its maritime sector. Nonetheless, when such proximity is combined with the lowest skilled labour wage rates in all of the Americas, i.e., from US$ 2.20 to US$ 2.60/day,26/ it would appear that numerous marine enterprises might be attracted to the island. For example, certain marine equipment plants in the United States have had to close due to high wage rates in that country. Since Haiti is only 36 hours by ship from Miami, Florida, mechanical and electrical components could be transported from the United States for assembly in Haiti with subsequent exportation to that country or to other demand areas. Further, if these as well as other marine enterprises were located within the envisioned free trade zone certain restrictive characteristics of the Haitian economy such as the lack of domestic investment capital, scarcity of industrial buildings and warehouses, and the complex nature of tariffs and customs controls would be overcome.27/

25/ World Bank, Haiti: Economic Memorandum, Report No. 3079-HA, 1981, p. i.

26/ Ibid., p. 109.

27/ Ginter, Inc., Extension du territoire portuaire et réalisation de la zone franche, Executive Summary, 1981, chapter I, p. 6.

/Although there

Although there are many aspects of the Haitian maritime transport environment which must be given careful consideration in order to take full advantage of the aforementioned advantages, some of the more important are (a) a staged maritime growth strategy, (b) project preparation - priorities (i) navigational aids, (ii) vessel construction and repair, (iii) maritime training, and (iv) container repair and maintenance.

(a) A staged maritime growth strategy

A staged maritime growth strategy is necessary to permit coastal transport to play its proper role in the overall national transport network while at the same time creating a basis for the establishment of a modern infrastructure of equipment and skills from which other related areas may be entered. This strategy might begin with the improvement of coastal transport services, modernization of the coastal fleet through the application of an intermediate boatbuilding technology such as ferrocement and/or the use of technical assistance to improve existing wood boatbuilding techniques, improvement and construction of navigational aids and feeder road systems, and establishment of marine-related industries such as container repair and training programmes for coastal fleet captains and crews.

The reason these areas have been selected for the first stage of the maritime development strategy is that such areas are normally reserved, either by legislation or by the type of undertaking, for Haitian nationals and permit the creation of skills, acquisition of modern equipment and the establishment of needed institutions without international competition. In fact, as these areas are largely national undertakings for all countries, the experience of other similar situated nations should be carefully evaluated to ensure that policies which have not proven successful might be avoided.

While this first stage might appear ambitious, such is not the case. As wooden vessels of the coastal fleet have an average useful life of approximately 12 years, the fleet modernization programme could commence by utilizing the new boatbuilding technology or techniques only for those vessels being replaced. For example, the number of vessels needed to be constructed would be

$$\frac{\text{412 wooden vessels}}{\text{12 year life}} = 34 \text{ vessels/year}$$

As a result, one half of the coastal fleet would be replaced in six years. Similarly, while vessels are being replaced, captains and crews could be given

/short training

short training courses on maritime safety, cargo stowage, coastal navigation, etc. It is interesting to note that, due to the incorporation of these new vessels into the coastal fleet and crew training courses, a basis would be established to obtain insurance for such fleet and cargoes.

Once modernization of the coastal fleet has been undertaken, training programmes for captains and crews established, and port infrastructures, navigational aids and systems of feeder roads are being improved or restored -a period which could take from 6 to 10 years- consideration might then be given to the feasibility of creating a Haitian presence in short-sea transport. The reason that modernization of the coastal fleet and related systems is a prerequisite for entry into short-sea transport is that the "human capital" acquired during such a period could be utilized as a basis for expansion of skills into other areas. Without the creation of needed "human capital" in the coastal transport field, Haitian participation in short-sea transport would only be nominal -for example, a joint venture which might not involve Haitian nationals in the operation of the company nor vessels.

The choice of a short-sea transport system should be carefully analysed at the appropriate time. Nonetheless, it can be advanced that the transport technology selected should be sufficiently flexible to permit Haitian participation in its important short-sea trade flows. For example, as Haiti exports bulk commodities such as cement to the United States and imports many of its manufactured goods in containers from that same country, the bulk-container vessel configuration would appear to merit further investigation.

Once the coastal and short-sea infrastructures have been established and the quality of transport services compares favourably with that of traditional maritime nations, a period which could take from 12 to 20 years, an evaluation might then be undertaken to determine the feasibility of expanding such infrastructures into deep-sea transport. While Haitian participation in deep-sea transport can take many forms, careful consideration should be given to those such as joint ventures and non-vessel-owning common carriers as well as the establishment of a national shipping line. The former methods of participation have the decided advantage of providing Haitian interests an opportunity to enter the industry without a heavy financial investment while at the same time creating a "human capital" basis for the establishment of a national shipping line.

/While the

While the need for Haitian-controlled international maritime transport services might be created by the adoption of legislation which reserves a stated percentage of national exports and imports for vessels of that country, legislation of this sort in no way lessens the need to create the aforementioned "human capital". Further, if such legislation is adopted prior to creating the "human capital" base, vessels would probably be chartered and operated with foreign crews. In this sense it is interesting to note that the Haitian national shipping line, Compagnie Nationale Haïtienne de Navigation, has recently established a trans-Atlantic service utilizing the chartered 12 500 dwt multi-purpose Norwegian owned Vestland.28/ While chartered vessels operated by foreign crews have been successfully utilized by many developing countries in the early growth stages of their national merchant fleets, they can increase the price of a country's exports in international markets as well as imports for national consumption and should, therefore, be carefully evaluated to ensure a maximum benefit to the national economy.

Although the time periods indicated to modernize coastal transport systems and train vessel captains and crews as well as establish a presence in short-sea transport are estimates, it should be understood that they are conservative when compared with similar undertakings of other countries. In this sense the experience of the United States would appear instructive. The United States Army Corps of Engineers, which is responsible for all construction and dredging projects in navigable waters of that country, has found that it normally takes an average of 24 years from the time Congress authorizes a project study until such project is completed.29/

(b) Project preparation - priorities

It is easy to discuss transport in broad macroeconomic terms in order to identify areas of concern but, if those problem areas are to be satisfactorily resolved, individual projects must be prepared by sectoral specialists. As each project in the transport sector seeks to respond to different needs, the analysis of problems and the preparation of projects which respond to such problems may be approached in equally different ways. There is, in fact, no universally accepted technique for problem analysis and project preparation. As a result, the preparation

28/ Fairplay International Shipping Weekly, 21 January 1982, p. 7.
29/ Ports and Harbors, December 1981, p. 9.

of projects by sectoral specialists which respond to transport problems is at the same time a creative and practical process.

It should be understood that there are many areas of the Haitian coastal transport environment which could benefit from the execution of projects with a practical focus. Nonetheless, those areas which are of a priority nature include (i) navigational aids, (ii) vessel construction and repair, (iii) maritime training, and (iv) container repair and maintenance. While container repair and maintenance is not an urgent need nor does the lack of such a facility create risks similar to those of the other priority areas, the repair of containers appears to be an undertaking which is within the financial and technical capacities of both the Haitian public and private sectors and, therefore, should be carefully evaluated.

(i) Navigational aids

As both the National Transport Study 30/ and the Coastal Shipping Development Study 31/ have indicated that navigational aids are needed at cabotage ports and along the coastline, the obvious response would be to recommend the installation of required aids. Nonetheless, in order to determine where and what aids should be utilized much more is involved. While a specialist in this area might recommend a system of lighted buoys with sophisticated electronic components, such recommendation must be evaluated on the basis of not only purchase and installation costs but also whether the corresponding country has the required vessels, equipment and technical skills to maintain such buoys. If a country lacks a supportive infrastructure for such buoyage system, it does not mean that it must continue to engage in coastal transport without navigational aids; it merely means that another system of aids must be selected. For example, prior to the advent of lighted navigational aid systems many countries utilized buoys with bells and gongs to guide vessels into and out of their ports. In fact, due to the prevailing fog conditions at San Francisco, California, United States of America, a similar mechanical sound buoy system is maintained as a back-up for other more sophisticated electronic aids.

To correctly interpret the coastal fleet's need for navigational aids, one must understand the different environments in which deep-sea and coastal vessels operate. Deep-sea vessels normally determine their positions three times daily;

30/ Berger, Luis, National Transport Study, Vol. III, chapter 8, pp. 50-51.

31/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Draft Final Report, 1979, chapter VI, pp. 18-21.

/that is,

that is, from morning and evening stars, and from the sun at its zenith for local apparent noon. While three positions daily are considered sufficient when navigating in the open ocean, this situation changes dramatically upon sighting land. When a vessel is within the sight of land celestial navigation does not provide information from which a vessel's position might be continuously determined. The need for exact and constant information concerning a vessel's position is made necessary by the closeness of land and the possibility of unseen navigational hazards such as reefs, rocks, sand and mud bars, etc. As a result, when navigating within the sight of land, vessel captains and officers utilize lighthouses, buoys and other prominent objects to constantly determine their position. Furthermore, these visual sightings become even more important at night when the sky, ocean and land become indistinguishable.

In the preparation of transport projects, it is essential that the problem sought to be resolved be clearly identified. For example, the grounding and sinking of coastal fleet vessels may be due to any one or a combination of the following factors: a lack of navigational aids, inadequate harbour and entrance channel depths, unprotected harbours and anchorages, inadequately trained captains and other vessel personnel, lack of harbour tugs to assist coastal fleet sailing vessels when entering and leaving ports, etc. Consequently, a project to reduce or eliminate the number of accidental groundings and sinkings of the coastal fleet might begin with an analysis of the aforementioned factors to determine the cause or causes of the problem

A project to install and improve the system of navigational aids must take into consideration, inter alia, width and depth of channels, particulars of tidal and seasonal variations, condition of existing aids, types of vessels which utilize cabotage ports, whether the channels are to be used at night and during all weather conditions, hazards, wind variations, rates of sedimentation and programmed port improvements. While these areas must be investigated to assure selection of the appropriate types of aids and their correct placement, much of the needed information may be readily obtained from captains of coastal vessels, cabotage port administrators, tide tables, navigational charts and similar sources.

While coastal vessels can usually enter and leave cabotage ports during daylight in a relatively safe manner, as knowledgeable captains can use prominent physical objects to judge their position, at night the dangers increase rapidly.

/For example,

For example, the passage through the coral reef at the Bay of Anse à Galets on the Ile de la Gonave is difficult to locate, particularly at night. Due to similar difficulties in locating the passage through the coral reef at the Bay of Baradères, rudimentary aids in the form of poles and floating wooden markers have been placed to assist the safe navigation of coastal vessels. Nonetheless, it should be understood that these aids are for daylight navigation and of little or no use at night.

Whether the system of navigational aids is for daylight use only or for both day and night, and whether its configuration conforms to international standards or purely local norms, should be determined by the amounts and types of commerce each port serves. Where a cabotage port serves only a small domestic trade, the use of daylight aids may be sufficient. Nonetheless, if a port is authorized to serve international commercial movements, a navigational aid system which permits vessels to enter and leave at any hour in all weather conditions and conforms to international standards would seem more appropriate.

