China's Potential and Global Strategy in Shipbuilding Industry

by

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Abstract

Shipbuilding, perhaps more than any other industry, has been subject to a major shift in geographic distribution in recent years. In the post-World War II period, the British shipbuilders succumbed to the other western European shipbuilders who by then commanded the most sophisticated technologies. Before long, however, these western European shipbuilders lost their market share leadership to the Japanese. Today, a potential challenge to the indomitable Japanese shipbuilders is coming from South Korea and other NICs.

In shipbuilding industry, a lot of people have predicted that China may well emerge as the industry leader toward the end of the twentieth century. But no one in western countries goes to the depth to do some research to analyze where on earth the comparative advantage exists in China's shipbuilding industry.

In my thesis, I am trying to introduce the China's shipbuilding industry in detail and use Michael Porter's theory about competitive advantage to analyze where the competitive advantage and disadvantage of China's shipbuilding industry are. Michael Porter's insight has been to highlight the reasons why certain industries are so strong in certain countries and vital importance of "clusters" of industry environment. By analyzing the historical global shifts of shipbuilding industry, we could see the interaction among the determinants in the shipbuilding industry and how the effectiveness of these interactions decides the competitive advantage of nation's shipbuilding industry. The large source of labor and enormous domestic demands of the ships are one of China's advantage. With the help of license agreements and joint ventures, China is fagging to establish its reputation in shipbuilding industry in a short time. I will suggest a cost focus strategy for China's shipbuilding industry at the present time. When the industry goes into maturity, China could adopt cost leadership strategy to compete other shipbuilding nations.

Thesis Supervisor: Frankel E.G.
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Chapter 1

Introduction

1.1 Global Trends

In the progress from birth to aging, shipbuilding industry experiences different forces which compel a shift in geographic distribution. At a time when, the world's merchant vessels were still made of wood, the United States was an undisputed leader in the shipbuilding industry with its abundant supply of cheap timber. With the advent of the steam-powered steel ship, however, the supremacy of the U.S. shipwrights was quickly eroded by the British shipbuilders, who by 1882 captured 80 percent of the world's shipbuilding market. In the post-World War II period, the British shipbuilders succumbed to the other Western European shipbuilders who by then commanded the most sophisticated technologies. Before long, these Western European shipbuilders lost their market share leadership to the Japanese (table 1.1). After 1965, Japan firmly established its leadship and held on to it with almost 50 percent of the world market.

Ever since the precedent set by Japan, shipbuilding has been perceived as key player in modernization of society and the furthering of national development which follows from industrialization. Shipbuilding is an enticing tool of development for three reasons. In the first place, it is a medium-technology industry which appears to conform to the factor-cost advantages of NICs. Thus, technology does not act as a barrier to entry on the one hand, and the labor-intensity of the industry works in favor of countries with large, cheap labor forces. Mr. Yoshio Miwa, Managing Director of Hitachi Zosen explained to *Marine Engineers Review* that more automation was not the complete answer at the existing level of technology because over 50% of ship construction could not be automated[58]. Secondly, the market is peculiarly open, which is to say, customers for ships are truly found all over the world. The existence of flags-covenience fleets adds to the emphasis on price competitiveness in the market and allows shipowners to circumvent market protection imposed by national governments. A newly-emergent producer, capitalizing on low factor costs, can offer competitively-priced ships which rapidly find customers in such an open market. Thirdly, shipbuilding has strong linkages with other industries. It should, therefore, serve to foster other nascent industries in the NICs. For example, shipbuilding acts as a stimulant to a host of steel-making and machinery sectors: all vital to the industrialization of the country. Not surprisingly, therefore, shipbuilding has been singled out by a number of countries in recent years as deserving of special treatment. Today a potential challenge to the indomitable Japanese shipbuilders is coming from South Korea, the People's Republic of China and other newly industrialized countries(NIC)(table 1.2).

Surveying the history of shipbuilding one can immediately raise a lot of questions: What caused the shift of leadship in shipbuilding over time? Why did certain nations achieve particular success in shipbuilding at a certain time? Who will be the next?

1.2 Classic Competitive Advantage Theory

There is a long history of efforts to explain international success in industries in the form of international trade. Adam Smith's original statement of the case for trade, contained in his epic *The Wealth of Nations (1776)*, was couched in terms of absolute cost differences between the countries. That is, Smith assumed that each country could produce one or more commodities at a lower real cost than its trading partners.

Table 1.1: Merchant ships completed by Japan 1960-1991[49]

Year	No	1000 grt/gt	grt/gt–% of world completions
1960	653	1838.7	21.9
1965	699	4885.6	41.5
1970	1037	10100.0	48.1
1975	930	16991.2	49.7
1980	943	6094.1	46.5
1981	839	8399.8	49.6
1982	800	8162.9	48.5
1983	755	6670.3	41.9
1984	902	9711.4	53.0
1985	817	9502.8	52.3
1986	648	8178.0	48.5
1987	616	5707.9	46.6
1988	598	4040.2	37.0
1989	640	5364.6	40.5
1990	633	6824.1	43.0
1991	602	7282.8	45.2

Table 1.2: New Building On Order–Fairplay

	Japan		South Korea		China	
Year.month	Total dwt (1000)	dwt-% of world	Total dwt (1000)	dwt-% of world	Total dwt (1000)	dwt-% of world
93.1	24,664	38	13,052	20	4,183	6.5
92.1	28,901	41	15,480	22	2,905	4.1
91.1	29,228	40.5	15,503	21.5	2,218	3
90.1	18,984	33.3	13,079	23	1,439	2.5
89.4	11,652	27.9	10,783	26	1,165	2.8
88.1[1]	8,445	25.3	10,783	32.2	1,404	4.2
87.1	9,533	28.3	8,484	25.2	1,867	5.5
86.1	17,790	41	8,426	19.5	1,888	4.4
85.1	23,433	43	10,785	19.8	1,829	3.4
84.1	28,795	43	11,503	17	1,908	2.8
83.1	19,137	34.4	5,235	9.4	1,468	2.6
82.4	24,054	36.6	6,260	9.5	1,424	2.2
81.2	27,885	40.7	4,914	7.2	848	1.2
80.2	20,277	33.3	4,387	7.2	437	0.7

It then follows that each country will benefit from specialization in those commodities in which it has an "absolute advantage" (for example, can produce at lower real cost than another country). "Real cost", for Smith, meant the amount of labor time required to produce a commodity.

David Ricardo clearly showed, in his *Principles of Political Economy (1817)*, that absolute cost advantage are not a necessary condition for two nations to gain from trade with each other. He recognized that market forces will allocate a nation's resources to those industries where it is relatively most productive. This means that a nation might still import a good where it could be the low-cost producer if it is even more productive in producing other goods. In Richardo's theory, trade was based on labor productivity differences between nations. He attributed these to unexplained differences in the environment of nations that favored some industries. The dominant version of comparative advantage theory, due initially to Hechscher and Ohlin, is based on the idea that nations all have equivalent technology by differing in their endowments of so-called factors of production such as land, labor, natural resources, and capital. Factors are nothing more than the basic inputs necessary for production. Nations gain factor-based comparative advantage in industries that make intensive use of the factors they possess in abundance. Nations with abundant low-cost labor will export labor-intensive goods, while nations with high technology will export capital-intensive goods. The assumptions underlying factor comparative advantage were more persuasive in the eighteenth and nineteenth, when many industries were fragmented, production was more labor- and less skill-intensive, and much trade reflected differences in growing conditions, natural resources, and capital.

It has become generally recognized, however, that these theories have grown inadequate to explain the current issues. Evidence hard to reconcile with factor comparative advantage is not difficult to find. Korea, having virtually no capital after the Korean War, was still able eventually to achieve substantial exports in a wide range of relatively capital-intensive industries such as shipbuilding, steel, and automobiles.

Most important, however, is that there has been a growing awareness that the assumptions underlying factor comparative advantage theories of trade are unrealistic in many industries[6]. The standard theory assumes that there are no economies of scale, that technologies everywhere are identical, that products are undifferentiated, and that the pool of national factors is fixed. The theory also assumes that capital does not move among nations. All those assumptions bear little relation, in most industries, to actual competition. Especially, governments can alter factor advantage either overall or in specific sectors through various forms of intervention. Governments have, rightly or wrongly, implemented various policies designed to improve comparative advantage in factor costs. Examples are reduction of interest rates, efforts to hold down wage costs, devaluation that seeked to affect comparative prices, subsidies, special depreciation allowances, and export financing addressed at particular sectors. Each in its own way, and over differing time horizons, these policies aim to lower the relative costs of a nations' industry compared to those of international rivals.

