Development in education and training of manpower for ship repair industry in Thailand

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Development in Education and Training of Manpower
For Shiprepairing Industry in Thailand

by

NOPPADON ROUMSUB

THAILAND

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

Degree of Master of Science

in

Marine Education and Training in Engineering

Year of Graduation

1991
DECLARATION

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

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

15 Oct 1991

Supervised and assessed by:

M. Kimura
Professor
World Maritime University

Co-assessed by:

Malte Persson
President
Kockums Engineering AB
Abstract

This paper presents the necessity of the development of new shiprepair facilities and the improvement of knowledge and skills for manpower in the shiprepairing industry in Thailand. Beginning with an examination of related aspects, the discussion covers the proposal of a new 40,000 DWT dock size and upgrading courses for repair engineers. The paper concludes with implementation and recommendation to future prospects. It is written from the perspective of a non-technical person in the shiprepairing industry and no apology is made for the relative lack of technical content.
Acknowledgements

I am very grateful to the following persons who were kind enough to give their work on the text of this paper:

Miss Suganda Pannak
Mr. Prasetyo Heru
Mr. Sukhin Ratanasathien
Mr. Liu Fu Sheng

I would also thank Lt. Cdr. Randall R. Fiebrandt for valuable suggestion on various aspects of technical contents.
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CHAPTER 1

General Introduction

1.1 General overview

The Thai economy has steadily grown for the last several years (see Table 3.1). The result is a sharp increase in expansion of international trade. Consequently, there is a higher demand for transportation of goods. Of the inland, air and sea transportation systems, sea transportation is the best in terms of energy saving and efficiency. Therefore, the demand for Thailand’s seaborne trade has been increased both in terms of value and volume (see Table 3.3). In order to fulfill this situation, Thailand has to have sufficient capability and capacity in the marine industry, namely shipping, ports and harbours and shipbuilding and ship repairing. However, the maritime industry has to be developed. In addition, it must be done simultaneously in each sector because they are related to each other.

In terms of the ports, effort has been made recently for the immediate improvement of the deep-sea port, Laem Chabang Port, enabling large scale ships to enter Thailand which were not able to be berthed at the former river port (Bangkok Port) due to some physical limitations in the access channel. The new deep-sea port will be a major infrastructure to accelerate the
modernization of Thailand's transportation in accordance with the rapidly changing technology and the present world trade.

Designed to accommodate large vessels, the port is believed to considerably minimize transportation costs.

In the shipping area, according to the MMPC (Merchant Marine Promotion Commission of Thailand) data, the number of ocean-going vessels, including tankers, is 185 representing a total tonnage of 847,629 DWT at the end of 1990. The cargo share of Thailand's international trade under Thai flag vessels is estimated at less than 10%. In the other word more than 90% of the total international trade of Thailand is transported by foreign flag vessels. Consequently, Thailand has lost financial benefit of foreign currency and the ability to control the import and export time schedule thereby reducing competition opportunities. In order to decrease these disadvantages, Thailand has to enlarge its merchant fleet. However, it should be noted that the total tonnage of Thailand is steadily increasing that the expanding of the Thai fleet is already underway.

In terms of shipbuilding and shiprepairing, there are 172 shipyards in Thailand today but they are exclusively engaged in building and repairing small craft.

Thailand faces many problems in building merchant ocean-going vessels.
1. There is a lack of technology, expertise and facilities

2. New building prices cannot compete with the foreign countries due to the lack of local related industries such as iron and steel, marine equipment and machinery.

3. There is a little demand from Thai shipowners because there are many alternatives to new, high cost construction such as purchasing second hand ships, conversion of existing vessels or chartering vessels.

Consequently, there is a high risk of investment in the shipbuilding industry in Thailand.

Conversely, compared with the shipbuilding industry, ship repair requires lower technology and is less dependent on foreign equipment, as well as the advantage of lower labour costs than neighbouring countries. With confidence, ship repairing will have a bright future of Thailand. However, at present, this industry has not been well developed. There are only 5 major yards whose facilities and equipment are mostly out-dated. They must be renovated to raise productivity. Furthermore, only the largest shipyard has a graving dock, with only 4,000 GRT capacity. Vessels above this size are repaired abroad such as in Singapore, Malaysia, Japan and Hong Kong. In order to satisfy the growing demand of the national merchant marine business and improve the efficiency of the existing fleet, the efficient and
higher capacity yards have to be established. The economic and social benefits can be expected as follows:

1. Increasing employment opportunities, as it is a labour intensive industry
2. Reducing the out flow of foreign currency.
3. Raising the level of technological capability
4. Supporting related industries
5. Supporting the shipbuilding industry

However, to run the business under the competitive pressure of foreign yards which have higher experience and technology, lower cost is not the only factor; quality and rapidity should be considered. Manpower is the main mechanism for achieving these requirements but, at present, the highly qualified or specialized workers have no experience repairing large ships because there is no large scale repair yard. Therefore, it is necessary to educate and train newly employed workers in various matters.

Education and training are time consuming and expensive. Consequently, before establishing the training programs, it is necessary to know the real need. Therefore, the study of organization of a new shiprepair yard is a crucial task. The objective of the new yard cannot be achieved without studying the precise pattern of shipping industry.
1.2 Objectives

The goal of this paper is to find the methodology which is necessary to improve and upgrade the manpower in the production sector of a new shipyard in Thailand.

In this context the main area to be identified is the optimum characteristics of a new shipyard for the fulfillment of the growing demand of the sea-going vessels in international trade.

1.3 The expected benefit

When these concepts are structured and set up, they will help to:

a. improve the efficiency of the shiprepairing industry due to the competency of manpower,

b. prevent the shortage of qualified workers, and

c. provide the skilled worker's which can be transferred to the shipbuilding industry.
1.4 Limitations of the study

Due to the limited material available and professional background, it was not possible for the author to research all groups of manpower in the shiprepairing industry. Therefore I am focusing only on upgrading workers in the production field by considering 3 categories of workers.

1. Skilled
2. Technician (Foreman)
3. Engineer

1.5 Methodology

The fundamental tool used in completing this paper is the analytic evaluation of the primary data collected from many departments in Thailand as well as library research at the World Maritime University. The basic concepts which were transmitted by the lecturers, professors and visiting professors are also used as guidelines in the process of developing the authors ideas. The authors experience is also a contributing factor in this paper.
1.6 Study layout and contents

This study firstly analyses the general situation of the Thai merchant marine industry, namely shipping, ports and the shipbuilding and shiprepairing.

Chapter 2 analyses the present situation of shipping and the shiprepairing market in Thailand and identifies the excess amount of Thai flag vessels which cannot be served by its repairing facilities.

Chapter 3 focuses on the shipping and shiprepairing demand forecast.

Chapter 4 determines the required optimum size of the new shiprepair yard. It can provide the basic facts for developing the education and training of manpower.

Chapter 5 focuses on the shiprepair business which should be utilized in developing curriculum.

Chapter 6 studies the present structure of education and training related to the shiprepairing industry in Thailand and proposes the upgrading courses for manpower.

Finally, the last chapter proposes recommendations in order to implement the requirements for the upgrading and development of the manpower in shiprepairing industry.
Present Situation of Shipping and Shiprepairing in Thailand

The objective of this chapter is an attempt to look at the current situation of shipping and the shiprepairing industry and to determine the excess amount of Thai merchant ships which cannot be docked in the country.

2.1 Shipping Industry

2.1.1 Introduction

The characteristic of Thai shipping is dependent upon the international trade, since some 97% of the volume of Thai international trade is freight by sea.

The major foreign trade of Thailand has been in the form of exporting and importing cargo.

Table 2.1 and 2.2 show major commodities of export and import cargo.
### TABLE 2.1 EXPORT CARGO VOLUME

(UNIT: 1,000 M.TONS)

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### TABLE 2.2 IMPORT CARGO VOLUME

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SOURCE : CUSTOMS DEPARTMENT
COMPILED BY OMPC
2.1.2 Construction of Thai fleet

Looking at the export and import cargo, we can classify the major types of merchant sea-going ships in four categories:

- Bulk Carrier
- General Cargo Vessel
- Container Vessel
- Tank Vessel

At the beginning of 1989, there were sixty-five companies having seagoing vessels over 500 grt, of which the total number is 162, deadweight 734,308 metric tons. The above number includes tankers and gas carriers which are operating in domestic coastal routes.

The actual number active in international trade equaled 94 vessels of which 70% are of the general cargo and bulk carrier types. Only 10 ships (10%) are full container vessels and the remaining 20% are mainly oil and gas tankers.

As for vessel size, only 12% of the total fleet are above 10,000 DWT. The average carrying capacity of the dry cargo fleet is approximately 7,000 DWT. Almost 62% of the dry cargo fleet are vessels below 7,000 DWT, around 38% are those between 7,000 - 20,000 DWT, while only 3 vessels are over 20,000 DWT. All tankers have a carrying capacity below 7,000 DWT.
### Table 2.3 Ocean Going Vessels Registered Under Thai Flag

**Thai Flag Vessel Classified by Type and Size**

<table>
<thead>
<tr>
<th>Size in DWT (Metric Tons)</th>
<th>Total No</th>
<th>DWT</th>
<th>General Cargo No</th>
<th>DWT</th>
<th>Container No</th>
<th>DWT</th>
<th>Bulk Carrier No</th>
<th>DWT</th>
<th>Tanker No</th>
<th>DWT</th>
<th>Gas Carrier No</th>
<th>DWT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Below 1,000</strong></td>
<td>17</td>
<td>11,789</td>
<td>1</td>
<td>950</td>
<td>5</td>
<td>4,217</td>
<td>11</td>
<td>6,622</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000-2,999</td>
<td>63</td>
<td>109,816</td>
<td>11</td>
<td>22,574</td>
<td>3</td>
<td>6,000</td>
<td>45</td>
<td>75,673</td>
<td>4</td>
<td>5,569</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,000-4,999</td>
<td>26</td>
<td>180,854</td>
<td>10</td>
<td>40,277</td>
<td>2</td>
<td>6,868</td>
<td>1</td>
<td>4,836</td>
<td>12</td>
<td>43,446</td>
<td>1</td>
<td>4,627</td>
</tr>
<tr>
<td>5,000-6,999</td>
<td>25</td>
<td>145,937</td>
<td>13</td>
<td>75,957</td>
<td>2</td>
<td>12,747</td>
<td>5</td>
<td>29,710</td>
<td>4</td>
<td>22,413</td>
<td>1</td>
<td>5,119</td>
</tr>
<tr>
<td>7,000-8,999</td>
<td>9</td>
<td>68,524</td>
<td>6</td>
<td>45,576</td>
<td>1</td>
<td>7,115</td>
<td>2</td>
<td>15,833</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>9,000-10,999</td>
<td>7</td>
<td>72,038</td>
<td>7</td>
<td>72,038</td>
<td>1</td>
<td>12,749</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,000-12,999</td>
<td>2</td>
<td>25,295</td>
<td>1</td>
<td>12,546</td>
<td>1</td>
<td>12,749</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>13,000-14,999</td>
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<td>124,434</td>
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<td>55,576</td>
<td>5</td>
<td>68,858</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15,000-19,999</td>
<td>1</td>
<td>17,213</td>
<td>1</td>
<td>17,213</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,000 &amp; Over</td>
<td>3</td>
<td>68,208</td>
<td>2</td>
<td>42,934</td>
<td>1</td>
<td>25,274</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total in DWT</strong></td>
<td>162</td>
<td>743,388</td>
<td>55</td>
<td>304,691</td>
<td>10</td>
<td>95,588</td>
<td>14</td>
<td>95,352</td>
<td>66</td>
<td>145,749</td>
<td>17</td>
<td>21,928</td>
</tr>
<tr>
<td><strong>Total in GRT</strong></td>
<td>468,630</td>
<td>243,876</td>
<td>63,766</td>
<td>36,910</td>
<td>17,282</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total in NRT</strong></td>
<td>275,718</td>
<td>144,188</td>
<td>37,001</td>
<td>36,296</td>
<td>45,685</td>
<td>12,476</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Over half of the ocean going vessels are over 15 years old. The average age of the dry cargo fleet is 19 years old; the average tanker is more than 20 years old.

<table>
<thead>
<tr>
<th>No. of Vessel</th>
<th>General cargo</th>
<th>Container</th>
<th>Bulk Carrier</th>
<th>Tanker</th>
<th>Gas Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Vessel</td>
<td>0-4yr</td>
<td>5-9yr</td>
<td>10-14yr</td>
<td>15-19yr</td>
<td>20-24yr</td>
</tr>
</tbody>
</table>

Fig 2.1 Thai Flag Vessels Classified by Age
Source: OMPC

Most Thai flag vessels active in international trade operate in nearby waters. 75% operate within the ASEAN plus Myanmar (termed "Home Trade Area" in Figure 2.2); 8% go as far as Hong Kong and Taiwan to the East, India to the West. Only 25 vessels go as far as Japan, Korea, Middle East or "overseas".
2.2 Shiprepairing industry

There are 107 shipyards in Thailand today, but they are almost exclusively engaged in repairing small craft. The largest shipyard has a dock of 4,000 GRT capacity. Vessels above this size are repaired abroad. All shipyards are privately owned; only the Bangkok Dock is a state enterprise. About one half of the shipyards are located in the central part of Thailand and the major yards are all located on the bank of the Chao Phraya river and in or around Bangkok which is surrounded by commercial and residential zones. The expansion or improvement capability is therefore limited.
2.2.1 Principal shipyards

The following description covers the 5 principal shipyards in Thailand.

(1) Bangkok Dock Co. Ltd.

The Bangkok Dock was established in 1914 by British interests and has been operating under its present corporate structure since 1957. The shipyard is equipped with 2 graving docks and situated 17 kms upstream Port of Bangkok.

(2) ItalThai Marine Co. Ltd.

The shipyard was established in 1978, equipped with a cradle and rail installation as well as a floating dock. The yard works mainly in newbuilding, mostly for the Royal Thai Navy. Very little shiprepair work is undertaken.

(3) Asian Marine Services Co. Ltd.

The firm started operation in January 1984 with a floating dock of 4,000 GRT capacity.