With reference to types of navigational aids, regulation 14 of chapter V of the International Convention for the Safety of Life at Sea (SOLAS) is quite flexible in that

> The Contracting Governments undertake to arrange for the establishment and maintenance of such aids to navigation, including radio beacons and electronic aids as, in their opinion, the volume of traffic and the degree of risk requires, and to arrange for information relating to these aids to be made available to all concerned. (Emphasis added.)

Moreover, in order to ensure that the navigational aid system selected can be easily utilized by coastal fleet personnel, the variation in types of aids which comprise that system should be kept to a minimum. Further, the construction, installation and maintenance of such aid system should be within the capabilities of appropriate government agencies and private sector interests.

Navigational aids may be classified into two types of structures -fixed and floating. Fixed structures are posts and combinations of posts, placed both on land and in the water, and prominent trees, rocks, buildings, etc. While fixed structures have low acquisition and maintenance costs, their installation cost for in-water placement should be carefully evaluated. The reason for this is that such structures normally require floating steam or hydraulic pile drivers to place principal members into harbour and entrance channel bottoms. Further, due to the nature of fixed

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structures, they cannot be used at night unless equipped with lights. As a result, fixed structures are used for daylight visual navigation and only if lighted for similar purposes at night. On the other hand, floating structures do not require pile drivers for installation and permit navigation by sound. In this situation a bell can be placed on a buoy and through wave action the bell will ring. By means of this ringing sound, vessels can be safely guided into and out of ports at night and during most weather conditions.

An evaluation of the appropriate types of navigational aids and their respective locations should also include a determination of the future vessel movements which may utilize such aids. In this sense, coastal fleet movements may be broken down into three main types -normal, diverted and generated. Normal coastal fleet movements are those which would have taken place even without the proposed improvements to the existing system of navigational aids. Other types of cargo movements may be diverted from competing means of transport since vessels of the coastal fleet can deliver their cargoes more rapidly as they will no longer have to wait for daylight to enter and leave cabotage ports, and cargo losses due to vessel groundings will be greatly reduced. Finally, as the proposed navigational aid system will permit a reduction in both overall cargo transit times and the risk of cargo losses due to vessel groundings, without any increase in transport costs, certain new cargo and passenger movements may be generated in response to this new level of service. Therefore, the normal, diverted and generated coastal fleet movements must be carefully taken into account in the selection of the most appropriate types of navigational aids as well as their locations.

While the determination of possible locations for placement of navigational aids would appear a technical speciality beyond the capacity of most developing countries, such is not the case. In a country such as Haiti, which has a substantial and growing use of its coastal vessels for domestic transport services, the captains of these vessels and authorities at cabotage ports can be called upon to relate from their experience where navigational aids might be placed. It should be understood that coastal fleet captains with 20 to 30 years of experience entering the same cabotage ports have an intimate knowledge of not only navigational hazards but also tide and wind conditions that a specialist would have to acquire in order to elaborate a plan for the placement of navigational aids. As a result, appropriate Haitian Government agencies might utilize the services of specialists in this area

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to elaborate such a plan based upon the extensive national experience, and to suggest types of aids which do not exceed domestic financial as well as infrastructural capacities.

The Governments of France, Germany and the United States of America have offered financial and technical assistance to the Haitian Government for restoration, improvement and maintenance of navigational aids under various programmes.32/ For example, during 1977 the French Lighthouse Authority prepared a survey of 17 Haitian lighthouses and made recommendations for their restoration. Further, other similar work has been undertaken by the United States Coast Guard concerning navigational aids in the Bay of Port-au-Prince. Nonetheless, the Haitian Government has not responded to these offers in a manner required to assure their timely acceptance. The elaboration of a project which incorporates these as well as other efforts could provide a valuable learning experience for appropriate Haitian Government agencies while at the same time effecting needed improvements.

(ii) Vessel construction and repair

Haiti has a small but quite active boatbuilding and repair industry composed of several large and a number of small enterprises located all along its extensive coast. For example, the village ports on the islands of Gonave and Tortue specialize in the construction of sailing vessels for the coastal fleet.33/ Further, many owner-captains engage in boatbuilding and repair activities to either replace their vessels or return them to an operating condition. It is interesting to note that due to the diminishing availability of wood suitable for vessel construction, boatbuilders currently quote only labour costs for new vessels, expecting owners to furnish all supplies and materials.34/

The wood boatbuilding techniques currently employed in Haiti do not conform to any code, regulations or other specifications which are normally regarded as a basis for safety and insurance purposes. As a result, the basic need of the Haitian coastal transport industry is to evaluate which boatbuilding technology or technologies can be employed, not only to improve the coastal fleet and the quality of its services but also to reduce the outflow of scarce foreign exchange, create

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32/ Ibid.

33/ Berger, Luis, National Transport Study, 1977, Vol. III, chapter 8, p. 4.

34/ Buckley, James C., Inc., Coastal Shipping Development Study, Phase I, Preliminary Report, 1979, Appendix C, p. 27.

/sources of

sources of employment and utilize native materials. Moreover, while designs of coastal fleet vessels, their tonnages and materials of construction are the result of market forces and are, therefore, not planned, if a new boatbuilding technology is to be employed it would appear most opportune that an evaluation be made of such designs to determine what changes might be introduced to assure that future vessels not only fully comply with trade requirements but also are inexpensive to purchase, operate and maintain. Although coastal vessel construction and repair facilities can be owned and operated by private interests, government supervision (possibly through the Haitian Navy) is required to approve vessel construction plans, inspect vessels during and after construction or repair, and issue certificates of seaworthiness.

Industrial employment is highly prized in all parts of the world because of the economic multiplier effect whereby not only are jobs created directly but the basic industry supports service industries and ancillary activities such as those of the government. As vessel construction technologies, whether they make use of steel, aluminium, fiberglass, wood or ferrocement, are largely labour intensive, this is clearly an area in which engineers and economists should co-operate to ascertain feasible limits in which labour may be substiuted for capital, given the desired boatbuilding technology and the quantity and cost of available resources, to devise lower-cost and more flexible construction methods.

With reference to investments in the Haitian boatbuilding and repair industry, a recent study entitled Economic Impact of the Maritime Industry on the US Economy 1971-78 (An Interindustry Analysis) 35/ found that the chain of purchases begun by the American shipbuilding industry have a cumulative multiplier effect of 4.701 throughout the economy. While exact information concerning the Haitian boatbuilding and repair industry is lacking, this multiplier effect can be conservatively applied to that industry in the following manner

1.	vessels constructed per year	X	average value of vessels	X	multiplier effect	=	contribution to the economy	total contribution
	34		US$ 20 000		4.701		$ 3 196 680	$ 7 126 716
2.	vessels repaired per year	X	average value of repairs	X	multiplier effect	=	contribution to the economy	
	418		US$ 2 000		4.701		$ 3 930 036	

35/ Ports and Harbors, December 1981, p. 37.

/It should

It should be understood that the impact of this multiplier effect might be somewhat less in Haiti due to the lack of certain enterprises which are ancillary to a modern boatbuilding industry and the attendant need to import needed components. Nonetheless, it can be concluded that a modern Haitian boatbuilding and repair industry would make an important contribution to the national economy. As a result, care must be taken to ensure that boatbuilding technologies and techniques selected are suited to local conditions; that is, they are labour intensive, require little investment capital and have a low level of mechanization. It should be highlighted that the purpose of improving and/or adopting new technologies and techniques is not to introduce sophisticated quality standards but rather to ensure that vessels of the Haitian coastal fleet are fitted for their intended purpose, i.e., seaworthy.

The vessels utilized in Haitian coastal trades vary from 1 to 550 dwt and are constructed of wood with the exception of seven steel-hull motor vessels. The distribution of these vessels by means of propulsion and dwt is as follows

DISTRIBUTION OF THE COASTAL FLEET BY MEANS
OF PROPULSION AND DWT

	Number		Dwt
Motor vessels	1		52
	8		121-163
	6		193-550
Subtotal		15	
Sailing vessels	63		1-15
	216		16-30
	100		31-45
	19		46-60
	5		over 61
Subtotal		403	
Total vessels in Haitian coastal fleet		418	

Source: Annuaire APN, 1980-1981, provisional edition, pp. 149, 152.

As can be seen from the above table, approximately 75% of the Haitian coastal fleet is within the 16-45 dwt range and constructed of wood at local boatbuilding facilities. Consequently, the boatbuilding technology selected must respond fully to the trading patterns of and cargoes carried by these vessels.

/While the

While the Haitian boatbuilding industry is largely of an artisan nature with only a minimal investment in facilities and tools, thereby reducing overhead costs to a minimum, vessel construction costs have risen sharply in the last few years. These cost increases have been largely due to the ever-decreasing supply of appropriate wood in Haiti and the attendant need to import wood and other materials for vessel construction. It should be understood that the costs of imported wood and other boatbuilding materials are influenced not only by their price and transport costs to Haiti but also by import duties and the availability of foreign exchange.

An evaluation of vessel construction technologies to determine the most appropriate for Haiti involves many aspects of its marine transport environment and boatbuilding industry. Some of the more important of these aspects for this analysis are that resulting vessels should (a) be economical to purchase and maintain, (b) provide owners a reasonable return on their investments, (c) be constructed and repaired in Haiti, (d) meet trade demands in terms of service quality and safety, and (e) minimize the outflow of foreign exchange due to equipment, energy and construction material purchases.

While Haiti may lack the financial resources and personnel skills to create a cost-efficient infrastructure which utilizes steel, aluminium or fiberglass for construction of coastal vessels, ferrocement is an intermediate boatbuilding material that not only can effectively compete with traditional materials but also is particularly suited to the needs of developing countries. Ferrocement, invented in 1874 by Lambet, is a highly versatile form of reinforced concrete made of wire mesh, sand, water and cement, which possesses unique qualities of strength and serviceability, and has been utilized for a variety of vessels ranging from yachts to Liberty ships. While many of the early ferrocement vessels were constructed in compliance with traditional framing requirements for steel vessels, and were therefore grossly overdesigned and overweight, these early vessels after more than 60 years in seawater have clearly demonstrated the high durability of concrete in the marine environment.

Ferrocement boatbuilding was nonetheless spasmodic in this century until 1960 when, due to the high cost of steel, aluminium and fiberglass hulls, it became increasingly popular. Advances in ferrocement construction technology led the

/United States

United States National Academy of Sciences Advisory Committee on Technological Innovation, in 1972, to identify ferrocement as an overlooked, labour intensive, intermediate technology material with wide potential for application in developing countries.

Vessels constructed of ferrocement are reported to remain dry and free from condensation, are odourless and easy to clear. Due to these characteristics, grain in bulk can be carried without any intermediate containment and without any damage due to moisture or chemicals. Ferrocement hulls are safe and strong, highly resistant to fire and have good seagoing qualities.