1.3 New Competitive Advantage Theory

Michael Porter, the American business guru, in his book, *The Competitive Advantage of Nations*(1990), analyzed the theoretical framework to explain why certain nations achieve particular success in certain industries. Fundamental to his study was the interaction between four main attributes forming the Porter " Diamond "(figure 1-1)

- **Factor conditions** are the fundamentals of production which enable a country to compete in certain industries and include raw materials, knowledge resources, capital resources, skilled labor and national infrastructure.

- **Demand conditions** are the nature of the domestic market for the industry's product. For example shipping industry in being very demanding customers plays an important role in the shipbuilding industry.

- **Related and supporting industries** is the presence in the nation of suppliers and related industries. The degree the depth of the maritime cluster and the wide range of services that can be supplied by the domestic market could greatly affect the competitive advantage of the shipbuilding industry.

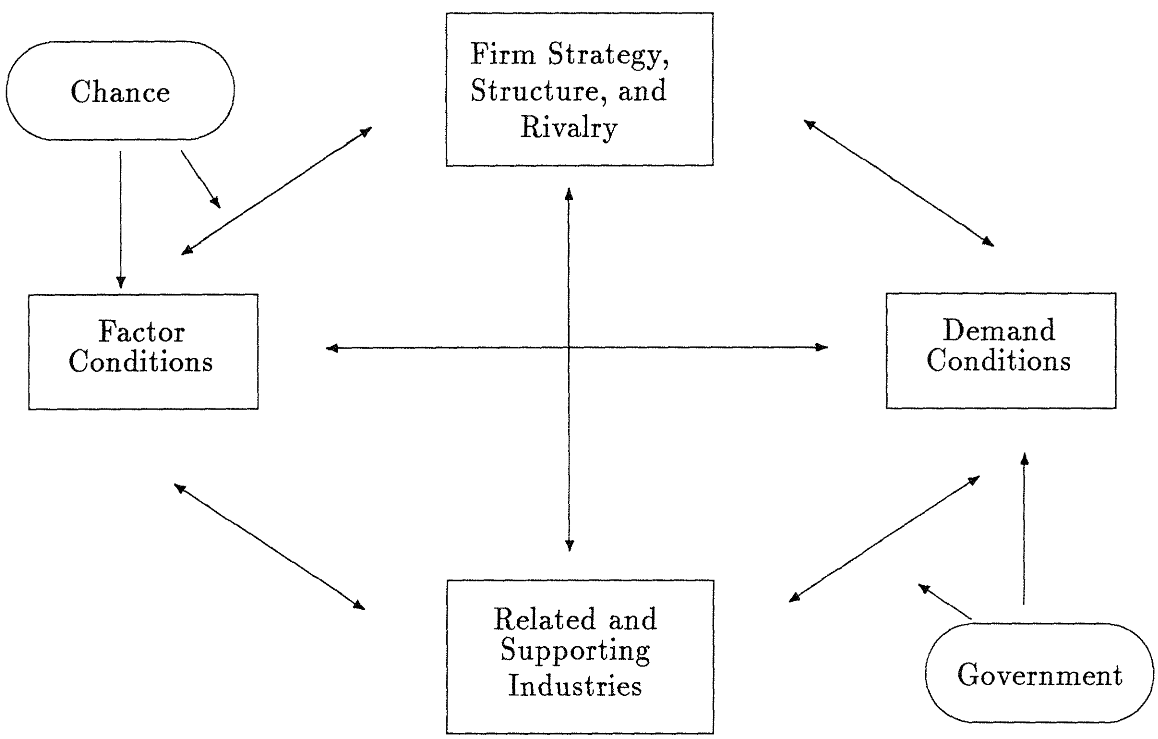
- **Firm strategy, structure and rivalry** reflects the depth of competition in the domestic market. For example, there are seven major shipbuilding concerns in Japan, which compete together so as to stimulate product innovations and the improvement of product process.

In addition to the four main attributes, two other factors can play a role; chance and government. Chance events are occurrences that have little to do with circumstances in a nation and are often largely outside the power of firms to influence. Acts of pure invention, discontinuities in input costs such as the oil shocks, significant shifts in world financial markets or exchange rates, wars etc. are particularly important in influencing competitive advantage as you can see when I talk about it in the chapter 2. Government policy in Japan and Korea is particularly associated with the success these nation's shipbuilding have enjoyed.

1.4 Organization of Thesis

During the last 10 years, Michael Porter has carved out a rapidly growing reputation for his work on competition. His insights have been highlighted the reasons why certain industries are so strong in some counties and pointed to the vital importance of clusters of suppliers, customers, rivals in the domestic market. I will use Porter's theory to analyze the competitive advantage of China's shipbuilding industry and recommend a strategy appropriate to China. In chapter 2, I will trace the development of that industry to test whether Porter's theory is valid for the shipbuilding industry. The operation and interplay of the determinants through the history of modern shipbuilding industry allow us to see the process in which the role of individual determinants shifts and changes in different countries. Nations are most likely to succeed in industries where the national "Diamond" is the most favorable. In chapter 3, the characteristics of the shipbuilding industry will be discussed because every industry is unique and has its own unique structure (In shipbuilding industry, for example, the major portion of the total cost is comprised of purchased materials and salaries of semi-skilled employees, whereas in pharmaceuticals industry, the major one is R & D). In order to have a clear picture of China's shipbuilding industry, in chapter 4, the present status of China's shipbuilding industry will be introduced. In chapter 5, I will analyze the competitive advantage of China's shipbuilding industry to determine how China can sustain its position as compared with Japan and South Korea and where any disadvantage exists, and I will suggest how the industry could overcome it. In chapter 6, I will recommend a global strategy for China's shipbuilding industry. My recommendations assumes that there are two basic types of competitive advantage the industry can possess: low cost or differentiation. These two lead to three generic strategies for achieving above-average performance: cost leadship, differentiation, and focus (cost focus and differentiation focus). After we know what the position of China's shipbuilding is, it will not be difficult to choose a global strategy. I hope that my thesis will contribute something to my country.

Figure 1-1: Michael Porter's Diagram



Chapter 2

Historical Changes In Global Leadership

Shipbuilding perhaps more than any other industry, is subject to quicker shift in geographic distribution. Britain and western Europe has increasingly declined relative to , first, Japan, and now newly-industrializing countries as well. The Japanese, for their part, are also evincing a degree of unease at the phenomenal rise of South Korea and other shipbuilding newcomers such as China. According to the Porter's theory, the interaction of the determinants in the diamond decides competitive advantage of the industry in a certain country. Gaining advantage requires a new approach to competing at a different time, whether it is perceiving and then exploiting a factor advantage, creating a new product features, changing the process by which a product is made, or changing policy, or facing the change of domestic and international demand. Comparative advantage is always in dynamic status. In order to understand the dynamic process by which national advantage was gained or lost in shipbuilding industry, it was necessary to study the industry's history.

2.1 Britain

2.1.1 Chance

The early nineteenth century saw two technological breakthroughs in the shipbuilding industry: the introduction of the steam engine and the use of iron and steel as shipbuilding materials. The steam engine, which had been invented by James Watt and which triggered the Industrial Revolution in England in the late eighteenth century, became widely used in ships by the 1830s. The British also pioneered in steel shipbuilding, taking advantage of the new steel-making technology developed by Bessemer in 1858. The introduction of the iron and steel hull tended to favor Britain as a shipbuilding center based on Britain's lead in the Industrial Revolution.

2.1.2 Demand and Factor Conditions

The British mercantile marine was the largest, most up to date and efficient of all the fleets in the world: it accounted for one-third of the world fleet and was almost four times the size of its nearest rival, Germany. British producers derived from the greater size of their market, which allowed for greater inter-yard specialization. The success of the British resulted from their having captured the expanding domestic market and much of the foreign market. This was a period when competing maritime nations lacked developed iron, steel, and engineering industries and sufficient skilled labor to supply shipyards. Having captured these markets, British producers drew a critical advantage from the greater extent of the market they commanded, resulting in a greater continuity of demand for different classes of vessels. This allowed British builders to achieve a degree of specialization that proved impossible in other maritime nations. The value of new merchant vessels accounted for approximately 1.25 percent of Britain's gross domestic product at the turn of the century, and the industry employed about 2 percent of the industrial labor force which enjoyed the high productivity(table 2.1). Between 1890 and 1914 the rate of growth of shipbuilding

Table 2.1: Comparisons of labor productivity in shipbuilding, 1900[43]

	Number employed	Tons constructed	Output per head (tons)
UK	85,000	1,290,369	15.2
USA	33,340	385,511	11.6
Germany	31,310	198,097	6.3
France	28,650	134,037	4.7

output exceeded that of the economy as a whole. Britain accounted for 60 percent of world output of ships and controlled some 80 percent of the world export market as late as 1913.