(4) Harin Shipbuilding Co. Ltd.

The yard was established in January 1948, with a slipway of 1,500 GRT capacity. In past years, 20-25 vessels have been repaired annually.
(5) Sahaisant Shipbuilding Co. Ltd.

Situated about 40 kms upstream of Bangkok, the shipyard possesses two slipways with maximum capacity 1,000 GRT. In shiprepair, about 30 vessels a year can be handled.

**TABLE 2.4 THAILAND MAJOR SHIPYARD**

<table>
<thead>
<tr>
<th>NO.</th>
<th>SHIPBUILDING COMPANY</th>
<th>TYPE AND SIZE OF DOCK AND/OR SLIPWAY (AREAS OF ACTIVITIES)</th>
<th>MAXIMUM CAPACITY (GRT/FEET)</th>
<th>AREA (SQ.M)</th>
<th>TECHNICIAN/ SKILLED WORKER (PERSONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BANGKOK DOCK CO., LTD. 1668 NEW ROAD, YANGWA, BANGKOK 10120</td>
<td>1. DRY DOCK = 108.58 M 2. DRY DOCK = 114.07 M 3. SLIPWAY = 93 M (CONSTRUCT &amp; REPAIR : STEEL AND ALUMINIUM)</td>
<td>4,000 GRT</td>
<td>32,700</td>
<td>163</td>
</tr>
<tr>
<td>2</td>
<td>ITALTHAI MARINE LTD. ITALTHAI HOUSE 11TH FLOOR 2813 NEW PETCHBURI ROAD, BANGKOK 10210 SHIPYARD : 309 SOI ITALIANTHAI, TAIKAN, SAMUTPRAKARN 10270</td>
<td>1. FLOATING DOCK = 165 M 2. SLIPWAY = 100 M (CONSTRUCT &amp; REPAIR : STEEL AND ALUMINIUM)</td>
<td>4,000 GRT</td>
<td>56,000</td>
<td>517</td>
</tr>
<tr>
<td>3</td>
<td>ASIAN MARINE SERVICE CO., LTD. 70/10 Moo 1, Soi Khun Sri Nok, Samut Prakan 10130</td>
<td>1. FLOATING DOCK = 186.2 M (REPAIR : STEEL)</td>
<td>3,500 GRT</td>
<td>7,200</td>
<td>122</td>
</tr>
<tr>
<td>4</td>
<td>HARIN SHIPBUILDING CO., 594/1 KRUNGTHEP BRIDGE, BANGKOK 10120</td>
<td>1. SLIPWAY = 80 M (REPAIR : STEEL)</td>
<td>1,500 GRT</td>
<td>33,600</td>
<td>54</td>
</tr>
<tr>
<td>5</td>
<td>SAHAISANT CO., LTD. 158/2 SUNKHOTHAI ROAD. SHIPYARD : 23 Moo 1, BANGKOK 10390 BANGKRAKANG, AMPHUR MUENG, PATHUMTANEE</td>
<td>1. SLIPWAY = 90 M 2. SLIPWAY = 80 M (CONSTRUCT &amp; REPAIR : STEEL AND FRP)</td>
<td>1,000 GRT</td>
<td>28,800</td>
<td>198</td>
</tr>
</tbody>
</table>

SOURCE: OMPCE
2.2.2 Technology and working period

All shipyards have enough technology to change hull plate, draw out tail shaft, overhaul main engine or repair slightly damaged propeller.

However, for jobs requiring higher expertise like controlling equipment, technician must be invited from other countries such as Singapore. Sometimes, due to insufficient technology, equipment unable to repair in the country must be sent to be fixed abroad.

The data regarding working periods is rather old. There was a survey done by OMPC in 1985 on the repair of ocean-going Thai flag vessels in and out of the country between 1979 and 1984. The working periods are shown in the below table; damaged work and emergency work are excluded.

Table 2.5 Survey Docking (under 4,000 grt)

<table>
<thead>
<tr>
<th></th>
<th>In Thailand</th>
<th>In Foreign Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ships</td>
<td>51</td>
<td>25</td>
</tr>
<tr>
<td>Average Tonnage (GRT)</td>
<td>1,577</td>
<td>2,734</td>
</tr>
<tr>
<td>Repair Period per Ship(day)</td>
<td>17.6</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Source OMPC
Working periods for various vessels are different, depending on the detail of job and volume. Therefore, the two factors determining working periods cannot be simply compared but they can be used to consider efficiency. For foreign docking, the countries are Singapore, Hong Kong, Malaysia and Japan.

Shortages of facilities and equipment as well as labor quality is the main reason for the inefficiency, resulting in a working period sometimes around twice as long as other countries.

2.2.3 Shiprepair Capacity

The actual record of shiprepair is presented in Table 2.6. In that Table, the item 8 indicated the number and size of cargo vessels that have been repaired in the country for the year 1989 and 1990; the repaired number of all size is only around 50 vessels each year. Comparison of the size and number of merchant ships from Table 2.3, it can be seen that all the merchant seagoing vessels above 4,000 GRT and some of the vessels under 4,000 GRT have to be docked abroad.

Table 2.7 showed the number of ships (over 4,000 GRT) for foreign drydocking.

According to the Thai Survey Regulation, all Thai merchant ships above 60 grt must be docked and inspected once every two years. Consequently, there are around 30 vessels which have to be docked in foreign countries each year.
TABLE 2.6 SHIP REPAIRED IN 1989-1990
BY MEMBER OF THAI SHIPBUILDERS AND REPAIRERS ASSOCIATION

<table>
<thead>
<tr>
<th>NO.</th>
<th>TYPE OF SHIP</th>
<th>DWT</th>
<th>MATERIALS</th>
<th>NUMBER OF SHIPS 1989</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LANDING SHIP TANK (L.S.T)</td>
<td>4000</td>
<td>STEEL</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2400</td>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>PATROL FRIGATE (P.F)</td>
<td>2150</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>DESTROYER ESCORT (D.E)</td>
<td>1514</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>LANDING CRAFT, UTILITY (L.C.U)</td>
<td>396</td>
<td></td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>PATROL CRAFT (P.C)</td>
<td>420</td>
<td></td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>PATROL GUN MEDIUM (P.G.M)</td>
<td>100</td>
<td></td>
<td>1</td>
<td>1</td>
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<tr>
<td>7</td>
<td>LANDING CRAFT MEDIUM (L.C.M)</td>
<td>600</td>
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<td>1</td>
</tr>
<tr>
<td>8</td>
<td>CARGO VESSEL</td>
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<td>42</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>1000</td>
<td></td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>OIL TANKER</td>
<td>1235</td>
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<td>16</td>
<td>12</td>
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<td>11</td>
<td>BARGE</td>
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<td>12</td>
<td>WATER TANKER</td>
<td>100</td>
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<tr>
<td>13</td>
<td>BARGE</td>
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<tr>
<td></td>
<td></td>
<td>5500</td>
<td></td>
<td>4</td>
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</tr>
<tr>
<td>14</td>
<td>DREDGING BOAT</td>
<td>2520</td>
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<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1761</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>15</td>
<td>FISHERY RESEARCH VESSEL</td>
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<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>366.62</td>
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<td>SURVEY BOAT</td>
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<td>17</td>
<td>TUG BOAT</td>
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<tr>
<td></td>
<td></td>
<td>80</td>
<td></td>
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</tr>
<tr>
<td>18</td>
<td>MINE SWEeper</td>
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<tr>
<td>19</td>
<td>REFRIGERATOR SHIP</td>
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<td>FISHING BOAT</td>
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<td>PATROL BOAT</td>
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<td>STEEL</td>
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<td>10</td>
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<td>380</td>
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<td>23</td>
<td>HOPPER DREDGER</td>
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<td>WORK BOAT</td>
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<td>YACHT</td>
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<td>FIBERGLAS</td>
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<td>26</td>
<td>RIVER CRUISER</td>
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<td>STEEL</td>
<td>3</td>
<td>7</td>
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<tr>
<td>27</td>
<td>RIVER CRUISER</td>
<td>100</td>
<td>WOOD</td>
<td>1</td>
<td>-</td>
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<tr>
<td>28</td>
<td>FERRY</td>
<td>60</td>
<td></td>
<td>10</td>
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<tr>
<td>29</td>
<td>PASSENGER BOAT</td>
<td>60</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>STEEL</td>
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<td></td>
</tr>
<tr>
<td>32</td>
<td>PONTOON</td>
<td>180</td>
<td></td>
<td></td>
<td>110</td>
</tr>
</tbody>
</table>

SOURCE: THAI SHIPBUILDERS AND REPAIRERS ASSOCIATION
### TABLE 2.7 THAI FLAG SHIP FOR FOREIGN DRYDOCKING
(AS OF DECEMBER 1989)

**NO.** | **NAME OF VESSEL** | **BUILT** | **GROSS TONNAGE** | **TYPE** | **ROUTE**  
---|---|---|---|---|---  
1 | FAR EAST NAUEE | 1978 | 14,479 | GENERAL CARGO | BKK-EUROPE  
2 | BANGKOK NAUEE | 1971 | 12,132 | " | "  
3 | SIAM PATRA | 1975 | 11,076 | CONTAINER | BKK-JAPAN  
4 | JUTHA KASEAMPHAN | 1979 | 9,998 | MULTIPURPOSE | BKK-JAPAN-KOREA  
5 | PI TUNE | - | 9,959 | CONTAINER | BKK-S'PORE-HONGKONG-TAIWAN  
6 | PIPOP SAMUT | 1970 | 9,917 | GENERAL CARGO | BKK-JAPAN  
7 | SU-PAN-YA | 1960 | 9,843 | CONTAINER | BKK-S'PORE-HONGKONG-TAIWAN  
8 | PET-Chomphoo | 1969 | 9,713 | GENERAL CARGO | BKK-ASEAN  
9 | MARITIME-GOLIET | 1970 | 9,467 | " | "  
10 | PIPAT-SAMUT | 1966 | 8,858 | " | "  
11 | PICHAI SAMUT | 1966 | 8,856 | " | "  
12 | JUTHA PIRIYANART | 1972 | 8,854 | " | "  
13 | HI LEE | 1968 | 8,811 | " | "  
14 | HI SOONG | 1972 | 8,643 | MULTIPURPOSE | "  
15 | HI-HAU | 1971 | 8,643 | " | "  
16 | HI-NEENG | 1970 | 8,304 | GENERAL CARGO | "  
17 | HI-HING | 1970 | 8,304 | " | "  
18 | CHAI BHUM | 1983 | 8,177 | CONTAINER | BKK-ASEAN-JAPAN-KOREA  
19 | DACHA BHUM | 1985 | 8,177 | " | "  
20 | BUA TIP | 1969 | 7,575 | BULK CARRIER | BKK-ASEAN  
21 | JUTHA-CHANATIP | 1972 | 6,667 | GENERAL CARGO | BKK-JAPAN-KOREA  
22 | JUTHA-PHANSIRI | 1969 | 6,582 | " | "  
23 | HA DOOR | 1968 | 5,668 | CONTAINER | JAPAN-MALAYSIA  
24 | HA WARD | 1968 | 5,664 | " | "  
25 | S.C.C | 1970 | 5,323 | GENERAL CARGO | BKK-ASEAN-JAPAN-KOREA  
26 | Boonkrong 2 | 1963 | 4,974 | " | "  
27 | JUTHA MALEE | 1973 | 4,794 | MULTIPURPOSE | BKK-JAPAN-KOREA  
28 | JUTHA JETSIMA | 1973 | 4,794 | " | "  
29 | HEG BHUM | 1981 | 4,499 | CONTAINER | BKK-S'PORE-TAIWAN  
30 | SANG THAI GALAXI | 1975 | 4,349 | GENERAL CARGO | THAI-ASEAN-JAPAN-KOREA  
31 | SANG THAI LUMBER | 1972 | 4,426 | " | "  
32 | TAN BHUM | 1973 | 4,381 | CONTAINER | BKK-ASEAN-JAPAN-KOREA  
33 | SIRI BHUM | 1981 | 4,374 | " | "  
34 | BANG BUA | 1973 | 4,198 | GENERAL CARGO | BKK-ASEAN  
35 | BANGBHUM TAIEN | 1969 | 4,098 | " | "  

**BKK** = BANGKOK
2.2.4 Comparison of Expenditures for repairing in local shipyard and foreign country

Table 2.8 and Table 2.9 are the figures showing the repairing expense, inside and outside the country, paid by the shipowners from 1979 to 1984. The figures came from the questionnaire issued by OMFC to all Thai shipowners and replied by the major eighteen firms.

The average annual payment by shipowners to local shipyards is 16.2 million Baht while the average payment to foreign shipyards is 43.9 million Baht, almost three times as much. The total expenditure in foreign countries was 260 million Baht (10 million US $) for six years.

<table>
<thead>
<tr>
<th>TABLE 2.8 EXPENDITURE FOR REPAIR IN LOCAL SHIPYARD.</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

SOURCE: OMFC, EXCHANGE RATE USED: 1 US $ = 25.8 BAHT
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9,748,128</td>
<td>--</td>
<td>28,663,766</td>
<td>16,967,375</td>
<td>14,926,557</td>
<td>6,500,000</td>
</tr>
<tr>
<td>B</td>
<td>5,011,700</td>
<td>25,813,350</td>
<td>992,000</td>
<td>4,340,000</td>
<td>1,415,000</td>
<td>6,970,662</td>
</tr>
<tr>
<td>C</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>2,238,000</td>
<td>--</td>
</tr>
<tr>
<td>D</td>
<td>4,167,748</td>
<td>1,923,210</td>
<td>2,118,170</td>
<td>11,491,732</td>
<td>759,000</td>
<td>300,000</td>
</tr>
<tr>
<td>E</td>
<td>--</td>
<td>8,303,640</td>
<td>1,203,656</td>
<td>3,674,562</td>
<td>3,000,000</td>
<td>--</td>
</tr>
<tr>
<td>F</td>
<td>--</td>
<td>3,270,780</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>G</td>
<td>--</td>
<td>--</td>
<td>3,241,321</td>
<td>--</td>
<td>6,792,521</td>
<td>--</td>
</tr>
<tr>
<td>H</td>
<td>2,032,180</td>
<td>1,200,857</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1,109,462</td>
</tr>
<tr>
<td>I</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>41,133,200</td>
</tr>
<tr>
<td>J</td>
<td>1,640,353</td>
<td>15,074,554</td>
<td>7,201,576</td>
<td>8,940,041</td>
<td>1,820,000</td>
<td>2,652,870</td>
</tr>
<tr>
<td>K</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1,300,000</td>
<td>5,000,000</td>
<td>--</td>
</tr>
<tr>
<td>L</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>473,000</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>23,400,109</td>
<td>55,586,311</td>
<td>43,390,489</td>
<td>46,713,710</td>
<td>35,951,078</td>
<td>58,486,324</td>
</tr>
</tbody>
</table>

**SOURCE**: OMPC
CHAPTER 3

Shipping and Shiprepairing Demand Forecast

3.1 Introduction

The study from Chapter 2 has shown that Thailand has lost much foreign exchange in ship repairing due to the limitation of adequate shipyards, therefore, in order to prevent outflow of foreign currency and to increase employment opportunities, the shiprepair facilities have to be improved. The establishment of large scale repair facilities requires a high amount of investment; consequently, a careful study is a necessity.