While it would appear that ferrocement hulls would be heavier than those of traditional boatbuilding materials, this is not entirely true. It should be understood that wood and fiberglass hulls weigh about one-half as much as those of ferrocement, while the latter usually weighs no more than steel. As a result, neither ferrocement nor steel are utilized for extremely small hulls. Ferrocement is normally utilized for hulls from 5 m to 50 m in length.36/

Another valuable ferrocement technique which should be highlighted is the skinning of old wood hulls. In this situation the wood hull has lost its structural integrity through extensive damage, marine borers, age, etc. While normal wood boatbuilding techniques would make the repair of such vessels uneconomic, steel meshes can be stapled to the planking and plastered with mortar resulting in a strong durable hull which will last for many years.37/

One of the major advantages of ferrocement as a boatbuilding material is that almost everyone in the world has some understanding of sand and cement. For example, as many of the houses and buildings in Haiti are constructed of cement, workers with experience using this material are usually available. The quality of plasterers is not particularly important because a cosmetic finish is unnecessary on an artisan boat which is to be employed at slow speeds. This technology is simple and the materials are basic and often available locally, which is seldom true with other materials such as steel, aluminium, fiberglass and even wood. The labour-intensive

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36/ Hardy, F., and Raynaud, J., Concrete ship versus steel ship: is the heavier hull feasible, Day 1, Paper No. 3, at "Concrete Ships and Floating Structures Convention", Rotterdam, 1980.

37/ MacAlister, Gowan, Ferrocement and the development of small boats, Day 2, Paper No. 2, p. 1, at "Concrete Ships and Floating Structures Convention", Rotterdam, 1980.

/nature of

nature of this technology is an advantage in a country such as Haiti, where large amounts of labour are available. On the other hand, a wide range of highly skilled workers is necessary for the construction of vessels with other materials.

As the costs for wooden vessel construction have risen rapidly in the last few years, ferrocement technology would seem to offer considerable advantages over other vessel construction technologies. Its principal features are:

(a) its basic raw materials -sand, cement and reinforcing mesh- are readily available in most countries;

(b) it can be fabricated into almost any shape to meet the needs of the user, is more durable than wood and cheaper than imported steel, aluminium or fiberglass thereby reducing the outflow of foreign exchange;

(c) the skills for ferrocement construction are quickly acquired, and include many skills traditional in developing countries;

(d) ferrocement construction does not require a large investment in plant and machinery, and

(e) ferrocement can be easily and rapidly repaired on site.

There are many examples of the successful application of ferrocement to the marine environment. For example, in the Solomon Islands ten ferrocement fishing vessels of 24 m length and 6 m breadth are being constructed with a US$ 3.6 million loan from the Asian Development Bank. According to Mr. Trevor Homes, General Manager of the boatyard where these vessels are being constructed, ferrocement hulls should cost only 60% of the price of similar hulls of steel, fiberglass or wood.38/

However, other boatbuilders estimate the cost of such hulls at one-fourth the cost of a fiberglass hull of the same dimensions.39/

Within the Latin American region the Cuban Government has successfully utilized ferrocement in the construction of a large proportion of its fishing fleet, which today numbers several hundred boats. Since the use of ferrocement for construction of coastal fleet vessels may be immediately employed without extensive personnel training programmes or large capital investments and as it would utilize a greater percentage of Haitian materials and labour than any of the other boatbuilding technologies, it would appear most advisable that ferrocement be evaluated for possible application to Haitian vessel construction needs.40/

38/ Journal of Ferrocement, Vol. 10, No. 3, July 1980, p. 264.

39/ Ibid., p. 189.

40/ See annex 1 for a more complete explanation of ferrocement as a boatbuilding material.

(iii) Maritime training

Many of the difficulties facing the coastal fleet were discussed in the section of this document entitled coastal transport services. One of the more important which was highlighted in that section is the need to establish a training programme for shipboard personnel. In order to provide a basis for the establishment of such a programme, it would appear advisable to evaluate those utilized by traditional maritime nations to determine which might most effectively fulfill Haitian needs. While the educational contents of maritime training programmes varies greatly, those utilized in the United States might be conveniently divided into formal and informal.

Kings Point Maritime Academy and California Maritime Academy are fairly typical of formal university-type programmes which are of four years' duration and consist of two courses of study -nautical science and marine engineering. While both academies have somewhat similar contents for theoretical training, Kings Point Maritime Academy sends its midshipment to sea for one year aboard merchant vessels of the United States to acquire the necessary practical experience. On the other hand, California Maritime Academy has its own training ship aboard which midshipmen acquire practical experience in voyages of three months' duration each year. Upon completion of these programmes, graduates must take and successfully pass an examination with the United States Coast Guard in order to receive a license which enables them to work aboard vessels.

Persons holding United States Coast Guard licenses as assistant engineers or mates with one year of practical shipboard experience at their present license level, may take an examination from the same governmental agency for the next higher license level. It should be understood that almost all persons seeking to raise their licenses will, prior to the aforementioned examination, undertake a course of study for a period of from one to three months at a private upgrading school. The course of study offered by upgrading schools -such as Law's School of Marine Engineering at Oakland, California, and Pacific Maritime Academy at Honolulu, Hawaii- is normally chosen as the practical experience gained aboard ship, although invaluable, has little of the theoretical content necessary to pass a license examination.

Informal training programmes for ratings are composed of specific practical shipboard experience, and courses of study undertaken either individually or at an upgrading school. For example, once an individual has acquired the necessary one year of practical shipboard experience as a "wiper" or ordinary seaman and completed a course of study, he may take an examination with the aforementioned governmental agency to raise his rating to either fireman or able-bodied seaman respectively. Further, the same combination of practical experience and upgrading school process may be repeated from the very lowest rating to captain or chief engineer. Thus, upgrading schools in the United States not only prepare persons to raise license and rating levels but also prepare persons for advancement from ratings to officers.

It should be emphasized that the types of licenses obtained from formal and informal officer training programmes, and the informal rating programme that may lead to officer status, are "unlimited tonnage any ocean" for mates and "unlimited horsepower steam and/or diesel" for engineers. By way of comparison, limited tonnage and horsepower licenses exist for specific ranges of dead-weight tonnages and engine horsepowers. To qualify for limited tonnage or horsepower licenses, an individual must acquire practical experience working aboard vessels within the necessary tonnage or horsepower range. In order to avoid a multiplicity of costly formal training programmes for each horsepower and tonnage range, the ocean transport industry of the United States relies upon shipboard experience and upgrading schools to train personnel for limited licenses and ratings.

The major reason for the difference between formal four-year maritime training programmes and those which seek to assist persons to raise their rating and license levels is the background and needs of their respective students. While formal four-year programmes direct their efforts toward persons with no seagoing experience, upgrading schools accept as students only those persons with seagoing experience performing certain functions for specific periods of time. Due to such experience, students at upgrading schools may be immediately trained for other related functions instead of taking various sequential courses which are utilized to create a sufficient depth of knowledge so that the student can be trained for related functions. Further, four-year programmes are directed toward the training of persons who can design ships as well as operate them, while upgrading schools seek only to assist officers and ratings to increase their current operating levels. As a result of the background and needs of students at upgrading schools, the major assets of such schools are their professors. Consequently, classes may be taught in any building during evening hours and even recorded on cassette tapes for use at sea. For example, Pacific Maritime Academy has successfully utilized cassette tapes to teach, <u>inter alia</u>, the International Rules of the Nautical Road to persons while at sea.

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As can be seen from the foregoing, upgrading schools and specific shipboard experience are extensively used throughout the maritime industry of the United States. The advantages of this system are its low cost and breadth of training programmes -whether for officers or ratings, deck or engine, unlimited or limited licenses. Since upgrading schools for the training of shipboard personnel could be immediately employed without expensive investments, it would appear that this system should be evaluated to determine its applicability to Haitian maritime training needs.

(iv) Container repair and maintenance

The extensive utilization of containers on all major and many minor trade routes has clearly shown the savings possible to exporters and importers alike through reductions in, for example, freight, stevedoring and insurance costs as well as those costs related to the time break-bulk cargoes normally wait for on-carriage services. Within a transport system as vast as containerization, Haitian public and private sectors desiring to participate must carefully select an entry level for which (a) the supportive infrastructures either exist or can be easily established, (b) the undertaking is local in nature, i.e., not subject to international competition, and (c) is labour intensive.

For those countries with an export container demand, the construction of containers would seem to be a viable entry level into this transport technology. Nonetheless, the construction of containers on a cost-efficient basis would require a wide range of manufacturers in diverse areas such as steel and aluminium for plating, corner posts, corner fittings and other structural members, as well as wood floors, container markings and paints. If these components cannot be manufactured nationally, they must be imported, with a corresponding increase in prices due to transport costs and customs duties. Therefore, as the construction of containers must be supported, either directly or indirectly, by the entire manufacturing, transport and export sectors, the establishment of such enterprises should depend on the verification that they do not substantially exceed infrastructural capabilities.

As an ISO standard container will be utilized all over the world during its 12-15 year economic life, both container construction and leasing are international in scope. If a Haitian importer of goods from Japan wishes to utilize containers, he will normally purchase or lease units as close as possible to the Japanese exporter, thereby reducing any empty container transport costs. If this importer were to purchase a container constructed in Haiti, he would require not only containerizable Haitian exports destined for Japan, in order to eliminate empty transport costs to the latter country, but also a competitive sales price for Haitian containers when compared with those of Japan.

While container construction and leasing are international in scope, container repair is different in that it is limited to a specific trade area, usually near a port. The local nature of this industry is a result of owners and repairers seeking to avoid empty container transport costs. Since leasing companies apply the policy of repairing containers as near as possible to the place where they are found to be damaged, repairers must either locate their facilities close to major export trade flows which utilize containers, or else absorb empty transport costs. As a result, the domestic container repair industry reflects domestic container needs, flows and export usages. If the export container usage for any given country is dynamic, stagnant or depressed, then so will be the container repair industry. In this sense it is interesting to note that a very high proportion of Haiti's international trade is carried in containers, as is indicated by the following table:

CONTAINERIZED CARGOES OF HAITI

Cargoes	1974	1979
Exports containerized	66%	87%
Imports containerized	49%	59%
All cargoes containerized	54%	67%

Source: World Bank, Staff Appraisal Report, Port Development Project, Haiti, Report No. 3205b-HA, 24 February 1981, p. 6.

Due to the local nature of the container repair and maintenance industry, competition exists only between those facilities offering services in the same trade area, and not between enterprises in diverse locations such as Europe, the Far East and North America.