British yards on average showed a preference for more labor-intensive methods. Maybe the severity of cyclical fluctuations in shipbuilding output encouraged British producers to minimize capital expenditure in order to avoid the potentially crippling overhead costs that would be incurred during recessionary periods. The fact that most vessels were expensive custom-made commodities, built with the close consultation of the owner who usually would pay in installments while the vessel was being constructed, meant that a strategy of speculative construction and stockpiling shipyards necessarily faced periodic depressions in demand and output. This encouraged British builders to preserve labor-intensive methods and to lay off labor during cyclical downswings. In Germany and America, on the contrary, interest in technical efficiency rather than cost minimization, and in innovation for innovation's sake, led to capital investment which in strictly economic terms was unwise. British entrepreneurs in general at that time adopted the right technology for British conditions taking into account relative factor costs and factor endowments, and that Britain was therefore right to continue up to World War I to exploit comparative advantage in shipbuilding.

However, this leadership began to slip in the early twentieth century as the German and United States shipbuilding industries adopted significant innovations(including the diesel engine and the all-welded hull), and by the second half of the twentieth century as almost all major innovations in the industry were being adopted first by producers outside Britain. Despite the fact that the coated welding electrode, which made possible the general adoption of welded connections in the 1930s, was a British invention, the British shipbuilding industry was the last to continue to use riveting for the assembly of ships hull. It is an oft-cited view that pioneers in the field of technological development suffer a disadvantage relative to newcomers because of resistance to change, the effect of sunk costs and the inherent difficulty of introducing new techniques which do not conform to the specifications of existing plant and equipment. The British shipbuilding paid the penalty for being the pioneer of the modern shipbuilding industry, clinging more tenaciously than any other industry to practical experience and tradition. By 1939, many British shipyards were badly out of date. The equipment installed was inefficient, production methods such as welding and prefabrication were regarded with great suspicion and skepticism and the quality of design had fallen behind that elsewhere. The central reason for the decline of the British shipbuilding industry was the changing pattern of world demand for shipping[16]. Actually British shipping industry was slower to adopt tankers[23]. The failure to adjust promptly and suitably to the changing pattern of world demand for shipping and to the technological changes resulted in the fewer orders and lower productivity.

2.1.3 Supporting Industries

There is little doubt that Britain's lead in the process of industrialization would have ensured the shipbuilding rise of supremacy. British steel industry could provide cheaper and high-quality steel. However, slowness to change steam to diesel engine, to some part, results in the decline of British shipbuilding. Although more costly than steam engines, diesel engines had an efficiency of 35-40 percent rather than the 20-25 percent obtained from the use of steam. On the long-haul Europe-Australia routes, hypothetical calculations suggest that a motorship would have generated a net cash flow two-and-a-half to three times larger than either a coal-fired or oil-fired steamship[46]. Domestic reluctance to diesel engines made both ships built in Britain unattractive and marine engineer backward. Dependency on foreign technology in marine engineering has affected British shipbuilding industry. Loss of technological independence in marine engineering is symptomatic of a loss of competitiveness in the whole field of marine industries. It is difficult to assert that the decline in innovativeness in marine engineering is chiefly responsible for the decline in shipbuilding competitiveness: nevertheless, there is plenty of circumstantial evidence to suggest that, in the British case at least, the two went hand-in-hand[55].

2.2 World War II to late 1950s: Western European leadership

During the 1950s, the global economy was recovering from the devastation of World War II. Most Western European countries other than the United Kingdom made a conscious effort to expand merchant fleets. A survey suggested that steel prices in Britain in 1953 were 35 percent lower than in Japan[14]. Although wage rates were already high (20 to 30 percent higher than in Japan), highly advanced ship component industries, especially in the production of engines and on-deck machinery, enabled European builders to set the total price of vessels as much as 10 percent lower than Japanese builders. As a result, Western European builders had low costs together with excellent product quality, capturing 70 to 80 percent world market share.

The wage level in the United Kingdom was higher than in the rest of Western Europe, but its substantial scale economies in production, superiority in components(especially in electric components), and its credibility established over a long period of time enabled it to command 41 to 57 percent of the world market in the late 1940s. English shipbuilders competed with the global differentiation strategy.

2.3 Japanese leadership

2.3.1 Government Intervention

The Government-sponsored "Programmed Shipbuilding Scheme" which was introduced in 1947 was the most significant action taken by the state to promote the growth of its shipbuilding industries. It should be appreciated that until the early 1950s the Scheme was virtually the sole supplier of capital to the shipping firms and without it they would have been unable to have ordered tonnage from the shipbuilding companies. The basic foundation of the Scheme was that each year the Government should decide in advance how much and what type of tonnage should be constructed. This figure was to take account of the needs of the economy and was to be implemented by the provision of a building fund provided form public sources.

2.3.2 Chance Conditions

The Korean War in June 1950 had a rapid impact upon world shipping. As a result freight rates, which had tended to rise when the war began, received an extra boost and by the end of 1950 a full-scale boom was in progress. Thus the Freight Index of the British Chamber of shipping, which had stood at only 71 in May 1950, rose to 115 by the end of the year and to 203 (the highest since the ending of the Second World War) in May 1951. Japan, like all other nations, gained from the general upturn in world trade, and her geographic position close to the battlefield in Korea gave her economy some additional benefits. The accumulation of the profit at that time was of great significance in the future expansion of many industries with engineering, metal, wood and textiles receiving the largest boost. Shipbuilding, especially, had experienced a momentary prosperity during the Korean War. Their main European rivals were already fully occupied in meeting the sudden boom, so the way was open for the Japanese industry to fill the gap between demand and supply.

The need to increase the size of tankers to offset the rising cost of carrying crude oil over longer distances from the Persian Gulf to Europe stemmed from the unaccess to the Suez Canal in June 1956. Once started, the movement toward larger tankers gained momentum independently from the Canal's situation in order to achieve further reductions in transport costs. The closure of the Canal was one important element in this, but a number of other factors were also working in the same direction. One such was that after the Second World War oil refineries had tended to move from the producing to the consuming areas. At the existing level of technology this meant that more tonnage was required for a given level of demand, as at that time part of the crude oil that was transported could not be effectively refined into finished products. In addition the increased proportion of world oil which originated in the Persian Gulf, in place of that from America, increased the distance across which much of the crude had to be carried to the refineries. These factors, combined with a sharply increased oil consumption, created further demand for the larger, more efficient tankers. The scence was thus set for the creation of various specialized ships of larger size which proved to be economical for carrying particular bulky cargoes. This was enabled by the appearance of big manufacturing firms like steel-makers, each of which created a large demand for shipping services, for the lifting of their respective materials. The overall effect of these changing demands on shipping technology was beneficial to Japanese shipbuilders. This was because the process of nationalization had gone far enough to give the shipbuilders sufficient economies of scale that could lead the world in the new technology. The years from the ending of the Korean War in 1953 to the reopening of the Suez Canal in 1957 were crucial ones for the Japanese shipbuilding industry. It was during this period that Japan became the world's largest producer and established herself as an important exporter(table 2.2)

Table 2.2: Progress of Japanese shipbuilding, 1950-57[14]

Year	Order received (g.t.)	Percentage occupied by foreign orders %	Tonnage completed (g.t.)
1950	310,354	16	368,370
1951	612,952	38	472,490
1952	486,472	9	541,076
1953	412,140	40	664,037
1954	935,370	69	430,392
1955	2,656,432	86	756,695
1956	2,904,311	64	1,781,058
1957	2,044,861	56	2,355,854

2.3.3 Factor and Demand Conditions

Japan was instrumental in developing efficient construction of VLCCs and associated process innovations affected shipyard layout and management. Furthermore, it perfected the idea of the standard prefabricated ship, introduced by the US shipbuilding industry as the cornerstone of its wartime programme. Flow-line series-production techniques were initiated in US wartime shipyards. The Japanese benefited from the presence in their midst of Daniel Ludwig. The VLCC and standard-ship product innovations constituted the twin pillars upon which Japanese postwar shipbuilding supremacy was founded. Technological change plus a judicious mix of the other factors of production served to give the Japanese a definite cost advantage in ship construction. In the first place, they were able to arrive at an optimum block size in modular construction which emphasized the efficiencies of mass production. Secondly, they made use of parallel building methods such that assemblies for several standard ships could be in process of simultaneous building. In this manner, series-built ships allowed for bulk economies in materials purchases and minimum delays in construction time. The last factor, that of shortened delivery times, was furthered by the wide-scale adoption of pre-outfitting methods.