An optimum size of shipyard could reduce the risk from running the business. However, a suitable shiprepair yard cannot be achieved without studying the possibility of repair demand as well as the trend of construction of the fleet. Those trends also depend upon the characteristics of trade.

3.2 Foreign trade

Foreign trade is very closely interrelated with the gross domestic product. Therefore the annual growth rate of trade and GDP are also interrelated. When the domestic economy become active, national industries develop and consumption demands increase. Reflecting these conditions, import goods such as raw
materials become prosperous. In this way, when GDP increases, the export and import trades also increase. Therefore, the trade growth rate forecast is made by the estimated GDP growth rate as the base because both are considered to be proportional. Table 3.1 shows the international trade of Thailand from 1985-1989.

### Table 3.1
**Economic Performance of Thailand**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (Billion Baht)</td>
<td>1,814.4</td>
<td>1,895.3</td>
<td>1,253.1</td>
<td>1,567.0</td>
<td>1,778.3</td>
</tr>
<tr>
<td>Economic Growth % (GDP)</td>
<td>3.5</td>
<td>4.9</td>
<td>9.5</td>
<td>13.2</td>
<td>12.3</td>
</tr>
<tr>
<td>Export (Billion Baht)</td>
<td>191.7</td>
<td>231.5</td>
<td>298.1</td>
<td>399.2</td>
<td>510.0</td>
</tr>
<tr>
<td>Import (Billion Baht)</td>
<td>253.4</td>
<td>245.7</td>
<td>341.4</td>
<td>501.4</td>
<td>650.7</td>
</tr>
<tr>
<td>International Trade (Billion Baht)</td>
<td>445.1</td>
<td>477.2</td>
<td>639.5</td>
<td>900.6</td>
<td>1,160.7</td>
</tr>
<tr>
<td>Trade Growth %</td>
<td>7.0</td>
<td>7.2</td>
<td>34.0</td>
<td>48.8</td>
<td>28.8</td>
</tr>
</tbody>
</table>

**Source:** Bank of Thailand

3.3 Thai International Trade and Shipping

Table 3.2 shows that Thai seaborne trade has grown by 65% over the period 1979-1989 corresponding to an average annual growth rate of 6.3%. During the 1985-1985 recession in international trade, Thai trade remained more or less stable while many other countries experienced contraction. During 1985-1989, Thai seaborne trade has increased by 60% or 12.6% per annum.
TABLE 3.2 DEVELOPMENT IN NUMBER OF VOYAGES AND CARGO TONNAGE AT THAI PORTS
BY THAI AND FOREIGN FLAG VESSELS, 1979-1989

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NO. OF VOY.</th>
<th>TOTAL CARGO TONNAGE (1000 METRIC TONS)</th>
<th>CARGO TONNAGE FREIGHTED BY THAI VESSELS (1000 METRIC TONS)</th>
<th>THAI SHARE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>7524</td>
<td>30072</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1980</td>
<td>7238</td>
<td>31010</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1981</td>
<td>7450</td>
<td>31722</td>
<td>2243</td>
<td>7.1</td>
</tr>
<tr>
<td>1982</td>
<td>7932</td>
<td>34307</td>
<td>3335</td>
<td>9.7</td>
</tr>
<tr>
<td>1983</td>
<td>8247</td>
<td>34533</td>
<td>4221</td>
<td>12.2</td>
</tr>
<tr>
<td>1984</td>
<td>8525</td>
<td>35238</td>
<td>3499</td>
<td>9.9</td>
</tr>
<tr>
<td>1985</td>
<td>7994</td>
<td>34585</td>
<td>3775</td>
<td>10.9</td>
</tr>
<tr>
<td>1986</td>
<td>8102</td>
<td>37423</td>
<td>3661</td>
<td>9.8</td>
</tr>
<tr>
<td>1987</td>
<td>8536</td>
<td>40466</td>
<td>4284</td>
<td>10.6</td>
</tr>
<tr>
<td>1988</td>
<td>10000</td>
<td>48254</td>
<td>4869</td>
<td>9.1</td>
</tr>
<tr>
<td>1989</td>
<td>11644</td>
<td>55610</td>
<td>4869</td>
<td>8.8</td>
</tr>
</tbody>
</table>

SOURCE: OFFICE OF MARITIME PROMOTION COMMISSION:
SHIP MOVEMENT SERIES.

In terms of volume, 97% of Thailand's international trade is freighted by sea, and around 95% of this volume passes through the port of Bangkok (see table 3.3). Over the period 1977 - 1989, the number of voyages in and out of Thai ports increased by only 55% indicating that the size and/or capacity utilization of the vessels calling on Thai ports have increased.
The Thai fleet's share of cargo freighted was only around 9% in 1989. Although Thai handled cargo tonnage increased by 6.6% per year during 1988-1989 this increase has not matched the growth in total seaborne trade, and Thai fleet shares have dropped by approximately 2% points from 11% in 1985 to 9% in 1989.

The low share of carriage of goods on Thai flag vessels is seen as a result of structural deficiencies of the Thai fleet itself. Most of the total ocean going vessels are very old and also of a small size; they are uneconomic, having high maintenance costs, which push the total operation cost high and consequently deteriorate competitiveness.
Certainly Thailand has a significant minus factor in the balance of payment on sea freight as trade volume increased. In 1987 the deficit was 45,242 million Baht (1,800 million U.S. $) and 81,636 million Baht (3,200 million U.S. $) in 1989.

The deficit balance affects not only one firm or business but also the country's balance of foreign currency. Shipping and harbour concerns, therefore, need to be solved on a national economic basis.
3.4 Government measure

The need for a maritime industry for economic development has long been recognized; the government of Thailand is now keen on the increase of Thai flag vessels transportation share, especially the reinforcement of ocean-going marine transportation. The following items are shown in the fifth five-year National Economic and Development Plan (NESDP) (1982-1986) as the international shipping target:

1. Expand the transportation of merchandise exports and imports by Thai flag vessels at an annual rate of 15%.

2. Expand and improve the state enterprise's merchant marine fleet, and

3. Open new shipping routes which have no Thai flag vessels at present, particularly the American and Australian routes.

Furthermore, the sixth NEDSP (1987-1991), the large scale port facilities such as Laem Chanbang has been established; a new industrial estate which will support port and industrial business is also developed under the Eastern Seaboard Development Project.
In addition, the seventh NEDSP (1992-1996), some of the plans to improve and promote marine transportation and maritime trading are issued as follows:

1. Expansion of Laem Chabang deep-see port
2. Building of new commercial ports and promotion of private wharfs
3. Improve dredging of rivers and canals
4. Improve cargo handling facilities
5. Tax incentives and other forms of financial aid to Thai shipowners for purchasing of new vessels
6. Promotion of containerization
7. Assistance with respect to personnel recruitment for the maritime trading industry

All of these measures will change the configuration of the Thai fleet in terms of both the number of vessels and size which will impact the characteristics of the new repair yard. The next steps will discuss in more detail the influence of trade in changing types and number of vessels of both Thai flag and foreign flag vessels which enter Thai ports as well as the influence of the new port (Laem Chabang) in changing the size of vessels.
3.5 Shipping Demand Forecast

3.5.1 Introduction

In view of the national policy, the Government of Thailand has requested some foreign countries to make various feasibility studies to find the viability of the projects which envisioned the overall scheme, such as

- The preparation of a 10 year development plan for the Merchant Marine Training Center by the Danish International Development Agency (DANIDA)

- The tendency of Merchant Marine Development by the cooperation between MMPC and the Japan International Cooperation Agency (JICA)

According to those reports, the estimation of the required Thai fleet as well as the foreign flag ships which enter Thai ports have been predicted. However, there are some differences in the numbers but the tendency is in the same direction.

3.5.2 Economic Growth Rate

Thailand’s economy after 1989 was backed up by direct investment before 1988 and the increase in consumers’ spending is expected to continue its growth in a stable pace.
The investment in the industrial sector will range widely for export industries (agricultural product processing, general merchandises) and supporting industries (spare parts, basic chemical products) to domestic end-user's products (electrical appliances). The investment expansion in the past will support, the manufacturing production and exports of industrial goods.

The recent trend of Thailand's economic growth is said to be due to the high growth rate initiated by the expansion of export-oriented investment and exports. The supporting factors are:

1) stable external demand centering on USA and Japan
2) government's stability
3) existence of cheap labor
4) superior exchange rate
5) infrastructure for new projects like Eastern Seaboard Development Project.

These factors are expected to be unchanged for the time being.

Regarding unfavorable factors, the insufficient infrastructure represented by electricity and roads does not meet up with the demand. The economy is expected to grow about 7.5% annually up to the year 2001. (see Table 3.4)
### 3.5.3 Foreign Trade

#### (1) Exports

In 1987, when considering export shipment, agricultural products shared 81% on weight basis, against industrial products' share of 13%.

Nevertheless, agricultural products, which are greatly restricted by natural factors, is not expected to grow much; in contrast, exports of industrial goods are expected to increase tremendously as a result of the active investment in the industrial sector during the past few years.

According to a micro-forecast, the percentage of agricultural exports in total exports is anticipated to gradually reduce its gap with the percentage of industrial exports.
It is estimated that the ratio will be 67% to 17% in 1991, 60% to 23% in 1996 and 52% to 30% in 2001.

(2) Imports

Until 2001, under the assumption that industrialization continues at a stable pace, a micro forecast states that imports of capital goods, raw materials and semi-finished products is expected to increase.

TABLE 3.5 FORECAST OF EXPORT CARGO VOLUME

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RICE</td>
<td>4960</td>
<td>5500</td>
<td>5800</td>
</tr>
<tr>
<td>MAIZE</td>
<td>3660</td>
<td>3920</td>
<td>4200</td>
</tr>
<tr>
<td>TAPIOCA</td>
<td>6970</td>
<td>7480</td>
<td>8810</td>
</tr>
<tr>
<td>SUGAR</td>
<td>2120</td>
<td>2120</td>
<td>2120</td>
</tr>
<tr>
<td>MOLASSES</td>
<td>750</td>
<td>750</td>
<td>800</td>
</tr>
<tr>
<td>MINING PRODUCT</td>
<td>4130</td>
<td>5350</td>
<td>6790</td>
</tr>
<tr>
<td>BULK CARGO TOTAL</td>
<td>22590</td>
<td>25020</td>
<td>27670</td>
</tr>
<tr>
<td>INDUSTRIAL PRODUCT</td>
<td>5130</td>
<td>8180</td>
<td>13060</td>
</tr>
<tr>
<td>RAW RUBBER</td>
<td>990</td>
<td>1060</td>
<td>1140</td>
</tr>
<tr>
<td>AGRI-PRODUCT</td>
<td>1120</td>
<td>1200</td>
<td>1280</td>
</tr>
<tr>
<td>WOOD PRODUCT</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>MARINE PRODUCT</td>
<td>600</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>GENERAL CARGO TOTAL</td>
<td>7820</td>
<td>11200</td>
<td>16440</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>30410</td>
<td>36220</td>
<td>44110</td>
</tr>
</tbody>
</table>

SOURCE: OMPC

NOTE: FORECAST IS ESTIMATED BY JICA TEAM
Iron and steel, which are important capital goods for the beginning stage of industrialization and are currently relatively small in amount, as well as other kinds of semi-finished products, tend to be imported more.

In the twenty-first century, Thailand is planning to produce integrated steel on a full-scale basis, so in 2001, imports of iron ore and coal are expected to increase sharply.

**TABLE 3.6 FORECAST OF IMPORT CARGO VOLUME**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PETROLEUM</td>
<td>11658</td>
<td>14100</td>
<td>20200</td>
<td>28800</td>
</tr>
<tr>
<td>IRON &amp; STEEL</td>
<td>3558</td>
<td>4550</td>
<td>5930</td>
<td>6640</td>
</tr>
<tr>
<td>CHEMICAL PRODUCT</td>
<td>2038</td>
<td>2370</td>
<td>3310</td>
<td>4280</td>
</tr>
<tr>
<td>WOOD PRODUCT</td>
<td>518</td>
<td>520</td>
<td>520</td>
<td>520</td>
</tr>
<tr>
<td>PULP &amp; PAPER</td>
<td>566</td>
<td>740</td>
<td>1140</td>
<td>1760</td>
</tr>
<tr>
<td>FERTILIZER</td>
<td>1312</td>
<td>1610</td>
<td>1810</td>
<td>2050</td>
</tr>
<tr>
<td>INDUSTRIAL MATERIAL</td>
<td>600</td>
<td>1070</td>
<td>1710</td>
<td>2730</td>
</tr>
<tr>
<td>OTHERS</td>
<td>2505</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>DRY CARGO TOTAL</td>
<td>11097</td>
<td>13360</td>
<td>16920</td>
<td>20480</td>
</tr>
<tr>
<td>IRON ORE/PELLET</td>
<td></td>
<td></td>
<td></td>
<td>2880</td>
</tr>
<tr>
<td>COAL</td>
<td></td>
<td></td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>BULK CARGO TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>4140</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>22755</td>
<td>27460</td>
<td>37120</td>
<td>49280</td>
</tr>
</tbody>
</table>

**SOURCE:** OMPC

**NOTE:** FORECAST IS ESTIMATED BY JICA TEAM
In the five-year intervals namely 1986-1991, 1991-1996, 1996-2001, the growth rate of imports on a weight basis, excluding petroleum, are estimated to be 42%, 27% and 46%. In the first five years, from 1986 to 1991, owing to imports of capital goods and semi-finished goods in accordance with industrialization, imports will show relatively high growth.