As repair work on a particular container depends on the damage, the type of container, its construction material, standards of repair and the customer, each task must be tailored to fit the situation. Due to the unique nature of each repair and consequent need for flexibility, repair work is very labour intensive. Moreover,

/the work

the work force must be moderately skilled and versatile. While some mechanization is possible with the use of hydraulic rams for straightening, automatic welding and painting, and some jigs and fixtures, it must be understood that these devices are merely used as aids to an otherwise manual operation. Automation or assembly line techniques have little application in container repair. Only rarely will a task be repeated in exactly the same manner more than a few times. The design, construction and condition of containers vary so much that jigs, fixtures and special tools cannot be utilized to make repairs under assembly line conditions. Even containers of the same design and from the same manufacturer become unique after repeated damage and repair.

There is wide agreement that, of the operational phases capable of inflicting container damage, those involving the actual handling of containers at terminals are the most significant. This is due to the nature of container handling facilities, which require a high throughput to justify their installation and rely heavily upon operator dexterity for safe operation of container handling equipment. Furthermore, it should be understood that container stuffing and stripping areas, such as those found in the port area of Port-au-Prince and shipping departments of major exporters, are generally congested, thus creating another source of container damage.

While it might appear that regions which have had over 20 years of container experience would have only minimal container damage, such is not the case. For example, Matson Navigation Company has found in its service between the West Coast of the United States and Hawaii, which is basically a closed-loop transport operation with little on-carriage, that with each handling -e.g., unloading from a ship and transfer to a storage area- 10% to 20% of the containers are damaged. Further, Overseas Containers Limited (OCL) has found that 39% of its containers utilized between developed regions are returned to the United Kingdom damaged with an average repair cost of US$ 140, and that in its service to the Persian Gulf area 54% are returned damaged with a repair cost from US$ 160 to US$ 475.41/

With reference to the use of containers in Haitian international trade flows, the following table presents the container movements at Port-au-Prince.

41/ CEPAL, An evaluation of the circumstances under which it would be feasible to establish container repair and maintenance enterprises (E/CEPAL/L.257), 1982, p. 27.

PORT-AU-PRINCE: CONTAINER MOVEMENTS

Year	Enter	Leave	Total
1972-1973 (1)	3 392	3 182	6 574
1973-1974 (1)	4 338	3 958	8 296
1974-1975 (1)	4 795	4 634	9 429
1975-1976 (1)	5 383	4 650	10 033
1976-1977 (1)	6 517	6 257	12 774
1977-1978 (1)	7 421	7 118	14 539
1978-1979 (2)	-	-	18 300
1979-1980 (2)	-	--	21 000
1980-1981 (3)	-	-	22 700

Source: (1) Annuaire APN, provisional edition 1980-1981, pp. 240, 241.
(2) APN, Service Central de Statistiques, p. 2.
(3) Estimation by Service Central de Statistiques based on first 10 months.

As the average growth rate in the movement of containers at Port-au-Prince since 1972 has been approximately 15% per year, it might be conservatively estimated that such growth for the reporting period 1981-1982 would be 10% thereby resulting in a total of 24 970 containers. Since that total has historically been divided almost equally into those entering and leaving Port-au-Prince, and assuming applicability of the Matson and OCL rate-of-damage experience referred to above, the following three situations can be envisioned

Situations	Possible gross revenues
1. Minimal container damage (20%) 12 485 containers X .20 damage rate X US$ 150 estimated repair cost =	US$ 374 550
2. Average container damage (40%) 12 485 containers X .40 damage rate X US$ 150 estimated repair cost =	US$ 749 100
3. High container damage (60%) 12 485 containers X .60 damage rate X US$ 150 estimated repair cost =	US$ 1 123 650

While exact information concerning the cost structure of repair enterprises is lacking, it has been found for the average repair that materials amount to about 30% of the total cost and labour accounts for two-thirds.42/ Based upon the labour

42/ Ibid., p. 12.

/intensive nature

intensive nature of the container repair and maintenance industry and due to the low-wage rates for skilled Haitian workers, it would appear that Haiti has a decided advantage for participation in such an industry.

Although most developing countries presently satisfy the criteria for entry into the container repair and maintenance industry, it must be highlighted that since containers continue to be modified to enhance their strength and handling features, they are the subject of ever-increasing levels of technological sophistication. It should be understood that as a transport technology becomes increasingly sophisticated, it will be found more and more expensive, its life span will be shorter, and operational, construction and repair skills will take longer to learn. For developed countries with sufficient financial resources to invest in the necessary facilities and equipment, and qualified personnel to perform repair and maintenance tasks, these ever-increasing levels of technology have not created any insurmountable problems. On the other hand, due to a scarcity of financial resources, skilled personnel and supportive infrastructure, many developing countries face the very real risk of being so overtaken by such technological changes that they might be unable to effectively participate in this growing industry. Thus, while repair technology yet remains within the reach of Haitian public and private sectors, an evaluation should be undertaken not only to determine the feasibility of establishing container repair enterprises but also the unsefulness of such enterprises as a technological base from which other areas of containerization might be entered.

/IV. CONCLUSION

IV. CONCLUSION

As can be seen from the foregoing, every effort has been made to evaluate the coastal transport environment in order to arrive at those projects which are within Haitian capabilities not only to elaborate and execute but also to effectively utilize. Based upon the evaluation presented in this document, four priority areas have come to light:

1. the restoration, modernization and installation of navigational aids;
2. the improvement and/or adoption of boatbuilding technologies;
3. the establishment of a maritime training programme; and
4. the establishment of a container repair and maintenance enterprise.

While the first three areas require immediate attention, the latter is presented as an enterprise which might be established to take advantage of the high utilization of containers in Haitian commercial flows. Further, due to the small investment required to establish a container repair and maintenance enterprise and its labour intensive nature, the circumstances under which it would be feasible to establish such an enterprise should be carefully evaluated by the Haitian public and private sectors.

If adequate financing were available, appropriate government agencies might wish to consider elaborating and undertaking projects in the first three areas simultaneously. However, assuming only limited amounts of financing can be made available, and based upon the substantial work which has already been undertaken and is programmed to be undertaken for the improvement of navigational aids, this would seem to be an area in which appropriate Haitian Government agencies such as DPP and SAT might wish to consider developing staff skills for the elaboration and execution of projects. In this sense, those government agencies might collaborate with organizations such as CEPAL's Transport and Communications Division, IMCO, UNCTAD, UNDP, the World Bank and others in a project which seeks to compatibilize the various bilateral programmes while, at the same time, assuring that those programmes respond to actual needs and do not exceed infrastructural capacities in areas such as repair and maintenance.

The remaining two priority areas -i.e., boatbuilding technologies and maritime training- are interrelated. It should be understood that a training programme could assist coastal fleet captains and crews to utilize existing vessels and related equipment in a safer manner. Nonetheless, since coastal vessels are constructed without adherence to any recognized standard, and employ only the most basic tools and materials which lack needed quality, such programme could not make the majority of the coastal fleet inherently safe or seaworthy. As a result, coastal vessel operators most urgently require inexpensive vessels which can be constructed and repaired in Haiti, are suited for coastal trades and incorporate needed safety features and equipment. Consequently, annex 2 contains a project entitled "An evaluation of boatbuilding technologies in the light of Haitian coastal transport needs" which appropriate Government agencies might wish to consider submitting to interested organizations such as the Inter-American Development Bank, the International Development Association, the World Bank, the United States Agency for International Development and other bilateral sources for funding.

/Annex 1

Annex 1

The Transport and Communications Division of CEPAL wishes to thank the editor of the Journal of Ferrocement, Dr. Jacques Valls, for permission to include in this document the following article which originally appeared on pages 189-203, Vol. 10, No. 3, July 1980, of that Journal.

Some Improved Methods for Building Ferrocement Boats

Martin E. Iorns*

Ferrocement boat building has been handicapped by overweight, voids, corrosion, poor impact resistance, and high labour requirements. This article outlines some principles and procedures which can overcome those handicaps both in one-of-a-kind and series building. How to design and prepare a high strength mortar which will inhibit corrosion and improve penetration is discussed, together with the most cost-effective ways to use rods, expanded or perforated metal, and welded or woven wire fabrics to increase impact resistance. Shotcrete, laminating, and cavity moulding techniques can improve appearance, eliminate the need for skilled finishers, and drastically reduce labour costs in series production. Important economies can be obtained in one-of-a-kind construction by building both the deck and hull inverted and by use of precast ferrocement bulkheads, frames, floors, soles, and tanks.

INTRODUCTION

The purpose of this article is to suggest some principles and procedures which will help the custom builder overcome the problems of overweight, voids, corrosion, poor impact resistance, and high labor requirements which have handicapped ferrocement progress.

By following these suggestions, a one-of-a kind builder should obtain a structurally sound hull with a minimum of labor at less than one fourth the cost of a fiberglass (GRP) hull of the same dimensions. Furthermore, the ferrocement hull will be superior to GRP in long-term durability; it will be fireproof, less likely to rip open in a collision, and much easier to maintain and repair.

The same principles and some of the procedures mentioned here are incorporated in a process [1-3] for series building, but efficient commercial production requires more sophisticated equipment and methods than can be described in the space available here.

PROBLEM AREAS IN CONVENTIONAL CONSTRUCTION

By conventional construction the author means to include all methods in which an armature of mesh tied to rods is fabricated and then impregnated with mortar. Tying mesh to rods is very time consuming and some builders report spending more than a thousand hours on this phase. Too few ties will permit the layers of mesh to spread apart when the mortar is forced though, resulting in a thick, overweight hull. Overweight may also occur if the rods are not supported by closely spaced station frames or are not of sufficient diameter and stiffness to prevent sagging under the weight of wet mortar. Even if the armature is strong enough to support the mortar, it may still be pushed out of shape by the pressure used to apply the mortar. Sometimes this escapes notice when the builder, under the mistaken impression that the mortar must be placed in one continuous operation, does not finish until dark. Filling concave spots

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with additional mortar adds weight and such unreinforced areas will crack and spall off under strain.

The obvious solution to the tying problem is to staple the armature to a solid backing. Such a system was advocated by John Samson [4] until it was discovered that the closed mould prevented visual control of penetration to the inner face and resulted in too many voids. This "cedar mold" method was superseded by the now widely used open mould in which the armature is stapled to longitudinal wood planks spaced several inches apart. In 1968 three men, under the direction of a naval architect and the author, built a 12 meter (40 foot) hull in one week by this method with the help of a professional plasterer called in to apply the finish coat [5]. The principal objection to this method is that the framework must be removed, has a limited salvage value, and the areas hidden by the planks must be back plastered.

The presence of rods within an armature introduces another problem in that rods may act as stress concentrators and promote cracking under impact. Tests by the US Navy [6] demonstrated a "remarkable increase in strenth-to-weight ratio by the use of mesh only". Some designers, though, feel that a network of high tensile rods makes a worthwhile contribution to the structural integrity of a hull in a severe collision. It is much cheaper to use rods than to obtain the same result by the use of an equal weight of high tensile mesh, so rods are acceptable provided they are of small diameter relative to the hull thickness, run in two directions at approximately 90 degree angles, and are covered on both sides by two or more layers of heavy gauge mesh.