By the mid 1960s Japanese tanker prices were from 15 to 20 percent lower than UK prices and less than West German and Swedish prices by about half that amount. Their price advantage over those nations amounted to between 7.5 and 15 percent in the case of bulkers, although the Japanese edge in cargo liner prices was scarcely significant. These price advantages owed very little to labor cost differences. The average hourly wage rates in 1964 for the leading shipbuilding nations was estimated to be $3.00 for the USA, $1.69 for Sweden, $1.08 for West Germany, $0.96 for the UK, and $0.73 for Japan. The advantage afforded to Japan by cheap labor cost was neutralized by two factors. First of all, labor costs represented only about 20 percent of total ship production costs in most countries for most types of merchant vessels and therefore, any savings in labor, it was argued, could have but a marginal effect on the overall pricing of ships. Secondly, Japanese shipbuilders enjoyed a large price advantage in tankships; vessels that are less labor-intensive than other types of ship. If the costs advantage accruing to Japan stemmed from cheap labor, it would logically have shown itself in the price differences pertaining to cargo liners; a type vessel expensive in labor input but one, in which, Japan had little competitive edge.

Porter's theory claims that advanced factors are more important than others. Technology innovation needs a high level of research. Actually, technology innovation could improve factor and demand conditions such as cost reduction and more demand. The evolution of the economical hull form by IHI, for example, enabled weight reduction while boosting the ship's carrying capacity. One obvious outcome of the new hull form was a relative decline in the amount of steel needed for ship construction. A second outcome was of direct benefit to the shipowner; namely, an increase in freight-earning capacity per unit weight of the vessel constructed. More benefits accrued to the shipowner from the costs for the ship operator. The bulbous and cylindrical bows were employed by Nippon Kokan (NKK). In that case, energy was saved a lot. So shipowners will be more willing to buy the ships built by the technology-oriented shipyards. In production engineering, reductions in the thickness of ship's plates combined with greater economies in steel usage throughout the shipbuilding process led to a 36 percent cut in steel input per grt from 1958 to 1964 in large tanker construction. As steel costs tend to be the largest individual cost constituent of large tankers, it is not an accident that Japanese competitiveness in this market was considerably enhanced. Innovations were also implemented in the allied marine engineering field. The introduction of advanced admission thermal and reheat cycles enabled IHI to produce the world's most fuel-efficient steam turbine engine in 1966. Marine diesel technology was not neglected either. Application of turbo-charging techniques to make use of exhaust gas energy served to augment the output of a given size of engine by almost 35 percent. The Ministry of Transport (MOT) concluded that, as a direct result of improvements in shipbuilding techniques, the man-hours required to produce one gross ton of tanker dipped from 100 in 1958 to 40 in 1964 while, during the same time horizon, the amount of hull steel required for the identical unit output plunged from an index value of 100 to 64. The complementary process innovations effected a radical change in shipyard lay-out to accommodate the production of large standard ships built in prefabricated blocks. As early as 1949-54 the yards were reporting that the adoption of block building, prefabrication of parts and welding combined to cut material consumption by 17 percent. After a suitable gestation period, block fabrication by welding was able to accomplish a 30-40 percent paring of labor costs and was instrumental in slashing tanker construction times from about seven months to scarcely four months. These innovations afforded shipbuilders the opportunity to realize significant economies of scale in the fabrication of large vessels, especially when those vessels could be built in batches rather than single units. It was calculated that when the cost of building a 55,000 dwt tanker was accorded an index value of 100 per ton, the equivalent cost for a vessel of 100,000 dwt reduced to 78, a 150,000 tonnage registered 70, a 200,000 dwt tanker cost 67, but shipbuilders able to avail themselves of giant docks could produce 300,000 dwt VLCCs for as little as 45 per ton and 500,000 dwt ULCCs for a paltry 35 per ton. With these structural assets, Japan had already dominant share of the world tanker market.

The national economic growth resulted in the expansion of shipping, which developed more demand of ships to shipbuilding industries. The economic growth rate ran at well over 10 percent per annum in real terms from 1964 to 1972. Japan's expansion during this era was totally exported-oriented, so Japan's merchant shipping fleet grew from 9.1 million g.t. in 1964 to 34.9 million g.t. in 1973, an increase of 383 percent. In the meantime, shipbuilding industry grew rapidly so that vessels completed increased form 2.01 million g.t. in 1961 to 14.18 million g.t. in 1973[14].

2.4 South Korea Shipbuilding

2.4.1 Government Intervention

The spectacular growth of South Korea in shipbuilding, from rank 70th in 1975 to second only to Japan in the 1980s has been attributed to the policies of the Seoul government of granting subsidies and export credit to infant industries. The Koreans prefer to downplay the importance of government-arguing that apart from an initial five year tax break they receive on direct subsidies-and claim, instead, that their phenomenal success in shipbuilding is owned to largely efficient modern plant, low steel prices, and a cheap, highly-disciplined labor force. Wages, for instance, are about one third those paid by the Japanese. They have taken advantage, moreover, of technology transfer arrangements largely from Japan to acquire state-of-art ship design expertise. In fact, the truth of the matter lies in a combination of far-sighted government planning and entrepreneurial initiative quick and ready to grasp new opportunities in shipbuilding.

Hyundai built the world's largest shipyard at Ulsan. To a great extent, the risks taken by the Hyundai were guaranteed by the support given by President Park[56]. It was Park, after all, who arranged for the state to establish a shipping line to take over three VLCCs that Hyundai were building. Cancellation of this contract in 1975 presented Hyundai with the prospect of huge losses if the government had not, opportunely, stepped in to take necessity of Korea to carry out the pathbreaking step entailed in the establishment of the mammoth greenfield shipyard and he was not prepared to see Hyundai face bankruptcy. This example of the ultimate guarantee of government support for the shipyard projects was of immeasurable benefit to the chaebol, sufficing to make palatable projects which would otherwise have appeared to bear unjustifiably high risk. The government would brook no opposition to its vision of shipbuilding as a pillar of national economic development. It applied all its powers to sustaining the industry. Survival in oil crisis was sought in the dry cargo and Ro-Ro markets rather than in tankers, and the MCI made available additional export credits to entice overseas shipowners into ordering in South Korea. Rigidly enforced protectionism helped conjure up business for the yard. The government insisted, for example, that all domestic ships below 4,000 gt (13,000 gt from 1969) must be built at home and, in order to encourage orders, went on to offer subsidized loans to shipowners which bore interest rates of 7.5 percent as opposed to the normal bank rate of 25 percent.

Policies compatible with shipbuilding expansion were conducted with a vengeance by the government in the second half of the 1970s. Set on providing a "captive" market for the builders, Korea Maritime and Ports Administration (KMPA) declared its intention of ensuring that the country not merely adhered to the UNCTAD liner code on shipping, but bettered it. The KMPA, unimpressed by the proposed share for domestic vessels, wanted half of all cargo involved in the liner trades touching the country to be transported in Korean Ships by 1981. To that end, it disbursed loans to shipowners, notably to those in sympathy with its aim of subjecting 65 percent cargo movements to containerization associated with this fleet expansion, valuing in particular the receipt of orders for relatively sophisticated container ships.

2.4.2 Supporting Industries

The purpose of the establishing the Pohang integrated steel plant in Korea ensures the future self-sufficiency of many downstream activities, including shipbuilding. In spite of its ability to produce steel one-fifth cheaper than imported supplies, the Pohang steel mill could only provide 70 percent of the builder's needs. Reliance on foreign producers of expensive special equipment exacerbated the problems of supply[57]. The fifth five-year plan, initiated in 1982, was as attentive to the needs of shipbuilding as had been its illustrious predecessor. Attention was given to ancillary activities especially those capable of substituting for the engines, navigation equipment and special steels which had to be imported from Japan and, alarmingly, constituted up to 60 percent of ship values. To remedy that failing, the government asserted that local content must be raised to account for 90 percent of ship values by 1987. Marine diesel engines, in particular, were targeted for domestic production, and the aim was to eliminate imports altogether once the new plant had been erected. Valiant efforts were made by Ssangyong Heavy Industries, the part of the Ssangyong chaebol discharging the group's responsibility for diesel engines, to meet rising demands in shipbuilding. By December 1988 its cumulative sales of diesels surpassed the million bhp mark, and the company was confidently casting around for foreign shipyard customers for its engines[55]. In Hyundai Engineering & Machinery Corporation, the impressive facility's output has surged to secure world leadership in low-speed engine production in 1991. Performance maintained Hyunder's No 1 status in low-speed engine production, comfortably ahead of Mitsui of Japan which logged 10.7 percent of world output[34].