Then until 1996, the first phase industrialization is completed, resulting in a drop in import growth rate.

Five years from 2001 will be the start of the second phase industrialization of which the main component is the steel industry. Imports are expected to rise accordingly.

Imports of fertilizer and wood products, due to localization and natural factors, is considered to remain stable (see Table 3.6)

Regarding petroleum, although demand for oil product will go up, the country's oil refineries will grow as well. However, as the supply cannot catch up with the demand, imports of petroleum will increase anyway.

3.5.4 Setting target for share of cargo carried by Thai fleet

According to the objective of 5th NESDP, the target share of carrying cargo by Thai flag vessels was set at 15% but the actual figure is still lower than the target.
JICA stated in the report "The Tendency of Thai Merchant Marine Development"; in fact, trade volume, economic environment and other factors are affecting all the time so in real calculation this must be taken into account.

Bulk cargo is directly delivered between two countries, so the improvement is simple.

General cargo and container are mainly on liner service routes and competition is fierce. They also go through many countries, so improvement is not easy.

Consequently, the realistic percentage share by Thai vessels has been reset by JICA.

Target share of cargo carried by Thai Vessels(%)  

<table>
<thead>
<tr>
<th>Type of Cargo</th>
<th>1991</th>
<th>1996</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry bulk cargo</td>
<td>13</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Liquid bulk cargo</td>
<td>13</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>General cargo</td>
<td>12</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Container</td>
<td>12</td>
<td>18</td>
<td>25</td>
</tr>
</tbody>
</table>
### 3.5.5 Estimation of Required Fleet

The estimation of the required fleet can be calculated by using the data from the forecast of import and export cargo volume and the target for share of cargo. The calculation detail, which was done by JICA, is shown in Appendix.

The plan for fleet expansion of Thai vessels is shown in Figure 3.2.

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>1991 (DWT)</th>
<th>1996 (DWT)</th>
<th>2001 (DWT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Carrier</td>
<td>422,000</td>
<td>738,000</td>
<td>1,143,000</td>
</tr>
<tr>
<td>(GRT)</td>
<td>234,000</td>
<td>410,000</td>
<td>635,000</td>
</tr>
<tr>
<td>Tanker</td>
<td>96,000</td>
<td>223,000</td>
<td>453,000</td>
</tr>
<tr>
<td>(GRT)</td>
<td>51,000</td>
<td>117,000</td>
<td>238,000</td>
</tr>
<tr>
<td>General Cargo</td>
<td>139,000</td>
<td>216,000</td>
<td>275,000</td>
</tr>
<tr>
<td>(GRT)</td>
<td>87,000</td>
<td>135,000</td>
<td>172,000</td>
</tr>
<tr>
<td>Container</td>
<td>3,330</td>
<td>9,500</td>
<td>20,610</td>
</tr>
<tr>
<td>(GRT)</td>
<td>57,000</td>
<td>144,000</td>
<td>302,000</td>
</tr>
</tbody>
</table>

| Total Gross Tonnage | 429,000 | 806,000 | 1,347,000 |
3.5.6 Estimated Amount of Thai Fleet

According to statistics from Table 2.7, at the end of 1989, there were 35 Thai ships of 4,000 gross tonnage and above, of which the average GRT is 7,600 GRT. For the prevention of error in estimation, actual GRT are estimated as only 80% of the fleet expansion plan (Fig. 3.2). Using the data from Fig. 3.2, consequently, the class of Thai ship of 4,000 GRT and above would increase yearly by 8 vessels as shown in the calculation below.
The fleet expansion plan from year 1991-1996

GRT in 1996 = 806,000 GRT
GRT in 1991 = 429,000 GRT

Total GRT increase (5 years) = 377,000 GRT

80% of the fleet expansion plan = 301,666 GRT
Increase GRT per year = 60,320 GRT
Average GRT/Vessel = 7,600 GRT
Increase vessel per year = 8 vessels

Therefore, the fleet projection can be done as in Table 3.7

<table>
<thead>
<tr>
<th>YEAR</th>
<th>THAI FLEET (X 1000 GRT)</th>
<th>NO. OF SHIPS OVER 4000 GRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>400</td>
<td>33</td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td>49</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>1996</td>
<td>800</td>
<td>72</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td>96</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>104</td>
</tr>
<tr>
<td>2001</td>
<td>1300</td>
<td>112</td>
</tr>
</tbody>
</table>
Due to the fact of the low share of cargoes carried by Thai flag vessel, the number of foreign flag vessels entering Thai ports is assumed to increase year after year. For reference, the number of ships calling at Bangkok Port in 1988 is classified by nationality and ship types. (See Table 3.8)

<table>
<thead>
<tr>
<th>NATIONALITY</th>
<th>GENERAL CARGO</th>
<th>CONTAINER</th>
<th>BULK, ORE CARRIER</th>
<th>OIL TANKER</th>
<th>GAS CARRIER</th>
<th>OTHERS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDONESIA</td>
<td>19</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>6</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>31</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>PHILIPPINES</td>
<td>17</td>
<td>16</td>
<td>27</td>
<td>6</td>
<td>5</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>SINGAPORE</td>
<td>142</td>
<td>129</td>
<td>2</td>
<td>133</td>
<td>9</td>
<td></td>
<td>416</td>
</tr>
<tr>
<td>CHINA</td>
<td>297</td>
<td>48</td>
<td>33</td>
<td>7</td>
<td>12</td>
<td></td>
<td>397</td>
</tr>
<tr>
<td>HONG KONG</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>2</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>JAPAN</td>
<td>62</td>
<td>-</td>
<td>5</td>
<td>36</td>
<td>39</td>
<td></td>
<td>142</td>
</tr>
<tr>
<td>KOREA, NORTH</td>
<td>16</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>KOREA, SOUTH</td>
<td>86</td>
<td>-</td>
<td>26</td>
<td>12</td>
<td>15</td>
<td></td>
<td>139</td>
</tr>
<tr>
<td>TAIWAN</td>
<td>18</td>
<td>34</td>
<td>10</td>
<td>-</td>
<td>17</td>
<td></td>
<td>79</td>
</tr>
<tr>
<td>BAHAMA</td>
<td>9</td>
<td>-</td>
<td>13</td>
<td>7</td>
<td>13</td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>BRITISH</td>
<td>-</td>
<td>19</td>
<td>7</td>
<td>26</td>
<td>-</td>
<td></td>
<td>52</td>
</tr>
<tr>
<td>CYPRUS</td>
<td>54</td>
<td>4</td>
<td>66</td>
<td>1</td>
<td>16</td>
<td></td>
<td>141</td>
</tr>
<tr>
<td>DENMARK</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>7</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>GERMANY</td>
<td>18</td>
<td>36</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>GREECE</td>
<td>33</td>
<td>-</td>
<td>51</td>
<td>6</td>
<td>1</td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>LIBERIA</td>
<td>33</td>
<td>99</td>
<td>75</td>
<td>100</td>
<td>3</td>
<td></td>
<td>310</td>
</tr>
<tr>
<td>MOROCCO</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>6</td>
<td>-</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>PANAMA</td>
<td>445</td>
<td>379</td>
<td>125</td>
<td>344</td>
<td>85</td>
<td></td>
<td>1378</td>
</tr>
<tr>
<td>USSR</td>
<td>158</td>
<td>-</td>
<td>23</td>
<td>3</td>
<td>35</td>
<td></td>
<td>219</td>
</tr>
<tr>
<td>OTHERS</td>
<td>262</td>
<td>84</td>
<td>75</td>
<td>3</td>
<td>50</td>
<td></td>
<td>475</td>
</tr>
</tbody>
</table>

| TOTAL        | 1721          | 851       | 562               | 782        | 328         |        | 4156  |

SOURCE: CUSTOMS DEPARTMENT, ONPEC
COMPILED BY AUTHOR.
3.6 Shiprepairing demand forecast

3.6.1 Estimated Shiprepair Demand

The ships which the new repair shipyard would cater to are those 4,000 GRT and above which have been limited by the present shipyard.

The management of the repairing yard should be based on domestic demands and should make positive efforts, at the same time, to consolidate the shipyard to attract repairs of foreign ships. In demand estimation, both Thai ships, as well as foreign ships, are considered.

(1) Thai flag ships

On the basis of the fleet reinforcement estimation (Table 3.7 Fleet Projection), the potential demand of 72 vessels are expected for 1996 while 112 vessels are expected in 2001.

As docking for survey is required for every 2 years, the actual demand is expected to be 36 vessels in 1996 and 56 vessels in 2001.

(2) Foreign flag ships

Of all foreign ships, those coming to Thai ports could be regarded as potential customer due to repairing expenses.
In Thailand, labor costs are generally cheap, especially in the labor intensive jobs, such as tank cleaning, sand blast and so on. Repair fees in Thailand, compared with neighboring countries, is shown in Table 3.9.

<table>
<thead>
<tr>
<th>COUNTRY NAME</th>
<th>THAILAND</th>
<th>SINGAPORE</th>
<th>HONGKONG</th>
<th>TAIWAN</th>
<th>KOREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOB ITEM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand Blast</td>
<td>120</td>
<td>385</td>
<td>109</td>
<td>300</td>
<td>238</td>
</tr>
<tr>
<td>PER SQ. METER SA-2</td>
<td>10,000</td>
<td>16,576</td>
<td>10,855</td>
<td>9,500</td>
<td>14,250</td>
</tr>
<tr>
<td>Anchor Chain</td>
<td>25,000</td>
<td>68,701</td>
<td>63,244</td>
<td>109,500</td>
<td>82,500</td>
</tr>
<tr>
<td>Range Out</td>
<td>1,200</td>
<td>1,895</td>
<td>1,353</td>
<td>1,600</td>
<td>1,375</td>
</tr>
<tr>
<td>Tail Shaft</td>
<td>1,400</td>
<td>2,009</td>
<td>1,826</td>
<td>2,200</td>
<td>1,750</td>
</tr>
<tr>
<td>Withdraw &amp; Refit 250 mm.</td>
<td>60</td>
<td>87</td>
<td>53</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Sea Valve 100 mm. Globe</td>
<td>80</td>
<td>225</td>
<td>144</td>
<td>165</td>
<td>225</td>
</tr>
<tr>
<td>100 mm. Gate</td>
<td>920</td>
<td>1,126</td>
<td>1,209</td>
<td>1,350</td>
<td>950</td>
</tr>
</tbody>
</table>

Table 3.9 Repair Fee in Thailand

UNIT: BAHT

SOURCE: OMPC, EXCHANGE RATE USED: 1 US$ = 25.0 BAHT
CHAPTER 4

Study of New Repair Yard

4.1 The situation of Thai port

The Bangkok Port, under the Port authority of Thailand, has been Thailand's major port for more than 40 years. It has grown and developed in line with the country's economic and social development program. However, as international trade is booming together with the modernity of transportation methods and Thailand's tendency to become an industrial country, only Bangkok, accommodating ships of not over 8.2 metres draught, could not cope with these trends.

The Laem Chabang new deep-sea commercial port was constructed in October 1987 and opened for operation in 1990. It is designed to render services to large container ships and bulk carriers which cannot be accommodated at the Bangkok Port. It is located at a distance of about 130 kms. from Bangkok.

The major components of Laem Chabang Port:

**TERMINALS**

<table>
<thead>
<tr>
<th>BERTHS</th>
<th>LENGTH/DEPTH</th>
<th>CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MULTI-PURPOSE TERMINAL</td>
<td>300 m. EACH/14 m. MSLm</td>
<td>- GENERAL CARGO SHIP OF 25,000 D.W.T. - CARGO THROUGHPUT 0.51 MILLION TONS/YEAR</td>
</tr>
</tbody>
</table>
4.2 Location of New Repair Yard

On the proposed location for a shipyard construction, the following points have to be taken into consideration:

1) To be in the vicinity of a major port or main trade route
2) Area to be deep enough for large ships to call
3) To be protected from strong winds and waves
4) Related industries are near by
5) To be ease for site preparation
6) To be apart residential areas (to avoid complaints from noise and paint spray)
7) Not too far from sea and air port for receiving material or ports delivery

From the above, the Laem Chabang area is the most suitable place since it is adjacent to the deep sea port and the hinterland is being developed as an industrial zone.
Furthermore, according to the results of a natural condition survey during the construction of the Laem Chanbang deep-sea port, such as

- meteorological conditions (rainfall, wind)
- oceanographic conditions (tides, waves)
- soil conditions

The area is suitable for a repair shipyard.

4.3 Estimate of Dock Size

According to the report "The Tendency of Merchant Marine Development" by the cooperation between MMPC and the JICA, at present, ships in operation all over the world are standardized by kinds.