Construction systems using only longitudinal rods covered by a few layers of (chicken wire) hexagonal mesh are now generally recognised as obsolete but lest owners of boats so built become unduly alarmed, it should be noted that hudreds of such hulls are giving satisfactory service providing the owners are careful to avoid severe impact situations. The curved parts of even a poorly reinforced hull can resist normal seaway stresses, but flat sections near the bow are vulnerable to wave impact if permitted to flex. Any areas in a hull which are found to deflect even slightly when pounding into waves should be stiffened by adding frames, shelving, berths or other substantial cabinetry, leaving access to the hull surface as unimpaired as possible. The bow compartment should also be isolated from the rest of the boat by a watertight bulkhead.

Another problem inherent in coventional construction is that impact resistance must be compromised to achieve a void-free hull. Impact resistance depends on steel content, the type of steel, its distribution, and its surface area. As steel content increases, mortar penetration becomes more difficult and voids more prevalent, weakening the section in which they occur and exposing the reinforcing to corrosion.

Three approaches to solving the void problem are worth considering:

1. Use a mesh with more open space between wires, but increase the diameter of the wires. This maintains ultimate tensile strength but does not provide the fine distribution and high bond surface which enables good ferrocement to deflect without cracking.
2. Make the mortar fluid so it can flow into all tiny crevices where wires touch and cross If a typical sand and cement mortar were watered down to achieve this, it would be both weak and porous. The water-cement ratio must never be more than 0.4 by weight for water retaining structures and should be kept below 0.35. If higher water-cement ratios are used which still meet strength requirements, make sure that the

hull is well sealed with an impervious coating. A sufficiently fluid high-strength mortar can be readily obtained at the 0.35 ratio by adjusting the amount and gradation of the sand or with the use of other fine aggregates.

Strength and permeability are directly related to the water/cement ratio, whereas the sand/cement ratio is relatively unimportant except in mass concrete where the sand is used to economically fill the spaces between larger aggregates and plays an important role in controlling shrinkage cracking. Cracking in ferrocement is controlled by the closely spaced reinforcing so the sand becomes mostly an adulterant by which the fluidity of the mortar can be regulated. With less sand, more cement is needed, but the extra cost is small compared to the gain in strength and durability and the investment in the completed boat.

3. Devise a laminating method whereby the reinforcing is embedded layer by layer into preplaced mortar. This embedding concept is basic to the patented process [3] offered to series builders, but it can also play an important role in the one-off methods described here. Laminating permits the placement of any amount or type of reinforcing material in any hull section without creating voids but requires the use of a solid surface to hold the mortar while the reinforcing is being positioned.

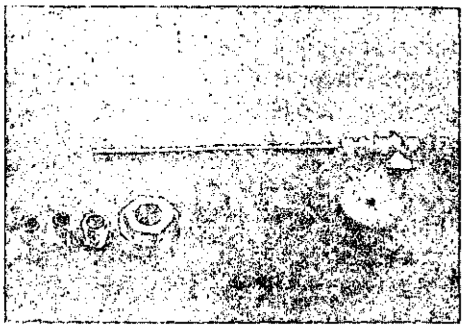
TOOLS AND EQUIPMENT FOR ONE-OFF CONSTRUCTION

A myth has arisen that ferrocement mortar must be placed and finished in one continuous operation. This has resulted in the marshaling of a crowd of skilled and unskilled workmen at the site on plastering day, and the procurement of expensive equipment, often in duplicate, for fear of a breakdown. All mortar prior to the finish trowel coat can be applied by conscientious laborers using methods and mixes which would be considered highly unconventional by professional plasterers.

The Fibersteel Company of West Sacramento, California, built a 10-meter (32-foot) tow boat in 1964 using strips of mesh tied to rods in the conventional manner. Plastering was done in three stages. On the first day the two hands built the armature, applied a rich fluid mortar, worked it well into the armature with gloved hands, rechecked the hull for fairness, scratched the surface, and allowed it to harden. The operation was then turned over to two professional plasterers who trowelled on what they called a "brown" coat, followed a day or two later by a final coat of commercial swimming pool finish plaster. The white hull needed no coating until many years later when it was converted to a pleasure boat and painted for cosmetic reasons. The boat was still in service in 1980, with no sign of any spalling or deterioration. Further evidence that continuity of mortar application is not necessary may be found in the hundreds of successful boats built by the "two shot" method advocated by Hartley [7].

Freed from having to rush the plastering phase, fewer workmen can be more efficiently employed and less expensive equipment can be used. Mortar can be mixed in any watertight tray with a hoe, carried to the job in a bucket, and applied with gloved hands, brush, roller, spray, or trowel. Or the mortar can be mixed in a drum with a paddle chucked in a low speed electric drill. Either method can provide enough mortar to impregnate the armature of a 12-meter (40-foot) hull in one day.

Spray equipment, while not essential, is desirable for multi-coat work, or the laminating techniques to be mentioned later, because mortar applied at moderate to high velocity seems to bond better to the substrate than when applied by trowelling. There are numerous commercial spray rigs costing $2,000 and up, sold in the U.S.A., but the one-off builder can rent a one horse power electric air compressor and use a hopper gun. Hopper guns, sometimes called pattern pistols, cost about U.S. $100 new but a serviceable one can be assembled using a funnel-shaped container holding about ten liters and pipe fittings costing under US$10 (see Fig. 1). The roller tool used to embed mesh is show in Fig. 2.



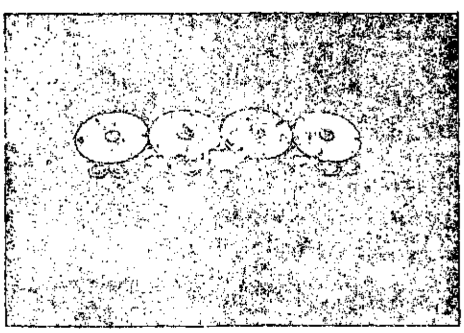
(a)

(b)

Fig. 1. Details of a hopper spray gun.

(a) Parts from a mortar spray gun. Select one of the three fittings show on the left which best suits air and mortar supply. Flatten one end if fan pattern is desired. A "Y" fitting is better than the black "T" shown, if mortar is from pump hose instead of hopper. Adjust air tube in and out to find the best operating position.

(b) Nozzle attached to 19 liter (5 U.S. Gallon) can, to make a hopper gun.



(a)

(b)

Fig. 2. Details of the laminating roller used for embedding mesh strips in each layer of mortar.

(a) Parts of a roller laminating tool as purchased from a retail electrical/plumbing store for less than US$5.00. The electrical cover plates are 4 inches in (10 cm) diameter. Larger discs would be even better, if available.

(b) Parts shown in (a) have been assembled to form the roller. Lock nuts should be left loose so that the discs are able to rotate freely. More discs may be coupled on if wider tool is needed (for flat surfaces).

MATERIALS

Reinforcing mesh

This is the most expensive component in ferrocement, so deserves the most careful cost analysis. Of the three types of mass-produced mesh commonly available, welded wire fabric, expanded metal, and woven wire fabric, the first two are the most cost-effective. Welding anneals wire and limits the tensile strength of welded fabrics, so a more expensive high tensile ungalvanized woven fabrio may be required in high performance planing hulls where thin ferrocement panels are subjected to severe tensile loadings [6]. High tensile mesh is not needed for displacement type hulls. When the same grade of steel is used, welded fabrics are superior to woven fabrics because their wires run straight and load up instantly under strain, whereas the undulating wires in woven fabrics straighten out and may allow the cement cover to crack before being fully loaded.

Woven fabrics with square openings are clearly superior to those woven with hexagonal openings, commonly referred to as "hex mesh" or "chicken wire". Most designers now recommend a widely available square mesh woven with 19 gauge (1 mm) diameter wires spaced about 13 mm (1/2 inch) apart. Galvanizing, like welding, anneals wire and precludes high tensile applications. It may also react with ungalvanized rods to produce hydrogen bubbles unless passivated by adding chromium trioxide to the mixing water at the rate of 200-300 parts per million. A better choice is 16 gauge (1.6 mm) square welded mesh with wires on half inch (13mm) centers. Benford [8] reports tests showing two layers of the 16 gauge mesh are stronger than three layers of the 19 gauge material.

A 14 gauge (2 mm) square welded fabric with wires spaced one inch (25 mm) apart and known in the trade as "Weldmesh 1114" provides the most strength for the money of any of the commonly available welded fabrics suitable for ferrocement. The wide spacing of its wires makes it ideal for deck to hull and bulkhead to hull joints, where penetration is often a problem. One commercial builder used it extensively for bulkheads, decks, foam core construction, or in any place where tensile loading governs, and equal strength is needed in two directions. Its openness and low specific surface makes it inferior for crack control purposes, so a layer of fine mesh or expanded metal plaster lath should be interposed between the Weldmesh 1114 and any surface subject to strain or wide temperature variations. A companion product with half as many wires in one direction costs less and can be used wherever equal strength is not required in both directions.

Expanded metal plaster lath is ideal for boat hulls because it presents a much greater bond surface than wire fabric and costs less, so provides the most economical way to obtain a ferrocement hull which can accept considerable strain on impact without cracking. The suitable types of expanded metal and the precautions to be observed in their use have been fully discussed in [2], so will not be repeated here.

There are many proprietary reinforcing materials being advertised for ferrocement, including steel and glass fibers. Fibers should never be used for boat hulls except in conjunction with some more continuous form of reinforcing. Fibers, because of their random orientation, are not as effective as welded fabrics or expanded metal lath, yet cost about the same per unit of weight. The author believes that the most efficient way to use fibers is not to add them at the mixer but to spray alternate layers of mortar and fibers on a solid surface or closely spaced mesh lattice. Random orientation would then be confined to one plane. Any reinforcing fabricated from ordinary mild steel can be evaluated by comparing its cost per pound or kilo with Weldmesh and expanded metal plaster lath. Weldmesh 1114 in January 1980 costed about fifty cents a pound (.4536 kg) or two dollars a square meter in the USA, and slightly less in England.

Expanded metal plaster lath made from 24 gauge (.023 inch or .584 mm) sheet steel expanded to weigh 3.4 pound (1.54 kg) per square yard (.9144 meter) can be purchased in the

USA from building supply stores for about $1.50 a yard ($1.80 a square meter). A similar three pound lath is manufactured in England.

Equivalent mesh may be obtained from sources outside the US and UK at lower cost, but be sure to check gauges and weights against the standards just given. There are many expanded metals on the market which are too flimsy for consideration. On the other hand, there are many stronger expanded metals made from thicker sheet steel by a more expensive process which are used for machinery guards, catwalks, and other heavy duty applications. Some of these heavier materials may be well worth their cost for those parts of a hull subject to high impact loads.

Cement

This is the second most costly component in ferrocement, but price and quality are fairly standard worldwide. The one-off builder may select the least expensive local cement that meets his government's specifications for compressive strength. If several brands are available at the same price, select the one with the lowest C_3A percentage as it should have the best resistance to the sulfates in sea water. There is no need to pay a premium for Type V sulfate resisting cement because the same protection can usually be obtained by pozzolans or coatings at less cost. A rich, nonporous mortar is adequately sulfate resistant even if made from common cement.