2.4.3 Factor Conditions

The days of low overheads and cheap materials for the Korea shipbuilding industry are at an end and all the yards now face a future with substantially rising costs for labor, materials and equipment. Labor costs in the past two years have risen for all the major yards by some 50 percent while the cost of shipbuilding steel has doubled between 1986 and 1988. The drive to reduce cost has led to substantial South Korea investment in research and development, particularly for computed-aided production. Increases in productivity have already been achieved, although the exact degree depended on the criteria used. At the end of 1990 there were 38800 people employed in shipbuilding, but by the end of 1991 this had declined to 31000. Despite these decreases in manpower South Korea Yards increased output. In 1990 they built 3.57 million gt and 4.43 million gt in 1991. The major yards aim to raise productivity by 15-20 percent by 1995 in an attempt to closes a significant gap with the Japanese industry. A typical Japanese yard will take 400,000 man-hours to build a VLCC whereas South Korea in 1992 required twice that much. But 1n 1987, they took 1.6 million man-hour[60]. Commitments have been made to invest in research and development at group level and at government centers. The shipbuilders are involved in a national computer ship design and production project with the Korea Research Institute for Ship and Ocean Engineering, universities and research institutes. The government-sponsored project targets the development and introduction of a computer integrated manufacturing system for the industry and embraces cost estimation, design, engineering, production and management by exploiting new computer technology. The project is divided into three phases over 14 years.

2.5 The Implementing of Michael Porter's Competitive Advantage Theory

Nations achieve success in international competition in situations where they possess advantage in the "Diamond". As we learn from studying in the process of historical leadership changes in the shipbuilding industry, it is hard to know where to begin to analyse competitive advantage. The interplay of the determinants is so complex as to obscure cause and effect. The national environment becomes more favorable over time as the "Diamond" restructures itself. A country's economic system is also constantly in motion. A national industry must continually evolve to reflect shifting circumstances, or will fall into decline.

National competitive advantage in the shipbuilding industry is lost, however, when conditions in the national "Diamond" no longer support and stimulate investment and innovation to match the industry's evolving structure. The national industry may not perceive needed change, may fail to invest aggressively enough to advance, or may be blocked by having assets and skills that are specialized to outmoded ways of competing and that make responding to change more profitable to newcomers. It is an ofted-cited view that pioneers in the field of technological development suffer a disadvantage relative to newcomers because of resistance to change, the effect of sunk costs and the inherent difficulty of introducing new techniques which do not conform to the specifications of existing plant and equipment. This suggests a hypothesis of "disadvantage of beginning" which implies that the younger the age of capital stock, the better the prospects for technical progress; conversely, the possibilities of technological innovation become increasingly limited as the capital stock grows older. As we saw before, the decline of shipbuilding in Britain proved this. Technological change is often a trigger for shifts in national competitive advantages and it can nullify old competitive advantage and create the need for new ones. Japan adopts new technologies and new production process to nullify the old competitive advantage in terms of productivity in western countries. The consequence was that the new technology put all the established European shipyards at a comparative disadvantage: most of them occupied cramped sites which could not easily be adopted to the radically different flow and organization of work, and investment new sites was rarely justified in the light of the European industry's declining market share. However, despite this, some European shipyards, particularly in Germany and Norway, did adopt similar techniques in response to the competitive threat of the Japanese industry. In fact, these Western European countries still advance in sophisticated types like cruiseships and containerships because they realize the necessity of research.

Rising factor costs are also a common threat to competitive advantage. The reason why South Korea jumps to the second position was its low labor cost at the beginning. Why Japan still can sustain its first position is that Japan has realized the importance of increasing the productivity by decreasing the cost of labor through robotics and introduction of new production processes. The productivity is increasing by an average 5 percentage per year. This improvement tends to be offset by wages and various yard expenses which have been rising every year. The gap between technology though is shortening much faster than the difference in wages. Japan's shipbuilding industry will meet much great challenge from new industrializing countries. But it is due to the advanced suppliers that makes Japan keep leading almost 30 years until now. Because overall industrial level is difficult for one country to catch up with in a short time.

As to the domestic rivalry, the nation like Japan which functions as the world leadership does need to compete vigorously at home and pressure each other to improve and innovate. But as an infant industry like in NICs, if there is a lot of domestic rivalry to compete each other in price bidding and technology transfer from advanced shipbuilding nations in the similar time, it would lead to duplication of efforts and prevent each firm from gaining economics of scale. For example, if South Korea shipyards had competed against each other fiercely at the beginning of the development of shipbuilding industry, it would have been impossible to emerge as today's strength. The right strategy in one nation in my opinion is that at the starting time, firms should corporate with each other and gain economics of scale; at the mature stage, firms should be encouraged to compete to nullify the types of advantage that come simply from being in the nation, such as low labor cost in the infant period to force them to seek high-order and ultimately get more sustainable sources of competitive advantage.

Chance is often involved in helping to accelerate the process by which an industry upgrades and penetrates international markets. A chance event such as the closure of

Sulz Canal created a discontinuity that nullified the advantage of traditional leaders and allowed Japanese shipyards leaped ahead. Government intervention helped Japan and South Korea develop their industry in the premature period. A principal factor in Japanese postwar shipbuilding success was the co-ordinating role of the Ministry of Transport which formulated areas of research, funded research efforts, and pooled the results of both private and government enquires during the 1960s. And in South Korea case, the shipbuilding is the result of the state planning.

The strength of the Japanese maritime cluster encompassing shipping, shipbuilding, equipment supply, research, education and training, financial status is significant. This is why Japan still keep its first position in shipbuilding industry until now.

Chapter 3

Characteristic of Present Shipbuilding Industry

3.1 Shipbuilding Organization

3.1.1 Shipbuilding Enterprise

Shipbuilding enterprises come in two distinct groups: those that engage purely in shipbuilding (perhaps including some of its ancillary trades such as marine-engine building) and those that are diversifies enterprises where shipbuilding is only one of portfolios of interests that may have very little in common. There are strengths and drawbacks associated with each of those forms of organization: so much so that they are frequently all found within a national shipbuilding industry.

Shipbuilders belonging to diversified corporations have the advantage of being able to rely on corporate resources for expansion and sustenance which are independent of the conditions applying gin the shipbuilding market. Consequently, in periods of shipping recession, the shipbuilding member of the group can call upon reserves acquired in other market areas in order to overcome short-term cash-flow difficulties. Moreover, this shipbuilder may be able to use group resources to modernize its production facilities at a time when independent shipbuilding firms are being obliged to cut back their overheads and capacity: hence, the shipbuilding member of the group can boost its competitive position relative to other shipbuilders. The flexibility inherent in within-group transfer of resources to the benefit of shipbuilding operations has played no small part in the success of Japanese and South Korean shipbuilders. In Japan, five of Japan's six major shipbuilders had connections with larger, diversified enterprises. The largest, Mitsubishi(MHI), derived only 19 percent of its sales from shipbuilding and steel structures. The bulk of revenues arose out of its operations in engine building, machinery, industrial plants, and other activities. Shipbuilding currently accounts for about 60 percent of the Hyundai(the world's largest shipbuilder) group's total turnover. There are now plans to reduce this to 50 percent[20]. In yet other respects, group membership can be advantageous. In the first place, the shipbuilding member can avail itself of Research & Development (R & D) initiatives sponsored by the group: initiatives that are likely to be on a more lavish scale than the shipbuilder could support if it was reliant on shipbuilding profits alone. In the second, diversified companies are, in the main, large enterprises and as such, command respect in industrial, financial and political circles. This respect may be manifested through easier access to capital markets. Financial institutions are reluctant to loan because of OPA 90. On the other hand, there are drawbacks to group membership notwithstanding these clear advantages applying to diversified companies. Unfortunately, this kind of organization can easily lead to inflexible decision-making. Hierarchical channels tend to stifle free flow of ideas and this may have a crucial bearing on both the generation of innovations through R & D and their subsequent acceptance as new production methods or new products.

3.1.2 Shipyard Organization

The shipyard is essentially an assembly plant geared to the assembling of structural steel units. Yet it has an important subsidiary manufacturing role, cutting, shaping and otherwise fabricating sheet and plant steel and pipe in conformity with the specifications of ship design. Sophisticated shipyards may also undertake the manufacture of propulsion machinery, but to all intents and purposes, shipbuilding is mainly hull-construction with the option of undertaking machinery manufacture and outfitting as well. At one extreme, some shipyards merely construct hulls, "buying-in" machinery and other fittings and leaving the installation of such items to specialist sub-contractors. At the other extreme, some shipyards are virtually self-sufficient entities providing steel, machinery and furnishings almost entirely from their own resources. Perhaps the typical shipbuilder is an organization possessing some facility for ship design, while undertaking the full range of hull construction functions, and engaging in various aspects of outfitting activity. In addition to the obvious "human capital" requirements for design staff and managerial personnel, a typical shipyards has need of a basic inventory of capital plant and equipment.