In the below, 32.2 m which is the maximum breadth that can pass through the Panama canal, is adopted for all cases except that of a tanker (VLCC). The largest vessels expected would be 40,000 DWT (23,000 GRT) which can use piers of bulk terminal of the Laem Chabang Port. Therefore, on the basis of the fleet reinforcement plan and the trend of foreign ships that enter Thai ports, the requirement is a dock which can be used for repairing of 40,000 DWT ships. Moreover the dock should be left extendible in order to meet change in future needs.
<table>
<thead>
<tr>
<th></th>
<th>DWT (N. TON)</th>
<th>LENGTH X BREADTH (METER)</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULK CARRIER</td>
<td>23,000</td>
<td>160 X 23</td>
<td>ST. LOURENCE</td>
</tr>
<tr>
<td></td>
<td>20,000</td>
<td>175 X 26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38,000</td>
<td>180 X 31</td>
<td>HANDY BULKER</td>
</tr>
<tr>
<td></td>
<td>45,000</td>
<td>190 X 32.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65,000</td>
<td>210 X 32.2</td>
<td>PANAMAX BULKER</td>
</tr>
<tr>
<td></td>
<td>120,000</td>
<td>290 X 46</td>
<td>CAPE SIZE</td>
</tr>
<tr>
<td>TANKER</td>
<td>29,990</td>
<td>175 X 29</td>
<td>PRODUCT TANKER</td>
</tr>
<tr>
<td></td>
<td>45,000</td>
<td>185 X 32.2</td>
<td>PANAMAX</td>
</tr>
<tr>
<td></td>
<td>65,000</td>
<td>210 X 32.2</td>
<td>AFRAMAX</td>
</tr>
<tr>
<td></td>
<td>85,000</td>
<td>245 X 42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250,000</td>
<td>320 X 60</td>
<td>ULCC</td>
</tr>
<tr>
<td>CONTAINER</td>
<td>1,500</td>
<td>190 X 32.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,200</td>
<td>210 X 32.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,700</td>
<td>240 X 32.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,300</td>
<td>290 X 32.2</td>
<td></td>
</tr>
</tbody>
</table>

Looking at the world shiprepair industry, the market forecast published by Drewry Shipping Consultants Ltd. indicated that the majority of dock employment has fallen in the size between 0-40,000 DWT as shown in Figure 4.1. Consequently, in the present need, the 40,000 DWT dock size can be counted as an optimum size for domestic and international use.
4.4 Government Measures to Aid in Shipbuilding and Shiprepair

The Thai Government, recognizing the importance of shipbuilding and repairing industries as the sources of employment and foreign exchange savings, has issued a number of measures to aid the industry.

The measures include

1) Taxation Measures

- import duties exempted from imported materials, machineries and equipment used in building and/or repairing vessels over 60 GRT
- sales taxes exempted from income derived from shipbuilding over 250 GRT
- boats built for export, irrespective of size, are eligible for tax refund

2) Financial Assistance

The National bank charges special low interest rates for discounting of promissory notes issued by shipyards.

3) Investment Incentives and Privileges

- permission to bring in foreign experts, technicians and their dependants;
- exemption from import duties and taxes for plant machineries and equipments which cannot be produced locally;
- exemption from sales taxes on the purchase of locally made machines;
- exemption from income taxes on dividends;
- rights to remit foreign exchanges out of the country to payback loans, investments and dividends; etc.
In conclusion, if the reinforcement of the shipping project is underway, it will contribute to an increase amount of Thai fleet. Tonnage increase, consequently, require repair shipyards. Especially required are facilities with the capacity to cope with large ships which would be in good demand by Thai shipping industry in the future.
Chapter 5

Shiprepair Business

5.1 Introduction

The market for shiprepair is a world market in which companies are competing with one another for repair and maintenance work; ships can be repaired at any places along their normal route.

Factors such as:

- cost to owner
- reputation for quality
- turnaround
- knowledge of ship
- placement along route
- special skills

all play a part when an owner decides to put in for repair work.

It is also a highly labour and skill intensive activity with only limited potential for automation. Much of work is done abroad, and consists of removal, inspection, repair, reinstallation and test. In addition, many parts of work are manufactured or rebuilt in-house, instead of being purchase new, as in ship construction.
The quality and availability as well as lower cost of the labour is very important factor which heavily influenced the price, quality and turnaround of shiprepair product.

In order to survive in the high competitive market, Thailand, with a comparative advantage based on cheap labour cost, should make efforts to develop the knowledge and skills of shipyard manpowers because it is a one mean to fulfill the requirement of a client in terms of reputation for quality.

In this chapter many aspects of the shiprepair business will be discussed.

5.2 Shiprepair Activities

There are four certain activities that are commonly performed in a shiprepair yard:

- Non ship(industrial work)
- Ship conversion
- Unscheduled or emergency and casualty repair
- Scheduled repair (maintenance and inspection of ships)
5.2.1 Non-ship (Industrial Work)

Shiprepair yards, in the normal course of their operations become proficient in steel fabrication, welding, boiler repair, motor overhaul, etc. A number of these skills have transferability to other industries. For examples:

- Drilling platforms required sophisticated welding
- Power generating plants need turbines repaired
- A number of industrial firms need boilers repairs

This type of outside activity has been useful in bringing in revenue during periods of slack repair volume.

5.2.2 Ship Conversion

Conversion of ships to increase their size, change their purpose, etc. is a traditional function of a shiprepair yard. It happens relatively frequently when new construction costs are high or new construction yards are busy.

5.2.3 Unscheduled Repair

Planned maintenance or preventive maintenance, such as is performed by airlines, is not currently typical of the shiprepair industry. Except for inspection and maintenance required by classification societies, ship comes to be repaired due to a
breakdown in machinery or equipment which cannot be repaired aboard or put off longer. A second reason may be the condition of the ship's bottom which must be cleaned and paint periodically to achieve greater fuel efficiency. And further, there are repairs caused by casualties; however, it has been mentioned that casualty repairs are a largely unplanable market.

5.2.4 Scheduled Repair (maintenance and inspection of ship)

Survey for classification or statutory requirements are part of this repair and often these will result in some repair work being necessary. The basic elements of the repair work consists of ripping out and refitting such as steel, pipe, machinery or wiring to exist system.

At the present, non ship-industrial work like drilling platforms or power generating plant are far above the exist ability of Thai repair yard to perform the task. Therefore, ship conversion, casualty repair and scheduled repair will represent an important part of the shiprepair market. However, their demand are not divided equally in the market.

According to the Drewry Shipping Consultant Ltd.'s report on the title the "World Shiprepair and Conversion Markets", the global shiprepair demand by work types have been forecast to the year 1995 as shown in Fig. 5.1.
The scheduled repair demand dominates the highest share in comparison to conversion and damaged repair. Consequently, it will be wise for the new Thai established shipyard for running business by emphasizing on the scheduled repair work. Furthermore, the sophisticated conversions and modification jobs require greater technical expertise which is not much available in Thailand.

5.2.5 Scheduled Repair Work

As the scheduled repair work is the task for the new established shipyard to perform. Therefore, the characteristic
of this work has to be taken into consideration. In order to be the guideline for preparation of manpower.

Work which is normally carried out in drydock can be divided into 2 parts:

- Normal survey and routine dry dock work
- Normal repair work

The following items indicate normal survey and routine drydock and repair work as well as its description.

Normal survey and routine work

1. Anchor and chain
   a) Range anchor chains for examination including disconnection at bitter ends, re-stow
   b) All shackle pins to be remove for examination and overhaul
   c) Open all shackles and connecting patent links, reconnect renewing all lead plug. Harden up all patent links and anchor pin
   d) Cable to be calibrated for special survey.

2. Chain locker and Tank
   Chain locker and tank to be cleaned out and coated.

3. Bottom and intermediate sea valves
   Open up for survey, grind, repack and close.
4. Anode on hull
   Install anodes on hull and seachests, including removal of depleted anodes

5. Rudder
   a) Check and record top and bottom bush clearances
   b) Cleaning and pressure testing

6. Tailshaft
   a) Draw in tailshaft for survey, clean, calibrate and refit
   b) Tailshaft wear-down to be taken and recorded

7. Propeller
   a) Propeller to be cleaned and polished
   b) Blades to be crack-detected

8. Hull and Topside
   a) Cleaning
   b) Surface preparation (sand blasting)
   c) Painting
   d) Hull marking

9. Lifting equipment
   Inspection, overhaul and load test have to be carried out

10. Echo sounder and speed log unit
    Checking

11. Main Switchboard
    Cleaning and checking
Normal repair work

1. Hull structure repairs (steel work)
2. Pipe renewals
3. Machinery overhaul or reconditioning
4. Boiler repairs
5. Instrumentation and control refurbishing
6. Electrical repairs

5.3 Manpower Consideration

According to the discussion in the previous section, the various kinds of work have to be done in the scheduled repair which lead to the requirement of a number of types of skilled workers.

The following is a listing of the most critical shiprepairing tradesmen:

1. Welders: makes or repairs structures or parts, using
gas or electric welding equipment, soldering equipment,
gas or electric cutting equipment etc.

2. Shipfitters: lays out and fits up metal structure parts
(such as plates, bulkheads, and frames) and maintains
them in position for welding.
3. Loftsmen: lays out lines of a ship to full scale on the mold loft floor and constructs templates and molds to be used as patterns and guides for layout and fabrication of various structural parts of ships.

4. Pipefitters: fabricates, lays out, installs, and main tains ships' piping systems such as steam heating, water, hydraulic, air pressure, and lubrication systems, using handtools and ship machines (may also perform pipe welding).

5. Machinist (inside): sets up and operates machine tools as well as fits or assembles parts to make or repair metal parts, tools or machines.

6. Machinist (outside): installs ship machinery such as propulsion machinery, auxiliary motors, pumps, ventilating equipment and steering gear.

7. Electrician: installs and repairs wiring, fixtures, and equipment for all electrical services aboard ship.

8. Electronics mechanic: works on various types of electronic equipment to put it in repaired operating condition.
9. Rigger/Crane operator : installs and repairs rigging and weight handling gear, attaches hoists and handling gear to rigging, and operates cranes and other mobile material handling equipment to lift, move and position machinery, equipment structural parts and other heavy loads aboard ships (may also called operating engineers).

10. Sheetmetal mechanic : fabricates, assembles, installs and repairs sheet metal.

11. Blaster/Painter : prepares surfaces for coating by abrasive blasting, mixes and applies paint or other coating materials for protective and decorative purpose by means of spray gun, brush, roller or immersion.


Work practices, work responsibilities and trade divisions vary between shipyards. However, all actual repairing work within a shipyard fall into the domain of trades such as those listed above.

5.4 Labor quality

The quality and availability of the labor force is very important factors in running business which high competitive like
the shiprepair industry. Lower labor quality will increase average cost and may change the optimum production rate. Therefore, there is a necessity to educate and train all levels of shipyard’s worker in the production department which responsible for obtaining the best productivity for the entire repair work. Generally, the workers in the production fields can be divided into 3 categories:

1. Skill worker (various trade as stated earlier)
2. Foreman (work leader)
3. Repair Engineer (supervisor)

Of these 3 categories for shiprepair in Thailand, the most critical, in terms of shortage, is the repair engineer. Therefore, the intention of this paper will focus only on upgrading this group who will assist and instruct as well as supervise to the other 2 groups of yard workers. Furthermore, the repair engineer can be subdivided into 3 main groups according to the characteristics of shiprepair works, namely

- Hull repair
- Machinery repair
- Electrical repair

In the following section of this chapter, the main section of upgrading the repair engineer are further discussed because there are another 3 parties, namely a shipowner, a classification
society and a regulatory agency who involve in the shiprepair business and play an important role for approving the finished product from shiprepair yard. Consequently, it is necessary to study the requirement from those 3 parties in order to obtain all necessary scope of education and training areas.

5.5 Shipowner requirement

After an owner has contracted with a shipyards, he has already clearly laid down general terms and conditions at the commencement of his repair/drydocking specification. Every specification will also reflect an owner view of what is technically necessary for the safe, efficient operation of his ships.

In addition an owner will organize his inspection team and designates his representative who will reside at the shipyard during the repair period. All kinds of inspection is intended to ensure through identification and notification of apparent deficiencies, that the yard repairs the vessels in accordance with the requirement of repair contract.

On the other hand, the shipyard must have quality control inspection force of it own to ensure the quality of workmanship and material of the yard and at vendor's plants as necessary. Failure on the part of the yard to provide these safeguards shall not later become a claim for delay in delivery if workmanship or material is rejected by the owner.
The following items are some standard example of owner conditions which extracted from repair specification of the P & O Ship Management Ltd.

1. While this specification is made as thorough and complete as possible, it is to be clearly understood that all repair items are to be carried out to the entire satisfaction of the owner's representative.

2. It is to be understood by the contractor (shipyard) that all repair items herein specified must be carried out and completed in all details and that the workmanship and material must be of the best quality throughout and conform to those now in the vessel, except where otherwise mentioned, and also meet the requirement of this specification and/or classification rules. In no case will replacement material of less weight or thickness than the original be allowed.

3. Owner will gas-free and clean all cargo tanks, pump rooms, cofferdams of the vessel, as far as practicable, prior to delivering her into the contractor's yard. The contractor shall keep said compartment and pumps or piping free from explosive and/or dangerous gas and/or gases during the repair and/or alterations.
4. The owner representative has the right to reject any equipment he considers defective, which the contractor may use to effect repairs in cargo tanks/machinery spaces with particular reference to oxygen/acetylene hoses and auxiliary lighting.

5. In the case of vessel's machinery, equipment or fittings such as winches, rigging, pipe lines, etc. being used by contractor, he shall be held responsible for any damage resulting from such use.

6. No extras will be allowed in this contract unless agreed to by the owners' representative in writing.

7. The contractor is to protect the owners of the vessel from claims for workmen injured during the execution of the contractor, and from any claims or fines against the vessel or her owner through the contamination of the harbor by fuel oil during the progress of the repairs directly attributed to the contractor's labour.

8. The waiving of any of the clauses of the contractor or the granting of any extension of time on any one or more items cover by this contract, shall not abrogate the contract as a whole, nor shall it relieve the contractor from the obligation of complying with all other
items and conditions of the contractor in the time and manner specified.

9. No work on this specification is to be undertaken prior to discussion between the owner's representative and the contractor.

10. The contractor is required to submit a bar chart showing the planned work schedule for all items, as soon as the work is awarded.

11. All large machinery items, pipes, service hoses, etc. to pass through the engine room top hatch. This is for the purpose of maintaining the vessel's staff's privacy and present state of accommodation cleanliness and habitability.