Be skeptical of claims for expensive ultra high compressive strength cements and mortar mixes. A rise in compressive strength is usually accompanied by a rise in the modulus of elasticity (brittleness) which must be controlled by the reinforcing mesh. Any mortar prepared from sound materials with a water-cement ratio below 0.4 and sand-cement ratio less than 2 to 1, should be strong enough for all normal ferrocement use.

Aggregates

Ferrocement designers have tended to specify the use of a sharp, well-graded silica sand without mentioning the relative merits of many alternatives which may be locally available at lower cost. Hardness, sharpness, and gradation are minor considerations if the water/cement ratio is kept between 0.3 and 0.35. The sand must be completely free from organic materials, particularly animal droppings, and should be relatively free from silt or clay. Some parts of the world have aggregates which react with the alkali in cement, so before using a new and untried source of sand, check with a local concrete authority and have mortar bar tests made if in doubt.

Particles larger than about 1 mm (one twenty fifth of an inch) should be screened out to aid in penetration. Woven wire fly screen makes a suitable sieve.

A fine, clean river or beach sand may be suitable for ferrocement, although its poor gradation may make it unsuitable for mass concrete.

There are many suitable aggregates which are lighter than sand, and some of these have a beneficial pozzolanic action as well. Check on the availability and cost of flyash, volcanic ash, slag, diatomaceous earth, expanded shale fines, perlite, pumice, vermiculite and inert alkali-resistant plastics. The plastic micro balloons used in synthetic foams may be too expensive, but low cost styrene beads and granules of scrap rigid urethane foam or styrofoam are worth investigating. Most lightweight aggregates reduce mortar strength proportionally more than they reduce weight, so mortars containing them must be tested for structural adequacy before use.

Water

Everyone agrees that potable water makes good concrete, but water containing enough salt and minerals to be unpalatable may also be used in a rich mortar. Steel will not rust if it is completely coated with a highly alkaline mortar whose pH exceeds 13. A Portland cement slurry meets this requirement but the sand and mixing water must be free from organic matter or other acidic materials which would reduce the pH. There is some experimental evidence [9] to indicate that water with some degree of salinity could be used in a rich fluid mortar without serious adverse effects on the reinforcing, but this practice is not recommended. Water from swamps and jungle ponds is likely to contain acids from rotting vegetation and should be tested before use to be sure the pH is 7 or above.

Admixtures

Anyone reviewing concrete literature encounters a bewildering array of reports and advertisements about admixtures. Most have little application to ferrocement although some play an important role in conventional concrete. Plasticizers and air entraining agents permit workable mixes to be made with higher sand contents but only a large-scale ferrocement builder might find it worthwhile to get involved in the intricacies of their use. Some advertised "waterproofing" admixtures would seem to have value for a boat hull, but all are superfluous in any workable (low sand-cement ratio) mortar whose water-cement ratio is under 0.4.

A retarder can be very useful in hot weather by enabling a small crew to take time to do a thorough job and avoid having to discard mortar because of premature set. There are many proprietary retarders on the market, but the least expensive and most readily available is ordinary sugar. Preliminary tests should be made on trial batches of mortar to determine the upper limit (20-60 grams of cane sugar per 43 kgs of cement) of amounts to use because only a small amount is needed and an overdose can be ruinous. Properly used, a retarder should have no adverse effect on ultimate strength and may even increase it.

Pozzolans are recommended additives which contribute to sulfate resistance and the long-term durability of concrete exposed to water. Some pozzolanic concrete placed by the Romans has withstood immersion in sea water for 2000 years. No one expects that length of service from a boat, so, if a pozzolan is not readily available at a reasonable price, it may be omitted and the hull protected by coatings. Even an unprotected hull should last several lifetimes if made with the non-porous mortar that has been discussed.

Pozzolans are available in several forms. Natural sources include some volcanic materials and diatomaceous earth. Flyash, a waste product of coal burning, is plentiful and much research has been done on its utilization. Pozzolans may contain undesirable impurities, so should be certified for concrete use by a competent authority. There is a common misconception that the pozzolan content of a mortar should not exceed 5%, or at the most 15%, of the cement weight. Pozzolans can replace up to 15% of the cement in most concrete hydraulic structures without affecting ultimate strength, although early strength will be less. Higher pozzolan concentrations are needed to convert all the soluble free lime in cement to an insoluble calcium silicate, so the author's recommendation is to keep the cement content and the water-cement ratio constant but replace 30 % to 100 % of the sand with pozzolan. The resulting mortar should be tested and compared with mortars of known suitability before being used in a boat.

Some pozzolans absorb considerable water into their interior structure which will not be immediately available for hydration of the cement. This can be checked by weighing a dry sample of the pozzolan, soaking it in water for a day or more, placing it in a warm (not hot) oven until it is surface dry, then reweighing. The completely dry weight is subtracted from the surface dry weight to find how much water was retained in the pozzolan. A proportional amount of water can then be added to the mortar.

MORTAR MIXING

It is assumed that the cement is being delivered in bags known weight and that the mixer will hold at least a one-bag batch, otherwise a container will be needed to hold and measure a known weight of cement. Another container must be marked or cut down to hold an amount of water which will not exceed 35 % of the cement weight, and thus provide a 0.35 water-cement ratio. Another container holding enough additional water to bring the w/c to 0.4 can be prepared for use in tempering an overly stiff mortar, but a better practice is to use a retarder or temper with a 0.4 w/c slurry.

The order of mixing, providing it is thorough, does not affect the final strength of the mortar, so the method used will depend on the equipment available. The mortar mixers used throughout the U.S. have paddles rotating on a horizontal shaft inside a stationary drum and may stall if dry materials are added first.

Revolving drum concrete mixers rely on the presence of coarse aggregate to do a thorough job of mixing and permit the dry ingredients to be added first. Revolving drum mixers, while not recommended for ferrocement, are cheaper and can be used if mixing time is lengthened and carefully monitored for thoroughness.

Dry mixing was the rule in older methods which used leaky wood boxes or flat platforms. It is still necessary for some admixtures such as polyethylene oxide, a pumping lubricant that will coagulate if not first mixed with one of the dry ingredients.

In paddle-type mortar mixers water is placed in the mixer first, then the cement, then the pozzolan if used, followed by just enough sand or other aggregate to obtain the desired consistency. If a fluid mix stiffens prematurely, a retarder should be used. The mortar used to impregnate an armature should be of an almost paint-like consistency and applied with a brush or spray so it will run down into all the crevices. The excess can be caught on a plastic sheet and remixed. The fluid mortar application is followed by a stiffer mix containing more sand or reclaimed fluid motar which has stiffened but not finally set.

MATERIAL TESTING

There are two tests which any builder can easily make with simple equipment which will tell whether a hull be structurally sound, and which should be made in every case where the builder departs from conventional methods or uses new mortar mixes and mesh combinations.

First, prepare a series of test panels about one meter long and about 15 cm (6 inches) wide. Dimensions are not critical as long as they are the same for all panels. Make three reference panels with materials known to be suitable and three panels of each of the materials to be tested. Give all the same cure. Support each panel near the ends and load the center through a wood block which will distribute the load over one fourth to one third the span. Compare the test panels to the reference panels with respect to the weight required to bend them and to produce audible or visible cracks.

Second, prepare a series of square reference and test panels one-half meter (19 inches) or larger on a side, place on a frame which will provide a continuous support around and near the edge, drop a heavy blunt weight from a height onto the center of each test panel, and compare the impact behavior of the test panels with the reference panels. Test not only for the amount of force required to produce a measured rate of leakage, but also for complete failure (an open hole). The striking weight can be made by filling a pipe or other container approximately 25cm (10 inches) in diameter with concrete and rounding its end, using a bowl for a form. This impact test is the single most important test which can be made by any builder who wants to evaluate previously untested local materials or who wants to improve the structural integrity of a hull for which other materials such as chicken wire were specified by the original designer.

CONSTRUCTION METHODS

All one-off boats of conventional design can be built more efficiently in the inverted *position, including the deck which should be built first.* All but the very smallest boats should be launched inverted and turned upright while afloat. A survey of several California builders who righted their hulls out of the water revealed a high rate of damage. Turning while afloat can usually be done with simple equipment and minimum risk.

If the boat is built away from the launching site, consider building it directly on the conveyance which will transport it to the water. Be sure to provide for the insertion of jacks, slings, or rollers, and a crawl space for access to the interior, unless a transom door is included in the design. Such a door leading into a stern cockpit is not difficult to construct in ferrocement and is a great convenience for boarding guests, swimmers, and large fish.

In addition to the open mold method mentioned earlier, the builder has a choice of three other systems, all more efficient than any previously published.

They are: (1) Closed mold, (2) Integral mold, and (3) Precast core. The first, an "all mesh" laminated version of Samson's "cedar mold" [4], will be a good choice for those parts of the hull above the cabin sole which are to have an interior wood finish. The penetration problems which brought the "cedar mold" into disrepute can be solved by embedding the mesh in preplaced mortar layer by layer as described later. Even so, a wood lining in the bilge is not desirable, so another method is recommended for those areas.

Where a wood lined interior is not required, the choice lies between an integral mold and a precast core, with the former favored for amateur use as it is more closely related to traditional methods using rods.

The precast core method has considerable potential but is still in the conceptual stage, so some experimentation would be needed to adapt it to a particular boat design. It is extremely versatile, especially for lightweight sandwich construction, but there are few guidelines available from prior experience.

All methods start construction by procuring enough sheets of thin plywood or other water resistant panels about 6mm (¼ inch) thick to cover the deck area twice. Place half the panels on a flat surface and the other half on top to form a double thickness. Stagger the joints and bond the top and bottom layers with any low-cost waterproof glue, and paint the top surface with a light color or whitewash. Loft (draw) the hull lines full size on this platform and outline the deck openings.

Prepare patterns for making the permanent bulkheads, hull frames and any deck beams needed. If the closed mould method is to be used, these elements, and possibly the deck will probably be made from plywood. The other methods normally use precast ferrocement.

Instead of preparing patterns, precasting may be done on transparent plastic sheeting laid on top of the lofted lines. As soon as the mortar stiffens, the casting can be pulled aside to make room for the next piece. These precast elements should be reinforced with at least two layers of Weldmesh 1114 or equivalent which should be allowed to project about 10 cm (4 inches) from the edge which joins the hull or deck. This projecting mesh will be bent fore and aft when the precast piece is in place and form the core of the joining fillet. The interior edge of frames and any large bulkhead openings should be reinforced with mild steel rod wrapped with mesh which overlaps the Weldmesh core Figs. 3-4.