Hull construction can be conveniently subdivided into three production phases: stockyard activity, steel preparation, and steel fabrication. If traditional shipbuilding was concerned with a series of sequential steps involving fabrication and assemblage of individual parts in a piece-by-piece manner, then modern shipbuilding is concerned with fostering batch production of standardized components and mass production. This switch is undertaken in order to simplify production as much as possible and therein reduce the amount of expensive skilled labor in the shipyard by replacing it with automated equipment. Consequently, the shipyard has become less labor-intensive and less demanding in the skill mix of the workforce remaining within the more automated shipbuilding process. A natural corollary of the move towards simplification of production and control of wage costs has been the tendency to abandon the ancillary machinery and outfitting functions to outside sub-contractors, leaving the shipyard to concentrate on hull construction Shipbuilders in Japan have made major use of subcontractors in the outfitting trades for outside labor so that they can avoid severe cut-backs in their own work forces during the recession.

3.2 Ship Prices and Costs

The success of the individual shipyard in remaining in business rests on its ability to command favorable factors of production. These embrace labor, capital and technology which constitute the costs of running the shipyard and thereby, the costs of building ships. It follows that a cost-effective supply of factors of production is tantamount to the shipyard offering a competitively-priced ship. By 1978, tonnage on order had dropped to 20 percent of the peak 1974 levels and has remained close to that ever since. Shipbuilding capacity has not been sufficiently reduced to match the low demand levels. Increased productivity and excess capacity and competition from developing countries have kept a downward pressure on prices. Responding to the protracted slump in tankers since 1973, yard closures and yard restructuring have occurred and these measures have reduced the capacity and demand imbalance. The buyers choose shipyards to build most ships except those sophisticated ships(table 3.1) according to the price mainly because of the low freight rate in shipping market. The normal linkage of prices to costs became strained as builders had to absorb an increasing proportion of their overhead expense to make prices attractive enough to win contracts. It does not necessarily follow, however, that ship prices will be faithful representations of ship costs. In a highly competitive market, shipbuilders will adopt pricing strategies that are deemed capable of drumming up orders even if the subsequent completion of those orders requires the shipbuilder to absorb losses on the contracts in question. The shipbuilder might rationalize such behavior on the premise that any activity is better than none at all in order to utilize as much of their capacity as possible. Government intervention(I will talk later) has become commonplace in the form of subsidies tied to restructuring plans that retain workers for other industries and commit to reducing shipbuilding capacity.

Prices today are frequently referred to as being at or below cost, the principal components of cost being the direct material cost and direct labor costs. Direct material cost is the cost of all shipyard material that goes into the vessel. Direct labor cost is the labor associated with the direct material and is a result of wages and labor productivity. In normal times, overheads and profit would be added to the direct costs to obtain the price of the vessel. In these depressed times, however, profit and overhead components are frequently reduced or overlooked in order to arrive at a competitive figure.

Vessel costs is the cost incurred by the builder to construct the vessel. Vessel price is the price a builder charges for the vessel. Vessel cost is the principal element but only one of many considered in arriving at vessel price. Factors influencing vessel cost:

- Material, labor and yard general expense cost (Construction)[30]
    1. Production labor hours
    2. production labor costs inclusive of shipyard overhead expense
    3. Material costs
    4. General expense
    5. General and administrative expense allocation
- Vessel design
- Time to construct vessel
- Number of identical ships included in an order
- Yards previous experience with owner
- Owner specified classification and regulatory requirements
- Differences between yards

The direct and indirect (overhead) labor expenses combined with material costs and general expense comprise the shipyard's product cost, which is the shipbuilding facility's cost to produce a ship. Additional costs allocated to a project, usually as a percentage of the product cost, include selling expense and general and administrative expenses. These are assigned as a burden for the corporate services provided to the operating divisionshipyard). The allocation for corporate overhead is likely to range between 4 and 6 percent of the product cost and, when added to the production expenses, represents the shipbuilding corporation's total cost for a project.

Material costs are normally grouped into the categories of steel, main engine, and other materials and components. In order to make the material cost low, the country had better have a strong marine engineering industry and steel production to support the shipbuilding industry. Production labor costs are derived form the analysis of production labor hours and the composite labor rate. These labor hours are developed based on the shipyard's workforce, the industrial engineering and production research measures taken to improve productivity, and the cooperation of employees in accepting other work assignments. In order to remain competitive, the shipyard must have a program which strives to continuously improve productivity. Hourly compensation is defined as all payments made directly to the worker: pay for time worked, overtime premiums, shift differentials, bonuses and premium pay, pay for time not worked including vacations, holidays, and other leave, cost of payment in kind, employer contributions to legally required insurance programs, and contractual and private benefit plans. Compensation is measured on an hour-worked basis for every country. In addition to labor compensation rates and control of overhead charges, the third and perhaps most significant factor in determining labor cost is productivity.

3.3 Technological Change

Shipbuilding is, for the most of part, a medium-technology industry. In the shipbuilding area the transfer of technology is comparatively easy. Until about 1957, in the so-called period of reconstruction in Japan, virtually all of the new technology was introduced from the United States, Great Britain and other European countries. Shortcoming in technology, when recognized by the shipbuilders themselves, can be remedied through the process of technology transfer. As its name implies, technology transfer is simply the transfer of superior technology from a donor firm to a recipient firm. It differs from innovation diffusion in the sense that it is the result of a conscious bargain struck between two partners in which both see their way clear to benefit. Innovation diffusion, however, is the adoption of new technology by firms other than the innovating firm which is just as likely to take place outside of a formal sharing agreement as within it. Technology transfer could be divided into two parts: product innovations and process innovation.

The transfer of product innovations between organizations is fairly commonplace because it does not usually involve the massive commitment of capital outlays which, in shipbuilding, accompanies the transfer of process innovations. In fact, product innovations, by and large, reduce to the issue of ship design, and technology transfer, in turn, is the relatively simple procedure of an exchange of know-how between shipbuilders. Technology transfer of this kind can be broadly divided into two areas: first, the transfer of design and expertise from a firm resident in a shipbuilding nation which is relatively advanced in technological usage to a firm that belongs to a relatively underdeveloped shipbuilding nation, and secondly, transfer of design and know-how between firms in nations that are fairly evenly matched in terms of technological capability. The first area refers, in the main, to the transfer of West European, American and Japanese innovations to NICs. The second area is confined to the instances of technology transfer between West European, American and Japanese shipbuilders. A leading beneficiary of the first type of technology transfer is South Korea. In 1974 Hyundai Heavy Industries was given a license to build 23,000 dwt Clyde-class general cargo carriers from Govan shipbuilders of the UK[55]. Process innovations in shipbuilding improve the operational efficiency of shipyards. Consequently, they are not so much concerned with innovations in ship design as they are with the methods used in ship production. The UK-China agreement on shipbuilding, struck in 1982, envisages the transfer of a wide range of innovations from Britain to the People's Republic of China., including those which are basically process innovations. As well as the construction of BS-designed ships in Chinese yards and joint R

& D, marketing and training, the British will also supply equipment for rebuilding the Chinese naval fleet[55].

A high level of efficiency in shipbuilding was attained through the use of extremely sophisticated and extensive systems involving computers and modern production-line techniques. This efficiency was subsequently reflected in a sharp rise in new investment in advanced assembly and fabrication methods. Of particular importance was the further development of flow-line systems which had already been introduced to increase the efficiency of fabrication and assembly work and which had been formed on the basis of block construction. Design work was computerized and in order to make the most effective use of the larger docks the semitandem building system and other similar methods were widely adopted. Outfitting was improved by the extensive use of advanced pre-planning and pre-fitting, which was made efficiently by zone outfitting, which enabled the different jobs required on each block to be carried out simultaneously. In order to make this more effective, fresh types of production control were introduced and workers were trained to be versatile so that they could undertake a range of processes instead of specializing. the whole of the production process was then subjected to a sophisticated control system, a typical example being PERT which were widely used. By utilizing a combination of these various methods and techniques it was possible to make meaningful savings in both the man-hour and material consumed, and they also helped to ensure quicker delivery and the fulfillment of promised delivery dates.

All these developments had various side effects. The production of large sections reduced the time each ship was under construction, so the turnover of each dock was increased. It was also discovered that some of fitting work could be transferred to shore workshops, away from the building docks, and this again had the effect of speeding up the entire process. On the other hand the quicker delivery meant that orders were completed so rapidly that the Japanese industry, which was export-oriented, became much more vulnerable to fluctuations in world demand. It should be remembered that the technological advances described above were only valuable when demand was high enough to justify a continuous throughput of new ships. At times when orders were scarce the expense of the investment proved to be a heavy burden for the industry to carry.