5.6 Classification Societies and Regulatory Agencies

The principal maritime nations have established classification societies in order to improve vessel safety. Although the original purpose was to ascertain the relative risk of insuring specific vessels, and are often closely coordinate with a government regulatory agency. Classification societies generally publish rules for the design, construction, and maintenance of vessels. It also facilitate documentation and safety regulation by government.
The following list are classification representative office in Thailand:

- Lloyd's register of shipping
- American Bureau of Shipping
- Bureau Veritas
- Germanischer Lloyd
- Nippon Kaigi Ngokai
- Det Norske Veritas

An operator is not required to have a ship classified. If it is not, however, certain government agencies will have to satisfied that the ship meets safety criteria before it can be documented and a various safety certificate issued. A classification surveyor will occasionally be on site for repairing programs. Their purpose is to ensure that the vessel is repaired in accordance with the classifications for which the owner has applied. Items within their cognizance included the structural strength of the ship, the installation of certain equipment, such as anchor, and reliability of machinery.

In order to maintain the classification, the ship is inspected in dry dock for corrosion, chafing, or distortion of the shell plating, sternframe, or rudder. Special surveys are also conducted at periodic intervals. This inspection varies with the age of the ship.
In addition to classification society inspection, government agencies inspect merchant vessels to assure that they are maintained according to published rules. Efforts have been made to avoid overlaps between classification society and regulatory body inspections. Primary areas of regulatory body safety involvement included stability, fire protection, machinery, and electrical system safety, hazardous and polluting substance control, lifesaving equipment and navigation and communication equipment. In Thailand, merchant vessel safety inspection is carried out by the Harbor Department.

Surveyors are generally experienced and will be able to assess the extent of knowledge of shiprepair yard personnel. Therefore, it is important that rules and regulation for these surveys are understood by shipyard personnel.
The Structure of Education and Training for a Repair Engineer

6.1 Introduction

The purpose of this paper is to propose the upgrading courses for a repair engineer in order to improve the quality and the productivity and effectiveness of Thai shipyard to meet the present need in shiprepairing industry in Thailand.

The course materials will be designed in accordance with two principles. Firstly, to identify the basis entry requirement and target group for the course, and secondly, to specify the technical content and levels of knowledge and skills necessary to meet the objective of the upgrading shiprepair courses.

Each up-grading shiprepair course will consist of two parts, i.e. a course framework and a course outline.

The course framework will state:
- the course objective;
- the standard requirement (i.e. the entry qualifications need for participants to attend the course).

The course outline will present the individual course in terms of subject areas and learning details.
However, the further details in the up-grading shipyard course will be presented in the next section. In this section, education institutions in the fields related to ship repair are studied in order to identify the target group for each course.

6.2 The Present Status

Educational related to shiprepairing of Thailand today are divided into the higher educational institutions as institutions for engineer and vocational training institutions as training institutions for skilled workers. For the purpose of this study will discuss only the higher educational level.

There are two universities, Songkla and Chulongkorn, which offer the mechanical engineering program related to shiprepairing. One of the objective of those two universities is to produce mechanical engineers at the bachelor degree level with theoretical, practical and design knowledge in marine technology.

The four-year course consist of engineering subjects, free electives and the basic sciences as well as humanities and social sciences. A number of elective subjects are available in the final year to permit students to specialize in the chosen fields. Furthermore, the vocational training of not less than six weeks are also included in the degree requirement in order to provide the graduates with solid practical background.
The mechanical engineering curriculum of each university is based on the following structure:

<table>
<thead>
<tr>
<th>Course Structure</th>
<th>Credits</th>
<th>Songkla</th>
<th>Chula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. General Subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Humanities</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Science &amp; Mathematics</td>
<td>35</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
<td><strong>42</strong></td>
<td></td>
</tr>
</tbody>
</table>

B. Engineering Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Credits</th>
<th>Songkla</th>
<th>Chula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Subjects</td>
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<td>23</td>
<td></td>
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<tr>
<td>Technical Subjects</td>
<td>55</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90</strong></td>
<td><strong>100</strong></td>
<td></td>
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</tbody>
</table>

C. Free Electives

<table>
<thead>
<tr>
<th>Credits</th>
<th>Songkla</th>
<th>Chula</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>145</strong></td>
</tr>
</tbody>
</table>

The program of study of both universities are shown in the Appendix.

However, when look closely to the curriculums, the graduates can not directly become a repair engineer for a shipyard due to there are still some lack of basic knowledge and skills in
various matters such as methods of ship repair, ship-related regulations as well as safety and pollution aspects in connection with ship repairing.

6.3 The proposal of up-grading for a repair engineer

6.3.1. Introduction to the course

The course is designed to enhance or supplement the existing education and training for personnel who will be a repair engineer of a shipyard.

All learning subject areas of the courses will derive from the repair work specification which normally carried out during the scheduled dry-docking repair in order to fulfil the shipowners as well as classification societies and regulatory agencies.

Aspects covered the technical content and levels of knowledge and skills necessary to perform the repair works including safety and anti-pollution measures. The objective and entry standard of the course will also be presented. However, the course have not indicated the assessment of the time which should be allotted to each learning subject area due to the limitation of the author's experience. Furthermore, the educational backgrounds of the trainees in repairing subject will vary from group
to group. Therefore, it must be appreciate that these allocations will be done by the person who interest.

6.4 Up-grading course for hull repair

6.4.1 Course framework

Objective:

The course should enable those successfully completing it to:

1) plan, organize or implement, repair works by the shipowner;
2) monitor the conduct of repair works without polluting the environment and most safely;
3) inspect or test the materials, structure and other equipment in respect of which a repair work is to be done;
4) understand the procedures of surveys or inspections of the repair works required by classification societies and regulatory bodies.
Entry standard

The course is open to:

1) The graduates from Songkla University in marine engineering but who have passed the technical elective subjects in naval architecture, ship strength, ship mechanics and ship design according to the program of study in previous section;

2) The graduates from Chulangkorn University in engineering (program in marine technology);

3) Chief engineers, naval architechs or qualified marine engineers;

4) The existing hull repair engineers of a shipyard;

5) The person who hold any equivalent qualification as one of the above categories and have experience related to the hull repair of ships.

6.4.2 Course outline

Subject area

(1) Introduction;

(2) Hull Material;

(3) Metal Processes;

(4) Piping;

(5) Non-Destructive Testing (NDT);
(6) Anchor and Chain;
(7) Rudder;
(8) Sea Water, Fuel Oil and Steam System on board a cargo vessel as well as Cargo System for oil tanker;
(9) Bilge Pumping System;
(10) Monitoring the condition of painted surface;
(11) Paints;
(12) Standard in Painting;
(13) Steel Surface Preparation;
(14) Paint Application;
(15) Control and Control Equipment in Painting;
(16) Underwater Hull Surface Finish;
(17) Safety and Health in Shiprepairing;
(18) Anti-Pollution measures;
(19) Basic Fire Fighting;
(20) Shiprepair Administration.

Learning details in the subject areas.

(1) Introduction

(1.1) The role of the International Maritime Organization (IMO);

(1.1.1) The certificates required under IMO regulations of a cargo vessels with respect to: SOLAS, MARPOL, Load Line and Tonage Measurement;
(1.2) The role of International Labor Organization;

(1.3) The International Association of Classification Societies (IACS);

(1.3.1) The principles of the classification societies;

(1.3.2) The survey work of classification societies for governments effects their relationship with shipowners;

(1.3.3) Preparation for surveys.

(2) Hull materials

(2.1) Steel making processes;

(2.2) Types of shipbuilding steels:
- low carbon,
- mild,
- ordinary-strength steel,
- higher carbon and other alloy steels;

(2.3) The properties of steels:
- strength and ductility,
- fracture toughness,
- fatigue strength,
- corrosion resistance;

(2.4) The commercial grades of steels and their requirements:
- manufacturing process,
- chemical composition,
- tensile and impact test,
- heat treatment;

(2.5) Other type of shipbuilding metal and their properties:
- alluminium and alluminium alloys.

(3) Metal Processes

(3.1) Welding;

(3.1.1) The characteristics of the fusion welding:
- heat source intensity,
- heat input rate,
- shielding,
- weld metal metallurgical effects;

(3.1.2) Welding processes:
- gas welding,
- electric resistance welding,
- other welding processes: electroslag, electrogas thermit, laser and electron beam welding,
- soldering and brazing;

(3.1.3) Welding inspection:
- the various defects associated with welding and required counter measures:
  * slag inclusion,
  * lack of fusion,
* incomplete penetration,
* surface defects,
* solidification crack,
* lamellar tearing,
* porosity,
* hydrogen-included cracking,

- some vital points in connection with a check list for welding inspection:
  * the preparation before welding,
  * the conditions during welding,
  * the conditions after welding,
  * the use of the correct consumables;

(3.2) Cutting
(3.2.1) Mechanical cutting:
  - shears for heavier, structural steel,
  - saws for sheet metal,
(3.2.2) Thermal cutting:
  - gas cutting,
  - plasma arc cutting

(3.3) Forming
(3.3.1) Mechanical technique:
  - rolls,
  - presses,
- shape bender;

(3.3.2) Thermal technique (flame bending);

(3.4) Distortion removal

(4) Piping

(4.1) Material and specification of machinery piping:

(4.1.1) Piping materials and their application uses on board

- carbon and carbon manganese steel
- copper and copper alloy,
- grey cast iron,
- nodular cast iron or ferritic type (special graphite cast iron),
- nodular cast iron of ferritic/pearlitic and pearlitic type,
- plastic pipe;

(4.1.2) The standard and codes applicable to the piping system on board and accepted by a classification society as well as an administration;

(4.1.3) The purpose of hydrostatic test of piping before and after installation on board;

(4.2) Piping processes:

- cutting,
- edge preparation for joining,
- hole and contour cutting,
- flange fitting and welding
- bending

(5) Non-Destructive Testing (NDT)

(5.1) The main purpose and method of NDT as well as advantages and disadvantages and application of the different methods of NDT:
- visual,
- radiography,
- ultrasonic,
- magnetic practical,
- dye penetrant.

(6) Anchor and chain

(6.1) Anchor system;
(6.2) Anchor characteristic;
(6.3) Type of anchors;
(6.4) Anchor chain;
(6.5) Determination of anchor and chain sizes;
(6.6) Anchor handling arrangements;
(6.7) Anchor storage.

(7) Rudder

(7.1) Type of rudders;
(7.2) Rudder structure and supports.
(8) Sea water, fuel oil and steam systems on board cargo ship as well as system for oil tanker

(8.1) Sea water system

(8.1.1) The fitting arrangement of sea valves of the ship's steel plate;

(8.1.2) The inspection of sea chest at periodical survey;

(8.2) Fuel oil system;

(8.2.1) The overflow or relief valve arrangements to prevent over pressure in any part of the system;

(8.2.2) The material of pipes, valves and flexible pipes use for the system

(8.3) Steam system

(8.3.1) The selection of steam pipes and fitting and the additional for high-pressure steam pipes;

(8.3.2) The arrangement of pressure-reduction valves in the piping system;

(8.4) Cargo system for oil tanker;

(8.4.1) The material and wall thickness requirements for cargo pipe;
(8.4.2) The examination of cargo tank venting arrangement with respect to connection, protections and positioning of pressure/vacuum valves.

(9) Bilge pumping system on board cargo vessel
   (9.1) The arrangement of bilge suction pipe in machinery spaces and the diameter requirement of various pipes:
         - bilge main,
         - branch bilge suction,
         - direct bilge suction,
         - emergency bilge suction;

   (9.2) The valve or other arrangements to prevent accidental flooding from the sea or from other compartments of machinery spaces, cargo holds, deep tanks or between compartments.

(10) Monitoring the condition of painted surfaces
   (10.1) The method of assessing the coating condition of the visible part of the underwater hull;

   (10.2) The theory of corrosion;
(10.3) The use of cathodic protection, by means of either impressed current or sacrificial anodes;

(10.4) The calculation methods of:
- the immersed surface area of the ship,
- the service period before the next dry docking,
- the mass of anode required to protect the underwater hull.

(11) Paints

(11.1) The main components of a paint

(11.2) The purpose of:
- binders,
- pigments,
- extenders/fillers,
- solvents, thinners;

(11.3) The principal features of:
- alkyd paints,
- butiminnous paints,
- chlorinated rubber paints,
- vinyl tar paints,
- epoxy/epoxy tar paints,
- polyurathene paints,
- shop primers;
(11.4) The calculation of the theoretical covering capacity in sq.meter/litre when the percentage of solid by volume and the film thickness are known;

(11.5) The calculation of the cost of paint per sq.meter when the details required in (9.4) and the cost/litre are known.

(12) Standard in painting

(12.1) The international standard of surface condition, surface preparation and paint condition;

(12.2) The standards for evaluation and degradation of paint coatings.

(13) Steel surface preparation

(13.1) The importance of ridding steel surfaces of:
- mill scale,
- rust,
- foreign matter such as water-soluble salts,
- welding flax;

(13.2) The cleaning method used;

(13.3) The cleaning of a steel surface prior to paint application;

(13.4) Dry and wet blast cleaning equipment;
(13.5) The abrasives in current use;
(13.6) The operation of blast cleaning equipment, 
   both as blast operator and as filler;

(13.7) The method of wet blasting by:
   - water injection or slurry,
   - water curtain or water shroud,
   - abrasive ejection,
   - high pressure water jetting

(13.8) Hand tool equipment.

(14) Paint application (1 hour)

(14.1) The advantages and disadvantages of different application methods;

(14.2) The best application method to be used in specified situations;

(14.3) How different dry film thickness are achieved by use of brush, roller and airless spray;

(14.4) The correct use of an airless spray, including how to:
   - make the pump ready for use,
   - handle the equipment,
   - operate the pump and use the gun correctly,
   - clean and store the equipment;
(14.5) The effects of the incorrect use of an airless pump;

(14.6) The danger in using high build coating with regard to solvent retention and the risk of bubble formation;

(14.7) The causes of bubble formation.

(15) Control, Control equipment in painting

(15.1) The circumstances in which water may condense on a surface;

(15.2) The precautions to be taken when condensation may occur;

(15.3) The measuring of:
- air temperature,
- relative humidity,
- steel temperature;

(15.4) The measuring of the wet or dry film thickness.