Fig. 3. Halfway point in casting bulkhead (same method used to precast deck and frames). A layer of mortar is first spread over outline on casting platform. Metal lath is rolled in and then covered with more mortar as shown here. Man in foreground is placing first of the two layers of Weld mesh to form core of fillet where bulkhead join hull. One more layer of metal lath and mortar will complete the precast phase.

Fig. 4. Bending Weldmesh 1214 about rod curved to deck camber to form core for precast deck beam. Crimping is preferable to cutting in order to flatten bulges.

While the precast pieces are curing, prepare the temporary station moulds from plywood or scrap lumber in the usual manner and set aside clear of the deck platform. Place longitudinal stringers at intervals and heights which will bend up the edges of the deck platform to the design camber, The transom will probably have a similar curvature and may be precast at this point. Flat transoms should have been cast at the same time as the bulkheads. Fill the seams in the deck platform and sand smooth or cover the deck area with any low-cost fabric such as burlap, the back of a discarded carpet or any sheet material which a test panel shows will impart a desirable pattern to the deck surface.. Nail a mortar stop around the deck edge and around deck openings. Saturate the surface with a proprietary release agent guaranteed to leave a paintable surface, or use diesel oil fortified with upto 50% of any cheap lubricating oil.

Spread or spray a layer of fairly stiff mortar not over 3mm (1/8 inch) thick and allow to harden but not dry out. Spread another similar layer of mortar and roll in sheets of expanded metal lath or closely spaced wire fabric. The purpose of this mesh layer is only to prevent temperature and shrinkage cracks from appearing on the deck surface later, so orientation of the mesh strips is not critical, but overlap all edges at least one open space.

Place as many layers of Weldmesh as are called for in the design and impregnate with a fluid mortar. The Weldmesh should be cut to reach at least 15 cm (6 inches) outside the deck edge and be bent up to provide an overlap with the hull reinforcing. If ferrocement hatch coamings are to be installed later, the Weldmesh can span the openings in the mortar, then be cut and bent up after demoulding.

The precast deck beams and bulkheads are now positioned and bonded to the deck with a fillet of mortar just covering the spread apart layers of projecting Weldmesh. Any wood bulkheads, frames, or beams used in the closed mould method should also be placed and fastened to the deck at this point.

Precast permanent hull frames and temporary station moulds which outline the shape of the hull are now placed and aligned. In the closed mould method the strips of wood or other material which have been selected for the interior finish are then fastened to the permanent frames and bulkheads and then protected on the hull side with a waterproof coating, preferably a high build elastomeric type. Prefinishing the interior face now may save work later. The closed wood mould need only be used for those parts of the boat requiring that interior finish. Other areas, particularly those below the cabin sole, will be more durable and fire resistant if done by one of the other methods.

In the integral mould method, rod (preferably high tensile) of a diameter less than one fourth the finished hull thickness is run fore and aft, spaced at as wide an interval as will accurately maintain the hull shape. No vertical rod is used, unless the designer insists on it and in relatively flat hull sections the spacing can be greater than in conventional construction. Strips of expanded metal lath or perforated metal are tied to the inner face of the rods and snugged tight. Very few ties are needed compared to those used in conventional construction, only enough to hold the mesh tight to the rods against gentle pressure. Wood battens can be used to back up the mesh in any area where the rods are so widely spaced as to permit sagging.

Gently fill the space between rods with a mortar which has been stiffened with enough ultra lightweight aggregate so it will not fall through the holes in the mesh yet will be firm enough to hold staples after it has hardened. This results in an integral mould which can be encased in mesh on the outside now and on the inside after launching and righting.

In the precast core method, planks running the length of the hull are precast on a flat surface with lightweight mortar sandwiched between strips of mesh. One or two rods may also be embedded in the plank if needed. Width and thickness of the planks will depend on the size and curvature of the hull. The planks need only be strong enough to span the gap between station frames and support one layer of laminate, so a wide range of rigid plastic foams or light weight aggregates could be used. One might also experiment with sawdust and cement or with bamboo either whole or split. When structurally weak materials are used for the core of the planks, strips of Weldmesh should be molded in or inserted between the planks for shear ties (see Fig. 5-8).

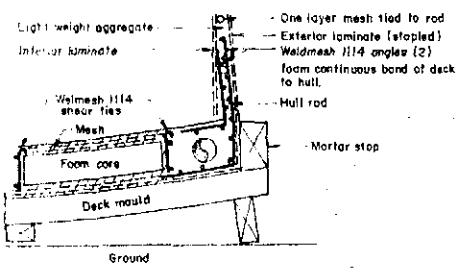


Fig. 5. Hull-deck joint, Integral Mould Method.

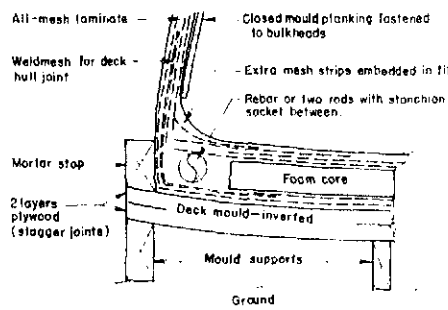
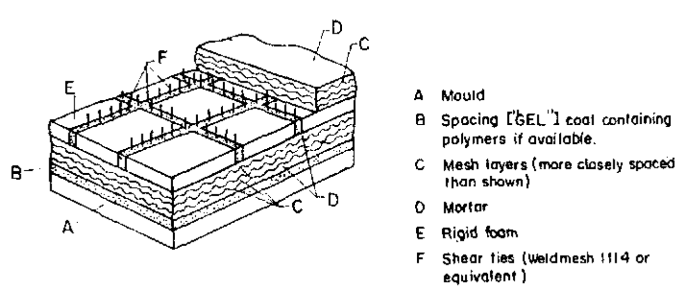
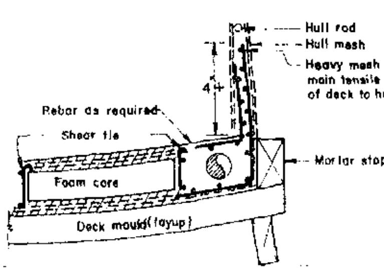


Fig. 6. Cross-section of deck-hull, Closed Mould Method.

(a)





(b)

Fig. 7. (a) Exploded view of foam core ferrocement.
(b) Cross-section of foam, core deck to integral mould hull. Shear ties and mesh upstand can be made from Weldmesh 1114 or equivalent in boats under 20 m. Rebar at deck edge may be replaced by two rods with stanchion sockets between. Foam core may be replaced by deck beams.

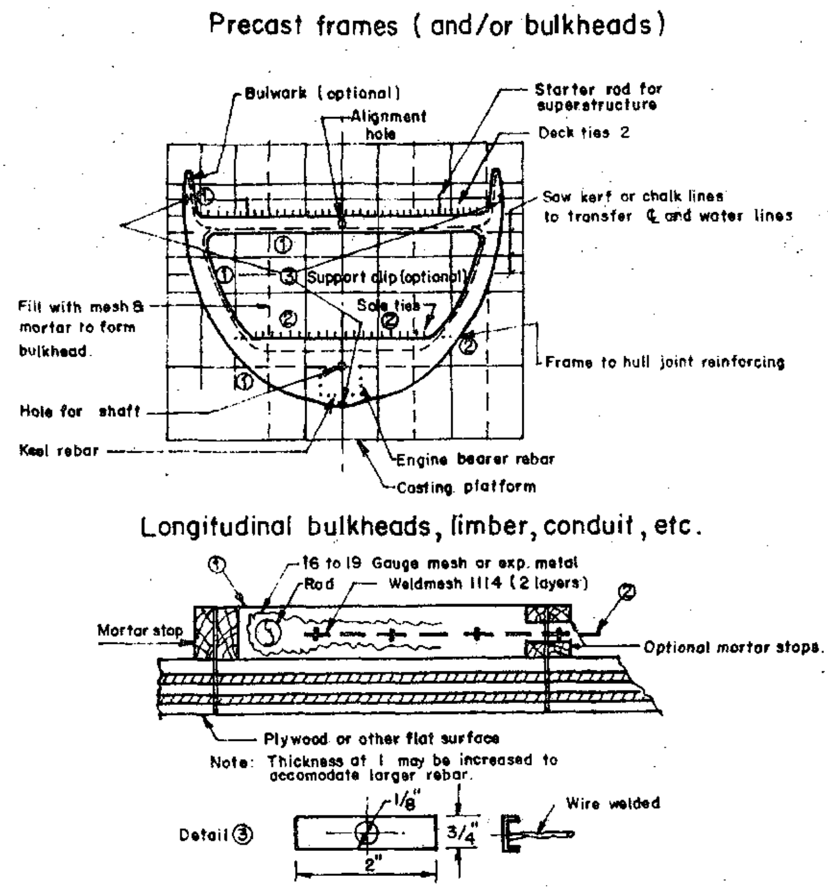


Fig. 8. Details of precast frames, longitudinal bulkheads, limber and conduits.

The precast planks are fitted to the station frames in the same pattern as wood planks would be fitted to a carvel type wood hull. Ties at bow and transom with occasional ties in between should be sufficient to hold the plank against the station moulds. Instead of precasting a garboard plank to fit the keel, it may be simpler to fill that area with solid concrete.

As soon as the closed mould, the integral mould, or the precast planks are in place, a thin layer of high strength mortar is brushed or sprayed on the surface and strips of expanded metal lath are pressed into it and stapled. The preferred pattern is to run the strips about 45 degress on the diagonal with the second layer at 90 degrees to the first. Do not overlap any mesh except along the keel and stem where the extra thickness is needed for impact resistance. Each strip and each subsequent layer must be embedded in wet mortar with no dry spots under any part of the mesh.

While the last layer of exterior mesh is being applied, call in a professional plasterer to apply the finish coat which should not be more than 3 mm (1/8 inch) thick. Tell the plasterer to provide a smooth but slightly rough surface which will make a good bond with any hull coating to be applied later. A slick steel trowel finish needs to be sanded or etched with phosphoric acid before paint will adhere well. Phosphoric acid is also useful for treating rust spots. Never use hydrochloric (muriatic) acid on ferrocement or on any concrete where steel is near the surface.

A word about coatings: Most epoxy formulations resist alkalis, bond well to concrete, and provide watertight, glossy surface. But they become brittle on aging, are considerably stronger than the concrete beneath, and have a much greater coefficient of expansion. They have been successful on hulls which are subjected to only minor temperature changes, but if several coats are built up on decks where daily temperature variations may be extreme, a shear failure can occur in the concrete below the bond line. If an epoxy is needed on deck for its adhesive qualities, it should be a thin coating followed by a tougher, more flexible paint such as a urethane.

As soon as the exterior mesh is cemented in place, work can start on the interior. The bulkhead to hull joint should be filled with mortar up to about the waterline, leaving overhead work until the hull is upright. The Weldmesh projecting upwards from the deck should be encased in at least two layers of mesh embedded in mortar.