3.4 Industrial Maturity

Shipbuilding, just like any other industries, is subjected to life cycle. For the duration of the childhood stage, production plant is scarce and most of the efforts depends on human capital; that is to say, the skills infused in the kernel of workers. To test the waters of market reception, it is vital that the enterprise progressing through childhood be located in a place conducive to good and easy contact relations with would-be customers. Skilled workers of this sort are likely to be found in large and diverse labor pools. Fortuitously, then , the twin locational criteria of market accessibility and ability to tap skilled and resourceful labor coincide to offer a limited number of choice sites for a precocious enterprise attempting to force the pace in product development.

In due course, the enterprise gambles on a preferred prototype, converting it into a marketable item with an extended production run. Quantity production, in turn, requires a revamping of process technology. Rather than the assemblage of odd, non-standing jigs and tools prevalent hitherto, the firm can take the plunge, so to speak, and invest in product-specific machine tools. The implementation of quantity production of either a single product or a narrow range of products effects a transformation of the enterprise, propelling it into the "adolescent" stage. Attention to the demands of production comes to the fore. It lends itself to the substitution of machinery and equipment for skilled manpower and, eventually, leads the firm into the mature stage. Maturity stamps its presence on the firm by enforcing a regime in which both products and processes are practically standardized. So as well as reducing the quality of

Table 3.1: Merchant ships (grt/gt-% share of total) completed by principal types 1975-1991[49]

Year	Oil Tankers	Bulk/Oil Carriers	Ore/Bulk Carriers	General Cargo	Container Ships	Liquid Gas Chemical	Others
75	66.4	4.7	13.6	8.1	0.7	2.5	4
76	58.7	3.7	19.6	9.8	1.8	2.6	3.7
77	37.1	4.9	28	17.1	3.7	5.3	3.9
78	26.6	3.4	25.1	24.6	7.2	6.3	6.8
79	28.9	2.7	16.5	29.5	7.8	7.9	6.8
80	30.1	2.4	20.1	20.6	10.5	6.6	9.7
81	28.1	4.3	37.5	12.5	3	6.6	8
82	21.1	4	46	11	4.6	5.4	7.9
83	19.6	4.5	38.4	14.4	8.3	4.9	9.9
84	11.5	0.7	50.6	14.9	9.4	4.5	8.5
85	15.1	2.4	47.2	13.9	8.4	3.3	9.5
86	22.4	3.9	39.7	9.7	10.7	2.6	10.2
87	24.9	4.1	31.4	18.1	9.2	1.6	10.7
88	37.9	1.9	19.1	17.4	13.5	1.4	8.8
89	37.9	0.3	29	8.9	9.4	4.9	9.5
90	32	-	34.9	10.1	10.4	5	7.7
91	42.1	3.8	19.2	9.7	11.9	6	7.4

labor, standard process technology rejoices in the added property of reducing it quantity, since, by dint of augmented productivity, fewer workers are required to produce a given level of output. The enterprise can dispense with expensive labor-intensive methods along with the work-forces required to operate them and, in their place, can make use of more cost-effective capital-intensive methods such as mechanization and automation which are adequately served by cheaper, less skilled work-forces. In a phase of settled product and process technology, market success depends more on price competitiveness than product superiority and the firm has no option but to subscribe to cost minimization as its primary objective. In the mature stage, the industry is largely devoid of product innovation, has by and large fixed on a well-known body of knowledge concerning production and, in consequence, presents few barriers to entry. From the table 3.1, we could see low added valued ships completed in 1991, which are in a phase of settled product and process technology, takes over 70 percent. Although the ratio of high added valued ships tends to increase according to the table 3.1, these types of ships are quick to go to maturity phase, as I said before, because technology transfer in shipbuilding industry is comparatively easy. For example, the first 125 000 m^3 LNG vessel to built in South Korea was launched at the Ulsan yard of Hyundai Heavy Industries(HHI) in April, 1993. The vessel will be delivered to Hyundai Merchant Marine Co. in March 1994[33]. This kind of vessel is regarded as one of the most complicated now.

3.5 Government Intervention

It is not clear exactly why shipbuilding has been given such massive support, by comparison with other industries, when in most countries its contribution to GNP and to industrial employment has never been more than a few percent[29]. It has been argued that the share of subcontractors is especially high in shipbuilding and that therefore many more people are involved than those directly employed by the yards. This seems to make sense. It has also often been argued that shipbuilding owes its preferential treatment to considerations of national security. However, it may still be asked why ships should be produced in each individual country when it is considered quite natural to import other war materials such as aircraft, tanks and guns. The fragility of the argument is perhaps best demonstrated by the fact that the US in peace-time has always had a relatively negligible shipbuilding industry. I think there is more sense in the argument that for developing countries, shipbuilding would at least be good for earning foreign exchange and stimulating the programme of national industrialization, and for developed countries, shipbuilding could keep their industry advanced because shipbuilding is associated with most industries.

During much of the 1980s, traditional shipyards throughout the world suffered from the worst shipbuilding recession in history, precipitated by the oil crisis of the mid-1970s and its subsequent detrimental effect on seaborne trade. The severity of the situation reflected not only the cyclical nature of the shipbuilding business responding to fluctuations in the shipping market, but also the massive overbuilding of shipbuilding capacity that had been undertaken in Japan and Europe in response to an unprecedented, highly speculative demand for new ships-particularly tankers during the 1960s and the early 1970s. During a ten-year period, for example, Europe increased its shipbuilding capacity by 136 percent and Japan by 650 percent. Exacerbating the situation was the entry into the marketplace of new, government-supported yards. The response of most governments of the world in 1980s to this situation was to provide increased measures of shipbuilding assistance. If the success of these measures can be defined as keeping merchant shipbuilding capability alive, then these governments achieved some degree of success. only three governments- USA, Canada and Sweden responded to the crisis by terminating commercial shipbuilding subsidies. It is interesting to note that these three countries are also ones to suffer a complete collapse of commercial shipbuilding markets in the 1980s.

In general, the major types of shipbuilding subsidies that have been and are still being provided are the following[53]:

- Special financing (credits): This category includes government-subsidies related to the financing of ship purchases for export or domestic customers and can include loans from government banks as well as interest subsidies and loan guarantees from governments.

- Construction subsidy grants: This type of subsidy encompasses direct government payments to shipyards of the contract price.

- Shipyard reorganization aid: This category covers a wide range of government subsidies to help shipyards modernize their facilities or to otherwise adjust to downsizing, and has included capital infusions, loan subsidies and guarantees, government buy-ups of redundant or outmoded facilities, and special tax benefits.

- Research and development aid: This type of aid involves government funding of research and development programs related to ship or ship production technology.

- Tax benefits: This category encompasses government tax measures to shipowners or shipbuilders that are not generally available to all other industries within that country.

Chapter 4

Competitive Advantage of China's Shipbuilding Industry

4.1 China's Shipbuilding Industry

After 1949, China's new leadership recognized the need for a strong shipbuilding industry for both political and economic reasons. However, China at that time lacked the personnel and equipment necessary for the task and turned to the former Soviet Union for aid. The Russians donated engineers, shipbuilding equipment and ship designs and by the mid 1950s, Chinese shipbuilding was functioning, although on a modest scale and nearly entirely for the Navy. Research and design institutes for ship construction and marine engineering were established to advance the country's shipbuilding capabilities. During these years, the merchant and naval vessels built in China's shipyards were based on foreign design utilizing foreign materials and equipment. However, with the Sino-Soviet split in 1960, the shipbuilding industry, like the petroleum industry, was forced to stand up and walk on its own two feet. China received some technical aid from Czechoslovakia, East Germany and Poland but basically from 1960 forward, China's shipbuilding industry developed along its own lines. By 1960, however, a 13,000-deadweight-ton freighter, DONGFENG, was under construction in the Jiangnan shipyard, in the Shanghai shipbuilding complex, utilizing for the first time Chinese designs, materials, and equipment[22].

But after 1960, the policy was influences by the former Chinese President, Liu Shaoqi, who advocated a policy of using foreign chartered tonnage and buying second-hand ships rather than massive building programmes in an effort to avoid making expensive mistakes that China could not afford. Technically, the shipyards had not advanced much beyond the point that the Russians left them. Production was still slow and based on models built in the 1940s and 1950s. The major improvement was that the yards now had trained work forces and were able to turn out vessel series such as the 'Da Qing' tankers(modeled on a Polish series).

Since 1982, CSSC has substantially improved the technical upgrading of its shipyards and manufacturing plants. Many equipment manufacturers have made license agreements, or co-production agreements with CSSC as well as joint venture service stations. MAN B&W diesel engines are produced at Hudong Shipyard and Sulzer diesel engines at Dalian Shipyard and Shanghai Shipyard. Many equipment manufacturers support their product sales with regional offices close at hand. For example, Alfa-Laval, the Swedish supplier of a wide range of marine engine room equipment has offices in Hong Kong, Shanghai, Guangzhou and Beijing. Many western marine equipment manufacturers quickly recognized the need to establish service stations to support local, and foreign owners in the major shipbuilding centers. In 1986 China announced specific investment plans for the renovation and reconstruction of six shipyards for building ships for export. These are the Dalian Shipyard, Zhonghua Shipyard, Xingang shipyard, Jiangnan Shipyard, Hudong Shipyard, and Guangzhou Shipyard. More modern production machinery has been purchased, together with replacement machinery bought from shipyards in Europe.