(16) Underwater hull surface finish

(16.1) The measuring of the surface roughness of a ship's hull;

(16.2) The factors which influence surface roughness;

(16.3) The cause and effect of sandwich coating;

(16.4) The action to take in order to avoid roughness.
(17) Safety and health in shipping

Safety measures for accident prevention in the following area:

(17.1) Work in confined spaces and dangerous atmospheres;
(17.2) Work with dangerous and irritating substances and reditions;
(17.3) Work on boilers, engines and machinery of vessels;
(17.4) Electricity;
(17.5) Pressure plant;
(17.6) Welding, flame cutting and other hot work;
(17.7) Abrasive blasting;
(17.8) Other work
  - Installing piping,
  - Installing appliances,
  - work both anchors and anchor chain;
(17.9) Scaffolding and staging;
(17.10) Lifting appliances;
(17.11) Protection against falls of objects;
(17.12) Protection against falls of person;
(17.13) Working chlotes and personal protective equipment;
(17.14) Medical supervision and first aid.
(18) Anti-pollution measures

(18.1) Measures for preventing water pollution:
1) Shipyard seawage,
2) Drydock effluent,
3) Boiler cleaning effluent,
4) Engine room bilge water;

(18.2) Other anti-pollution measures;
1) Noise,
2) Atmospheric pollution,
3) Solid wastes.

(19) Fire fighting

(19.1) Basic principles;
(19.2) Breathing apparatus;
(19.3) Portable fire extinguisher;
(19.4) Rescue of injured personal;
(19.5) Detection and measuring of hazardous gas.

Note: (No. (19.2) - (19.5) include practical training).

(20) Ship repair administration

(20.1) Planning and preparation of repair work
- preparation of bids/tenders,
- the evaluation allocation of manpower requirements,
- the yard’s specification with a detailed work description,
- the yard’s preparation
(20.2) Organizational and administration;
- layout of yard,
- yard organization,
- division of responsibility and authority,
- the co-operation of the ship and yard’s management team.

6.5 Upgrading Course for Machinery Repair

6.5.1 Course framework

Objective

The course should enable those successfully completing it to:

1) plan, organize or implement, repair works by the shipowner;
2) monitor the conduct of repair works without polluting the environment and most safely;
3) inspect or test the materials, structure and other equipment in respect of which a repair work is to be done;
4) understand the procedures of surveys or inspections of the repair works required by classification societies and regulatory bodies.

Entry standard

The course is open to:

1) The graduates from Songkla University in marine engineering but who have passed the technical elective subjects in naval architecture, ship strength, ship mechanics and ship design according to the program of study in previous section;

2) The graduates from Chulangkorn University in engineering (program in marine technology);

3) Chief engineers, or qualified marine engineers;

4) The existing hull repair engineers of a shipyard;

5) The person who hold any equivalent qualification as one of the above categories and have experience related to the hull repair of ships.

6.5.2 Course outline

Subject area

(1) Introduction;

(2) Non-Destructive Testing (NDT);
(3) Pump;
(4) Compressed air system;
(5) Boiler and pressure vessels;
(6) Turbine;
(7) Diesel Engine;
(8) Gearing arrangements;
(9) Shafting arrangements;
(10) Propeller;
(11) Steering gear system;
(12) Anchor handling machinery;
(13) Safety and health in shiprepairing;
(14) Anti-pollution measures;
(15) Basic fire fighting;
(16) Shiprepair administration.

Learning details in the subject area

(1) Introduction

(1.1) The role of the International Maritime Organization (IMO);

(1.1.1) The certificates required under IMO regulations of a cargo vessels with respect to: SOLAS, MARPOL, Load Line and Tonage Measurement;

(1.2) The role of International Labor Organization;
(1.3) The International Association of Classification Societies (IACS);
(1.3.1) The principles of the classification societies;
(1.3.2) The survey work of classification societies for governments effects their relationship with shipowners;
(1.3.3) Preparation for surveys.

(2) Non-Destructive Testing (NDT)

(2.1) The main purpose and method of NDT as well as advantages and disadvantages and application of the different methods of NDT:
- visual,
- radiography,
- ultrasonic,
- magnetic practical,
- dye penetrant.

(3) Pump

(3.1) The overhaul and inspection procedures on the following types of pumps
- centrifugal pump,
- screw and gear pump,
- displacement (piston) pump;
(3.2) The bilge pumping system

(3.2.1) The compartments which are to be connected to the bilge pumping arrangement;

(3.2.2) The calculation of the capacity of a bilge pump;

(3.2.3) The required number of bilge pumps and their location for a cargo ships.

(4) Compressed air system

(4.1) The examination and testing of air compressor and emergency air compressor including air valves

(5) Boiler and pressure vessels

(5.1) The hydraulic pressure testing;

(5.2) The inspection of boiler foundations and stays and boiler mountings;

(5.3) The mounting, alarm and safety systems of boilers;

(5.4) The kinds of damage to be expected and the possible repair procedures for the steam drum;

(5.5) The inspection and possible damage of superheaters with respect to deposits on and corrosion of headers and lubes,
- thermal cracks and high-temperature creep cracks;

(5.6) Some acceptance for deformation.

(6) Turbine

(6.1) The measurement and testing for turbine with respect to:
- vibration,
- turbine rotor and bearing,
- governor system,
- monitoring and alarm system,
- safety system;

(6.2) The abnormal indications observed during operation, cause of failure and repair for following defects of the steam turbine components:
- excessive wear of turbine thrust bearings,
- excessive wear and cracks of journal/bearings,
- bent turbine rotor,
- failure of single blade, blades-row wise and stationary nozzles,
- deposits on blade and nozzles,
- erosion of low-pressure turbine blades, shrouds and rims;
(6.3) The types of damage that critically affect the functioning of steam turbines.

(7) Diesel Engine

(7.1) The inspection of engine alignment
- metal chocking,
- tightening of bolts,
- crankshaft alignment;

(7.2) The overhaul inspection and repair method of diesel engine components
- bedplates and frames,
- reversing gear,
- starting air system,
- cylinder cover,
- cylinder liner,
- pistons and piston rods,
- connecting rods, crossheads and top end bearings,
- bottom end bearing and crankpins,
- main bearings and journals,
- drive for camshaft and attachments,
- fuel oil system,
- turbo-charging arrangement;

(7.3) Testing, including sea trials

(7.3.1) The testing of monitoring and alarm safety systems
- parameters to be checked,
- vibration,
- reversing of propulsion engine,
- protection against noise;

(8) Gearing arrangements

(8.1) The damages frequently experienced of the gearing in service and repair methods
- wear,
- surface fatigue,
- plastic flow,
- fracture of teeth;

(9) Shafting arrangements

(9.1) The inspection of propeller shaft taper part with respect to:
- crack detection method,
- type of damage frequently experienced,
- repair of damage

(9.2) The inspection of propeller shaft with respect to:
- damage of shaft and shaft liner;

(9.3) The inspection of shaft sealing arrangement in stern tube;

(9.4) The inspection of stern tube bearing and allowable clearances for oil and water lubricated shaft;
(9.5) The shaft alignment checking by gap and sag, jack-up and disadvantages of each method;

(9.6) The precaution to which attention has to be paid during shaft alignment control.
(10) Propeller

(10.1) The inspection of propeller fitting to the shaft with respect to:
- shape and finishing of tail shaft taper,
- contact area and non-contact band,
- friction coefficient and surface pressure,
- maximum equivalent uniaxial stress for fitting with key or keyless propeller,
- pull-up distance,
- key and keyway arrangement;

(10.2) The corrosion, erosion and deformation often found on the propeller blades and the cause of these types of damage;

(10.3) The cracks often found in the blade and bosses of propellers:
- stress corrosion,
- fatigue cracks;

(10.4) Non-destructive testing as used for propeller inspection;

(10.5) The repairing of propeller by welding with respect to:
- location of welding works,
- qualification test of weld,
- preparation of weld,
- preheating,
- stress-relieving,
- welding method and procedures;

(10.6) The repair method for straightening of propeller blade;

(10.7) The balancing of propeller blade;

(11) Steering gear system

(11.1) The pressure testing of the piping system, pumps and actuators;

(11.2) The examination of electrical arrangements of steering system
- cable installation,
- protection of circuits and motor;

(12) Anchor handling machinery

(13) Safety and health in shipping

Safety measures for accident prevention in the following area:

(13.1) Work in confined spaces and dangerous atmospheres;

(13.2) Work with dangerous and irritating substances and radiations;

(13.3) Work on boilers, engines and machinery of vessels;

(13.4) Electricity;

(13.5) Pressure plant;
(13.6) Welding, flame cutting and other hot work;
(13.7) Abrasive blasting;
(13.8) Other work
   - Installing piping,
   - Installing appliances,
   - Work both anchors and anchor chain;
(13.9) Scaffolding and staging;
(13.10) Lifting appliances;
(13.11) Protection against falls of objects;
(13.12) Protection against falls of person;
(13.13) Working clothes and personal protective equipment;
(13.14) Medical supervision and first aid.

(14) Anti-pollution measures
(14.1) Measures for preventing water pollution:
   1) Shipyard sewage,
   2) Drydock effluent,
   3) Boiler cleaning effluent,
   4) Engine room bilge water;
(14.2) Other anti-pollution measures;
   1) Noise,
   2) Atmospheric pollution,
   3) Solid wastes.

(15) Fire fighting
(15.1) Basic principles;
(15.2) Breathing apparatus;
(15.3) Portable fire extinguisher;
(15.4) Rescue of injured personal;
(15.5) Detection and measuring of hazardous gas.

Note: (No. (15.2) - (15.5) include practical training).

(16) Ship repair administration

(16.1) Planning and preparation of repair work
- preparation of bids/tenders,
- the evaluation allocation of manpower requirements,
- the yard’s specification with a detailed work description,
- the yard’s preparation

(16.2) Organizational and administration;
- layout of yard,
- yard organization,
- division of responsibility and authority,
- the co-operation of the ship and yard’s management team.
6.6 Upgrading Course for Electrical Repair

6.6.1 Course framework

Objective

The course should enable those successfully completing it to:

1) plan, organize or implement, repair works by the shipowner;
2) monitor the conduct of repair works without polluting the environment and most safely;
3) inspect or test the materials, structure and other equipment in respect of which a repair work is to be done;
4) understand the procedures of surveys or inspections of the repair works required by classification societies and regulatory bodies.

Entry standard

The course is open to:

1) Chief Engineers, qualified marine engineers or electrical engineers.
2) The existing electrical repair engineers of a ship yard.

3) The person who hold equivalent qualification as one of the above categories and have experience related to the electrical repair of ships.

6.6.2 Course Outline

Subject areas

(1) Introduction
(2) Electrical system of ships
(3) Elements in safety concept for electrical installations
(4) The electrical hazard in zones with high risk of fires and explosion
(5) Insulation Resistance Testing
(6) Main generators
(7) Main and emergency switchboards
(8) Motor
(9) Steering gear
(10) Cables
(11) Safety and health in shiprepairing
(12) Anti-pollution measures
(13) Basic fire fighting
(14) Shiprepair administration
(1) Introduction

(1.1) The role of the International Maritime Organization (IMO);

(1.1.1) The certificates required under IMO regulations of a cargo vessels with respect to: SOLAS, MARPOL, Load Line and Tonnage Measurement;

(1.2) The role of International Labor Organization;

(1.3) The International Association of Classification Societies (IACS);

(1.3.1) The principles of the classification societies;

(1.3.2) The survey work of classification societies for governments effects their relationship with shipowners;

(1.3.3) Preparation for surveys.

(2) Electrical system of ships

(2.1) Main system

(2.2) Separate and independent emergency system
(3) Elements in safety concept for electrical installation

(3.1) Passive safety measures;
(3.2) Active safety measures;
(3.3) Component quality or reliability level;
(3.4) Redundancy
(3.5) Circuit protection;
(3.6) Erroneous operation;
(3.7) Safety earthing;
(3.8) Personal protection;
(3.9) Fire prevention

(4) The electrical hazard in zones with high risk of fires and explosions

(4.1) Hazardous areas aboard ship;
(4.2) Electrical equipment safe for use in hazardous areas

(4.2.1) Certification of safe equipment;
(4.2.2) The methods for making equipment safe:
- flame-proof joint,
- pressurized equipment,
- sand-filled equipment,
- oil-filled equipment;
(4.3) The inspection and testing of electrical equipment in hazardous areas.
(5) Installation resistance testing
   (5.1) The criteria for insulation resistance;
   (5.2) The methods of testing.

(6) Main generators
   (6.1) Generator load test;
   (6.2) Generator parallel operation;
   (6.3) Generator synchronization;
   (6.4) Interlock system;
   (6.5) Auto connection system;
   (6.6) Auto connection of emergency generator.

(7) Main and emergency switchboards
   (7.1) Overcurrent release;
   (7.2) Short circuit release;
   (7.3) Reverse voltage release;
   (7.4) Others (tripping of non-essential loads etc.).

(8) Motor
   (8.1) Starting arrangements;
   (8.2) Cooling arrangements;
   (8.3) Insulation resistance;
   (8.4) Earthing arrangements;
   (8.5) Protective relay settings.
(9) Steering gear
(9.1) Motor overload alarm;
(9.2) Main supply failure alarm on bridge;
(9.3) Phase failure alarm;
(9.4) Automatic resistant upon restoration of voltage after a "blackout";
(9.5) Auto-standby start upon failure of running motor;
(9.6) Running indication.

(10) Cables
(10.1) Cable protection and fixing arrangements;
(10.2) The specified materials of cables and all associated parts;

(11) Safety and health in shipping
Safety measures for accident prevention in the following area:
(11.1) Work in confined spaces and dangerous atmospheres;
(11.2) Work with dangerous and irritating substances and radiations;
(11.3) Work on boilers, engines and machinery of vessels;
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           - the yard’s preparation
   (14.2) Organizational and administration;
           - layout of yard,
           - yard organization,

           - division of responsibility and
           authority,
           - the co-operation of the ship and yard’s
           management team.
6.7 Other Training for Every Course

6.7.1 One-month as observer on board a cargo vessel

A participant who never have an experience on board a cargo ship.