After the hull is upright, the interior laminate is completed and the keel is poured in layers heavily reinforced with rod. Short lengths of rebar, strap, and angle iron are sometimes available from steel fabricators at scrap prices, and their elongated shape will arrest cracking much better than punchings or pellets. Ferrocement is an excellent choice for cabin soles and for integral tanks to hold water, sewage, and diesel fuel, although the latter requires special construction techniques and sealing methods to prevent leaks.

The recommendations in this article have been stated in general terms because it is difficult to be specific without a particular design in mind and without knowing what materials are available at the builder's site. Even with all that information at hand it is not possible to say with certainty which of the three building systems outlined here will be the most efficient. Each can be made to work, but some designs may be more easily constructed by one method than by the others. It is conceivable that all three methods might be used during the building of a single boat.

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/Annex 2

Annex 2

AN EVALUATION OF BOATBUILDING TECHNOLOGIES IN THE LIGHT OF HAITIAN COASTAL TRANSPORT NEEDS

Justification of the project

For many Haitians, the coastal fleet has been the traditional lifeline which ensures mobility for themselves and their goods. This is particularly true for the island districts of Ile de la Tortue, Ile de là Gonave, Les Cayemites and Ile-à-Vache, where coastal vessels are the only means of transport. The Government of Haiti has recognized the important role the coastal fleet plays not only in the economy but also in providing means by which such islands and other isolated areas of that country might communicate among themselves as well as with the rest of the world.

The attraction of coastal transport lies in the fact that waterways are provided by nature, and capital investments may be limited to the cost of construction and maintenance of port facilities. Further, due to the energy-efficient nature of water transport systems they have experienced dramatic growth rates in recent years. France has been in the forefront in promoting waterway use and has produced statistics to show the energy savings possible from this means of transport. For example, it was found that a self-propelled barge can move one metric ton of cargo 500 kilometres with 5 litres of fuel; an electric train can haul the same load 333 kilometres; a tractor-trailer unit 100; and an aircraft 6.6. Similarly, water transport has the lowest power requirements per ton-mile -i.e., one horsepower moves 150 kilogrammes by road, 500 kilogrammes by rail and 4 000 kilogrammes on water. Thus, water transport is universally recognized as the lowest-cost means for many classes of goods, over both long and short distances.

As coastal vessels are the most inexpensive means of transport in Haiti, they are of particular importance to the poorest sections of the rural population. As a result, even minor improvements in the coastal fleet, navigational aids and boatbuilding facilities can have a considerable effect in terms of income and living standards of such rural areas.

Haiti has a small but quite active boatbuilding and repair industry composed of several large and a number of small enterprises located all along its extensive coast. For example, the village ports on the islands of Gonave and Tortue specialize in the construction of sailing vessels for the coastal fleet. Further, many owner-captains engage in boatbuilding and repair activities to either replace their vessels or return them to an operating condition. It is interesting to note that due to the diminishing availability of wood suitable for vessel construction, boatbuilders currently quote only labour costs for new vessels, expecting owners to furnish all supplies and materials.

Based upon the nature of the trade in which coastal sailing vessels operate, they are largely constructed at artisan facilities or by their owners without utilizing modern wood boatbuilding techniques and equipment. For example, since vessel ribs and planks are only rough-cut by hand tools, the necessary close fitting of hull joints and subsequent caulkin to ensure watertightness is made extremely difficult if not impossible. As a result, these vessels have an average replacement lifetime of approximately 12 years.

While Haitian domestic cargo movements are principally effected by land transport, i.e., trucks and buses known locally as "tap-tap", the coastal fleet accounts for 18% of all freight revenue, 29% of the ton-kilometres for cargoes and about 10% of the passenger movements. One can only imagine what these percentages would be if the coastal transport industry could reach its full economic potential. The principal obstacles for achievement of such potential are of both an institutional and a physical nature. For example, the unsafe conditions for most of the coastal fleet are due to primitive boatbuilding techniques and the almost total lack of adequate facilities for vessel construction and maintenance. Further, while improvement of existing boatbuilding techniques and/or adoption of a new technology might seem to involve only the physical infrastructure, such is not entirely the case. It should be understood that boatbuilding techniques and technologies require the preparation, promulgation and enforcement of standards for their application.

Objectives

Although the existing coastal fleet provides an adequate quantity of transport services, the quality of such services requires immediate improvement. The major reason for this is that vessels constructed for Haitian coastal trades do not comply in even a minimal way with accepted wood boatbuilding standards and, as a result, create unnecessary risks for vessels, cargoes, passengers and crews. For example, since 1968 over 400 lives have been lost due to coastal vessels sinking within sight of land.

The wood boatbuilding techniques currently employed do not conform to any code, regulations or other specifications which are normally regarded as a basis for safety and insurance purposes. As a result, the fundamental need of the Haitian coastal transport industry is to evaluate which boatbuilding technology or technologies can be employed, not only to improve the coastal fleet and the quality of its services, but also to reduce the outflow of scarce foreign exchange, create sources of employment and utilize locally available materials.

Industrial employment is highly prized in all parts of the world because of the economic multiplier effect whereby not only are jobs created directly but the basic industry supports service industries and ancillary activities such as those of the government. As vessel construction technologies, whether they make use of steel, aluminium, fiberglass, wood or ferrocement, are largely labour intensive, this is clearly an area in which engineers and economists should co-operate to ascertain feasible limits within which labour may be substituted for capital, given the desired boatbuilding technology and the quantity and cost of available resources, to devise lower-cost and more flexible construction methods.

The vessels utilized in Haitian coastal trades vary from 1 to 550 dwt and are constructed of wood with the exception of seven steel-hull motor vessels. The distribution of these vessels by means of propulsion and dwt is as follows

DISTRIBUTION OF THE COASTAL FLEET BY MEANS
OF PROPULSION AND DWT

	Number		Dwt
Motor vessels	1		52
	8		121-163
	6		193-550
Subtotal		15	
Sailing vessels	63		1-15
	216		16-30
	100		31-45
	19		46-60
	5		Over 61
Subtotal		403	
Total vessels in Haitian coastal fleet		418	

Source: Annuaire, Autorité Portuaire Nationale, 1980-1981, pp. 149, 152.

As can be seen from the above table, approximately 75% of the Haitian coastal fleet is within the 16-45 dwt range and constructed of wood at local boatbuilding facilities. Consequently, the boatbuilding technology selected must respond fully to the trading patterns of and cargoes carried by these vessels.

An evaluation of vessel construction technologies to determine those most appropriate for Haiti involves many aspects of its marine transport environment and boatbuilding industry. Some of the more important of these aspects for this project are that resulting vessels should (a) be economical to purchase and maintain, (b) provide owners a reasonable return on their investments, (c) be constructed and repaired in Haiti, (d) meet trade demand in terms of service quality and safety, and (e) minimize the outflow of foreign exchange due to equipment, energy and construction material purchases.

Work programme

In an effort to create an environment in which Haitian public and private sectors as well as appropriate international and national organizations can work together to modernize the coastal fleet, a work programme will be undertaken which includes the following:

(a) collection and analysis of information concerning the applicability of each boatbuilding technology -steel, aluminium, fiberglass, wood and ferrocement- to the needs of the Haitian coastal fleet;

(b) evaluation of the Haitian boatbuilding industry in the light of its capacity and needed institutional assistance to improve existing techniques and/or adopt a new technology;

(c) convening of a workshop in Haiti at which the project expert and other needed specialists in boatbuilding technologies will present the advantages and disadvantages of their respective fields of concentration, for both the short and long term, as well as an evaluation of such technologies in the light of the criteria in the last paragraph of the section entitled Objectives, and

(d) provision of technical assistance to:

(i) boatbuilding facilities, in order that improved techniques and/or a new technology can be effectively employed, and

(ii) appropriate Government agencies for the preparation, promulgation and enforcement of boatbuilding standards for the improved techniques and/or new technology.

The overall work programme will be of 24 months' duration and implemented in three stages. The first stage of twelve months will involve the collection and analysis of information concerning the economic, industrial, operational and financial circumstances under which it would be feasible to establish boatbuilding enterprises in Haiti which utilize each of the aforementioned technologies. Information gathering missions will be undertaken by the project expert to appropriate boatbuilding enterprises in developed and developing countries which employ these technologies. The analysis of such information will be published as a didactic document for use at the project seminar. To assist the project expert with these tasks, a counterpart committee will be established with representatives from government agencies such as the Autorité Portuaire Nationale (APN), Direction de Promotion des Projets (DPP), Secrétariat d'Etat du Plan (SEP), Secrétariat d'Etat des Travaux Publics, des Transports et Communications (TPTC), and Service Maritime et de Navigation d'Haïti (SEMANAH).

The second stage of three months will involve preparations for and convening of the workshop indicated in subparagraph (c) above. The final stage of nine months will involve technical assistance to boatbuilding enterprises and Government agencies, as is indicated in subparagraph (d) above.

Expected impact

As many outlying areas of Haiti are unable to offer sufficient cargoes to induce operators of coastal vessels to make more than occasional calls at their ports, this may, in the absence of Government initiatives, lead to a downward spiral of economic activity. The lack of an efficient and regular coastal transport service acts as a disincentive to expand their production of crops for export. Their earning from exports and their ability to import either remain low or decline. As fewer inward and outward cargoes are offered for transport, fewer vessel calls tend to be made, thereby reinforcing the disincentive. The provision of low-cost, efficient and regular coastal transport services must be viewed as a means by which production in such areas may be stimulated and so lead to more cargoes being offered in due course. Coastal transport services, therefore, are a most important developmental tool for assisting the growth of areas served as well as the Haitian economy as a whole.

With reference to investments in the Haitian boatbuilding and repair industry, it has been recently determined that the chain of purchases begun by the American shipbuilding industry have a cumulative multiplier effect of 4.701 throughout the economy. While exact information concerning the Haitian boatbuilding and repair industry is lacking, this multiplier effect can be conservatively applied to that industry in the following manner:

1.	vessels constructed per year	X	average value of vessels	X	multiplier effect	=	contribution to the economy	total contribution
	34		US$ 20 000		4.701		$ 3 196 680	
								$ 7 126 716
2.	vessels repaired per year	X	average value of repairs	X	multiplier effect	=	contribution to the economy	
	418		US$ 2 000		4.701		$ 3 930 036	

It should be understood that the impact of this multiplier effect might be somewhat less in Haiti due to the lack of certain enterprises which are ancillary to a modern boatbuilding industry and the attendant need to import needed components. Nonetheless, it can be concluded that a modern Haitian boatbuilding and repair industry would make an important contribution to the national economy.

Inputs required

	US dollars
(a) project expert (US$ 70 000/year)	140 000.00
(b) travel and per diem expenses for project expert (US$ 10 000/year)	20 000.00
(c) travel and per diem expenses for boatbuilding specialists to participate in workshop	12 000.00
(d) publication of analysis prepared by project expert and of specialists' presentations at workshop	3 000.00
Total	175 000.00