The required period of observing on board a cargo vessel is necessary on assumption that this would enable the participant to obtain a good understanding and a real life experience of ship operating conditions. Thus, it can support the knowledge in repairing the ship. Furthermore, it should be emphasized that in any repair work on a ship the best result will be obtained when there is a good understanding and close co-operation between the parties involved, i.e. the yard, the shipping company and the ship.

6.7.2 Six-months as apprentice at a shipyard

The purpose of an apprentice ship is to ensure that the newly recruited personnel would be systematically trained beforehand, to permit their integration into the existing organization with minimum disturbance to the running productive activities.
Chapter 7

Conclusion, Implementation and Recommendation

7.1 Conclusion

At present, Thailand's shiprepair industry has not been well developed to satisfy the growing demand of national merchant marine business due to the limitation of the existing shipyard's capacity. As a result, there was a need to study the requirement for expanding the shiprepair capacity. Therefore, the 40,000 DWT dock size has been proposed by the author after considering the influence factors such as the future trend of the Thai shipping and the port development.

According to the author's proposal, if the new ship yard scheme has been implemented the author believed that the yard will face the difficulty in the beginning of running business due to the lack of experiences in the large scale shiprepair. In order to eliminate this problem, the shipyard's manpowers have to be educated and trained. However, at present, there is no an educational institute that provides such a shiprepair course in Thailand.

Therefore, the author has proposed the series of shiprepairing courses by the means of concerning the requirements of shiprepair
works as well as the requirements from the involved parties i.e. the shipowners and the classification societies and regulatory agencies. This will only be the first step to take until manpower development in public education institutions in Thailand have been established. However, the courses have been conducted particularly for the repair engineers who will be the vital tradesman for shiprepairing operation and they are also the most shortage tradesman in term of quantity.

When looking at a course, its objective cannot be obtained if there are still some lack in support factors such as instructors who will present the course. The next section will discuss in details about the implementation of the courses.

7.2 Implementation of the shiprepair courses

For the course to run smoothly and to be effective, considerable attention must be paid to the availability and use of:

- properly qualified instructors;
- teaching facilities and equipment, and
- teaching aids

7.2.1 Instructor

A minimum of three groups of instructors is required to implement the program successfully. Each group of instructor must have an appropriate background in a particular discipline as follows:
Group 1: Experience in large scale hull repair combine with technical background.

Group 2: Experience in machinery repair combine with the qualifications as a chief engineer of an ocean-going cargo vessel.

Group 3: Experience in electrical repair of a cargo vessel.

Furthermore, all instructors should have a good knowledge of rules and regulations requirements related to their fields as laid down by the involved parties such as IMO conventions, classification societies and regulatory agencies' rules. The good knowledges in safety operation and anti-pollution measures are also required.

Thus, the number of existing qualified instructors, as mentioning above, are insufficient in Thailand. Therefore, for the author's opinion, some Thai engineers who has an appropriate background in shiprepairing in each group should be sent to some developed shiprepair countries in order to get training in various technical matters. The country like Japan, for example, which give aid in both financial and technical cooperation to developing countries by government funds. The technical cooperation such as development survey dispatch of experts and training are carried out through the Japan International Cooperation Agency (JICA). The financial cooperation such as yen loans are offered through the Oversea Economic Cooperation Fund (OECF).
7.2.2 Teaching Facilities and Equipment as well as Teaching Aids

Classroom facility, including teaching equipment such as overhead projector and slide projector, are sufficient for lecturing sessions when making use of video tapes or films, the appropriate equipment should also be available. In addition the necessary equipment such as marine engine, marine boiler, auxiliary machinery, work shop machines, electrical marine equipment fire fighting etc. should be also available.

Teaching aids such as textbooks, references and bibliography which related to the learning area of the courses should be available as much as possible.

For the requirements of teaching facilities and equipment as well as teaching aids, the author would like to suggest the Merchant Marine Training Centre which is responsible for training marine engineers is the most suitable place for fulfilling the courses because some of the principal equipment needed is already exited. In addition, the fire fighting facility and the training vessel are also available whereas the shipyards itself and other educational institutes do not have such facilities and equipment.

7.3 Recommendation

This section will discuss in the long term development of shiprepairing industry in Thailand. The discussion will be divided into two parts. Firstly, the development of the private sector who run the
operation of the shipyard. Secondly, the support measures from the government.

7.3.1 The development of private sector

The expansion of shipyard capacity and the education and training of manpower, as discussed earlier, are only the short term development. For the long term development, a shipyard has to improve its capacity toward to more sophisticated works such as ship conversion and modification, shipbuilding and industrial engineering activities. In this way, it will be useful for the yard in bringing in revenue during periods of slack repair volumes. In order to implement this task, shipyard’s facilities, equipment, technologies and manpower’s capacities have to be improved simultaneously and systematically.

Furthermore, it should be mentioned that all changing aspects in shiprepairing and related matters are studied and analysed with carefully because changing in one aspects may impact on others. For example, changing in the principle of ship design such as a shallow draught and wide beam cargo vessel may require the adaption of shipyard’s capacity in the future. Development in ship’s automation system also leads to the requirement of sophisticated repair. The improvement in repairing technologies, such as underwater hull repair, need new equipment as well as new skills and knowledge of manpowers. The strengthen rules for environment standard requires special equipment and qualified expertise.
The following examples in Figure 7.1 and Figure 7.2 are the impact of technological development on the shiprepair industry both in the past and the future trend. The author believed that it will be some useful reference for Thai shipyard operators who start studying in the model shiprepair business.

In short, the applied shiprepair technology as well as human resource and management techniques should be all closely monitored in order to meet the objective of the long term ship repair development.
FIGURE 7.1
TECHNOLOGICAL DEVELOPMENTS IMPACTING
SHIP REPAIR OVER THE PAST

TECHNOLOGY AREA/IMPROVEMENT

<table>
<thead>
<tr>
<th>TECHNOLOGY AREA/IMPROVEMENT</th>
<th>EFFECT ON REPAIR INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDERWATER HULL CLEANING - MANNED (e.g. SCAMP)</td>
<td>INCREASE INTERVALS BETWEEN DRYDOCKING</td>
</tr>
<tr>
<td></td>
<td>REDUCE WORK DONE IN YARD</td>
</tr>
<tr>
<td></td>
<td>REDUCE LENGTH OF DRYDOCKING</td>
</tr>
<tr>
<td>UNDERWATER HULL SURVEY/DAMAGE ASSESSMENT</td>
<td>REDUCE DRYDOCKING TIME</td>
</tr>
<tr>
<td>UNDERWATER WELDING WITH DIVERS</td>
<td>DRYDOCK REPAIR CAPABILITY</td>
</tr>
<tr>
<td>CATHODIC HULL PROTECTION</td>
<td>AT-SEA REPAIR CAPABILITY</td>
</tr>
<tr>
<td>ANTI-FOULINGS - REMOVABLE BY SCRUBBER</td>
<td>ELECTRONIC EQUIPMENT</td>
</tr>
<tr>
<td>SELF-POLISHING BIocide coatings</td>
<td>SKILL REQUIREMENTS</td>
</tr>
<tr>
<td>IN-WATER HULL PAINTING</td>
<td>MANPOWER REQUIREMENTS</td>
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<tr>
<td>EXPLOSIVE HULL SCALING</td>
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<tr>
<td>HIGHER-PERFORMANCE ANTI-CORROSIVE COATINGS</td>
<td></td>
</tr>
<tr>
<td>USE OF CRUDE OIL TANK CLEANING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>INCREASED USE OF DIESEL ENGINES</td>
<td></td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; GAS TURBINE ENGINES</td>
<td></td>
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<tr>
<td>BORESCOPE INSPECTION OF GAS TURBINES</td>
<td></td>
</tr>
<tr>
<td>CHROMIUM ELECTROPLATING OF MACHINE PARTS</td>
<td></td>
</tr>
<tr>
<td>IMPROVED MACHINERY MONITORING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>ON-BOARD ENGINE REPAIR CAPABILITY</td>
<td></td>
</tr>
<tr>
<td>LONG-LIFE STERN TUBE BEARINGS</td>
<td></td>
</tr>
<tr>
<td>STEERAGE BEARINGS - REPLACEABLE AT SEA</td>
<td></td>
</tr>
<tr>
<td>HYDRAULIC SUPPORTS IN LIEU OF BLOCKS</td>
<td></td>
</tr>
<tr>
<td>ELEVATED PLATFORM REPLACE DRYDOCK SCAFFOLDING</td>
<td></td>
</tr>
</tbody>
</table>
TECHNOLOGY AREA/IMPROVEMENT

- UNDERWATER WELDING - UNMANNED
- DEVELOP LASER CUTTING/JOINING TECHNIQUES
- MECHANICAL HULL SCRUBBERS AT PORT ENTRANCE
- DEVELOP CORROSION-RESISTANT STEEL
- DEVELOP AUTOMATIC NAVIGATION SYSTEM
- DEVELOP AUTOMATIC COLLISION AVOIDANCE SYSTEMS
- RE-INTRODUCE COMMERCIAL NUCLEAR PROPULSION
- DEVELOP HIGH-EFFICIENCY ELECTRIC PROPULSION
- STANDARDIZE ENGINE/MACHINERY COMPONENTS
- MODULARITY IN ENGINE/MACHINERY COMPONENTS
- INCREASING USE OF WIDE BEAM, HIGH CAPACITY VESSELS
- AUTOMATIC STORAGE/SECURING OF PALLETTIZED CARGO
- INTERNATIONAL ACCORD-RETROFITTING SBT's

<table>
<thead>
<tr>
<th>EFFECT ON REPAIR INDUSTRY</th>
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<th>REDUCE WORK DONE IN YARD</th>
<th>REDUCE LENGTH OF DRYDOCKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIESEL REPAIR CAPABILITY REQUIRED</td>
<td>NUCLEAR REPAIR CAPABILITY REQUIRED</td>
<td>GAS TURBINE REPAIR CAPABILITY REQUIRED</td>
<td>UNDERWATER REPAIR CAPABILITY REQUIRED</td>
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<tr>
<td>AT-SEA REPAIR CAPABILITY REQUIRED</td>
<td>ELECTRONIC EQUIPMENT REPAIR CAPABILITY REQUIRED</td>
<td>INCREASED SKILL REQUIREMENTS</td>
<td>INCREASED DRYDOCKING REQUIREMENTS</td>
</tr>
</tbody>
</table>

SOURCE: A SHIP REPAIR MARKET ASSESSMENT (J.R McCaul, S.W.Phillips)
7.3.2 The government's support measures

In promoting shiprepair, there are various measures the government can take. As shown in Chapter 4, taxation measures, financial assistance as well as investment incentives and privileges are good examples. However, in this section, only technological supports will be recommended.

One key factor for the future of the shiprepairing industry in Thailand is depended upon how far facilities and technologies are developed. The extension of technology are time consuming and expensive process. It is difficult to carry out by individual shipyards separately. Therefore, the establishment of public organ, which give sophisticated technical advices for the shiprepair industry is necessary. However, at the beginning, all new technologies for shiprepairing activities should be introduced to the personnel of the new organization through technical assistance from developed shiprepair countries.

The following is a listing of required personnel for the new organization:

- Naval Architect
- Marine Engineer
- Material Engineer
- Welding Engineer
- Electrical Engineer
- Electronic Engineer
- Computer Engineer
- Ship operation Expert
- Regulation Expert
- Environmental Expert
- Economist

The author believed that the certain improvement by this government department can improve opportunities for the shiprepair industry.
Appendix

Program structure in Mechanical Engineering (program in Marine Technology) at Chulalongkorn University.

<table>
<thead>
<tr>
<th>Program Structure</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Total credits</td>
<td>145</td>
</tr>
<tr>
<td>2 General Subjects</td>
<td>42</td>
</tr>
<tr>
<td>2.1 Social Sciences</td>
<td>6</td>
</tr>
<tr>
<td>2.1.1 Man and Society</td>
<td>3</td>
</tr>
<tr>
<td>2.1.2 Society and Culture</td>
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</tr>
<tr>
<td>2.2 Humanities</td>
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<tr>
<td>2.2.1 Civilization</td>
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<tr>
<td>2.2.2 Electives</td>
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<tr>
<td>2.3 Languages</td>
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<td>2.3.1 Foundation English 1</td>
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<td>2.3.2 Foundation English 2</td>
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<td>2.4 Sciences and Mathematics</td>
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<td>2.4.1 Chemistry</td>
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<td>2.4.1.2 General Chemistry Laboratory</td>
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<tr>
<td>2.4.2 Physics</td>
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<tr>
<td>2.4.2.1 General Physic 1</td>
<td>3</td>
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<tr>
<td>2.4.2.2 General Physic 1 Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

118
- General Physic 2
- General Physic 2 Laboratory

2. Mathematics
- Calculus 1
- Calculus 2
- Calculus 3
- Statistics for physical science

3. Engineering Subjects
3.1 Basic Engineering Courses
- Introductory to Engineering
- Engineering Graphics 1
- Engineering Mechanic 1
- Engineering Materials
- Manufacturing Processes
- Engineering Tools Operation
- Engineering Management
- Computer Programming
- Engineering Practice

3.2 Core Subjects
- Electrical Engineering 1
- Electrical Engineering Laboratory 1
- Electrical Engineering 2
- Electrical Engineering Laboratory 2
- Machine Design 1
- Machine Design 2
- Machine Mechanics 1
- Mechanical Drawing
- Fluid Mechanics 1
- Fluid Mechanics 2
- Thermodynamics 1
- Engineering Graphic 2
- Mechanics of Materials 1
- Mechanical Engineering Laboratory 1
- Numerical Method for Mechanical Engineering
- Mechanics of Machinery
- Thermodynamics 2
- Mechanical Engineering Laboratory 2
- Differential Equations
- Mechanical Engineering Project

3.3 Technical Subjects
- Ship Resistance and Powering
- Ship Buoyancy and Stability
- Ship Design 1
- Shipbuilding Engineering
- Refrigeration
- Power Plant Engineering
- Internal Combustion Engines
- Calculus 4
- Technical Elective

4 Free Elective
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