The 132 ships completed by CSSC in 1992 totalled 1.117 million dwt, 36.84% above the target, up 38% over 1991, according to Shi Fengjun, an official of the corporation's Production and Business Department. In 1991, CSSC completed vessels of 809,000 dwt, which represented an increase of 26.6% over 1990[8]. The corporation exported

36 vessels aggregating 597,000 dwt in 1992 which was 53% of its total output. Newbuilding orders received by Chinese shipyards in 1992 amounted to 1.66 million dwt an all-time high. The corporation's domestic newbuilding contracts of 1.23 million dwt in 1992. This will keep Chinese major shipyards busy till 1995. With Chinese efforts, the country's annual shipbuilding capacity will be increased to two million deadweight tons by 1995. According to Zhang Shou, the president of CSSC, says: " For increasing vessel output in the near future, we will mainly rely on further improvement of work efficiency rather than facility expansion." For instance, he says, a 70,000 dwt building berth, which now produces two to three vessels a year, is expected to build four vessels annually in the coming year(table 5.2). In the next three years, output is expected to grow by 200,000 dwt annually, to reach 1.6 million dwt by 1995 double that of 1991.

4.2 Industry Structure and Organization

4.2.1 Structure of China's Shipbuilding Industry

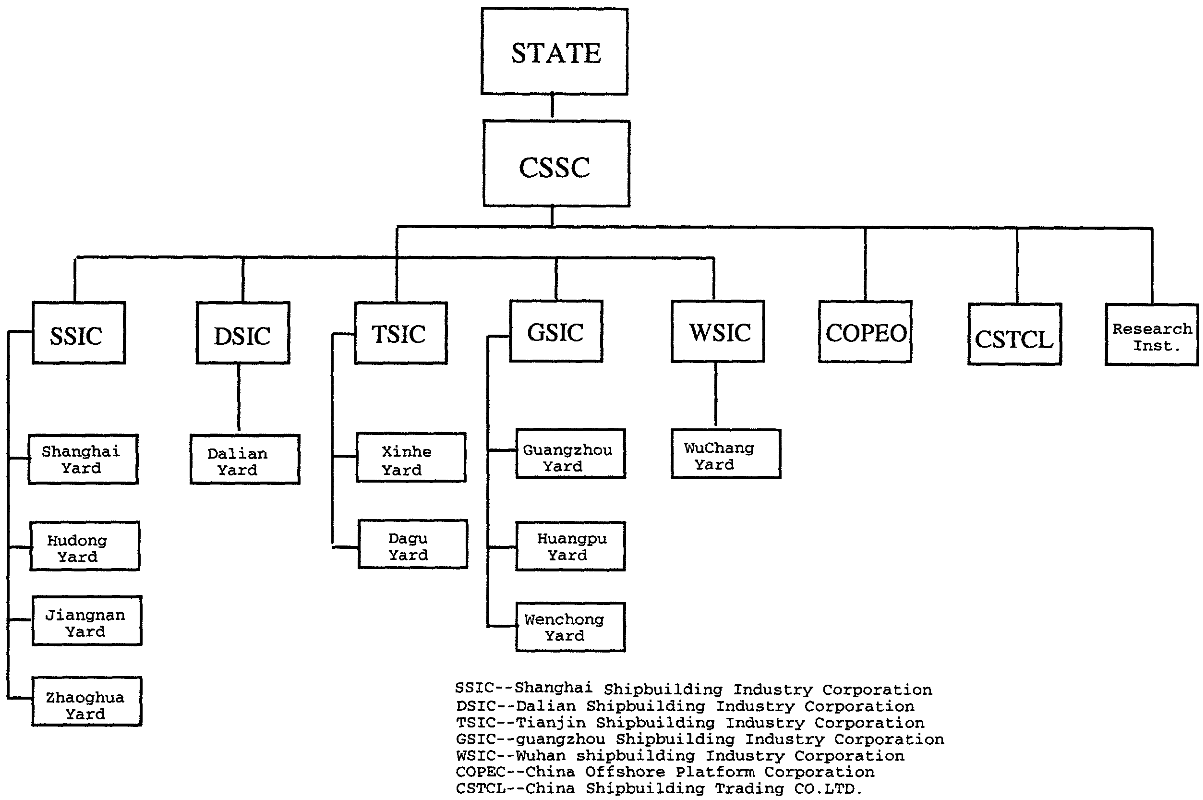
Prior to May 1982, China's shipyards, associated institutes, and factories were organized under the Sixth Ministry of Machine /Building Industry, the Ministry of Communications, and the State Administration of Aquatic Products. The Ministry of Defense exercised input in the design and construction of all types of naval vessels. Provinces, municipalities, and autonomous regions also were permitted to operate shipyards. Their output, however, played only a small part in the nation's total production of oceangoing ships of all types.

Construction of larger merchant ships of various types, specialized vessels to serve the oil industry's exploration and development efforts, and naval vessels were under the jurisdiction of the Sixth Ministry of Machine Building Industry's China Corporation of Shipbuilding Industries(CCSI). Some smaller merchant ships, inland water-way vessels, and ship repairs for coastal ships were the province of Communications. Fishing vessels and their repair came under the supervision of the State Administration of Aquatic products. Under this system, the shipbuilding program became subject of bureaucratic self-interest. The lack of unified jurisdiction over China's shipbuilding made it difficult to carry out an effective national shipbuilding policy. The shipbuilding situation was that there was a tremendous duplication of facilities and bureaucratic overlap. Added to the problem of the bureaucratic overlap was the fact that most of the supporting facilities for the supply of steel, cement, glass fiber and machinery were under different ministries, making it sometimes easier to import equipment from abroad rather than buy it from a local factory. Finally, China had never really exported a ship before and was not sure what foreign shipowners expected. Although the PRC had exported craft since the early 1960s - 30 hydrofoil gunboats to Albania - the idea of competing with other builders of merchant ships was difficult. The Chinese immediately turned to the Japanese for help and they appointed a representative to help the Chinese with the shipbuilding programme.

In keeping with the reforms instituted by Deng Xiaoping in 1978 to simplify, restructure management, and reduce China's bureaucracy, a number of ministries, state corporations, and commissions were merged or eliminated in the years that followed. In the overall review of the government's structure, attention was focused on the splintered organization of the shipbuilding industry. As a result the Fifth National Congress in May 1982, directed that the Sixth Ministry of Machine Building Industry be abolished. At the same time, the Ministry's China Corporation of Shipbuilding Industry was merged with the shipbuilding and ship repair functions of the Ministry of Communications to form the new, more unified China State Shipbuilding Corporation(CSSC). CSSC as a state corporation has ministry status under the direct authority of the State Council(figure 4-1). CSSC's mandate is to[41]:

- produce both civilian and military ships; working in cooperation with the Ministry of Communications to provide ships repairs for COSCO and the coastal fleets, and with the Ministry of Defense(Naval Department) to design and build

Figure 4-1: China State Shipbuilding Corporation



surface vessels and submarines;

- cooperate with trade officials in securing orders for ship exports;
- increase China's ability to become more self-reliant in ship construction by developing advanced technology and producing materials and equipment of the highest standards for the shipbuilding industry;
- conclude and sign contracts with civilian and military buyers for ships and ship repairs, and to honor those contracts in the strictest manner;
- build ships of all types and off-shore rigs, supply ships, and other equipment to comply with international standards;

- build ships of the highest quality in materials and workmanship, at the lowest costs, to enable the shipbuilding industry to compete effectively in world shipbuilding markets;
- reduce ship delivery time through greater productivity.

CSSC operates 27 shipyards, 56 equipment manufacturing plants,and now has annual vessel production capacity of 1.5 million dwt[8]. While the Ministry of Communications retains the right to import ships, virtually all other shipbuilding functions except certain ship repairing were transferred to CSSC. Although it would appear to foreigners as a simple alteration, the change has fundamentally altered the aims and the day to day operations of shipyards. The most obvious change was that it grouped various shipyards and factories into units such as Shanghai, Tianjin, Guangzhou (which includes the yards in Guangxi), Wuhan and Dalian. The units were formed by taking shipyards and factories that had belonged to other ministries, notably the Ministry of Communications, and placing these in a self-supporting group. CSSC takes care about the long term development of shipbuilding industry, such as setting up strategies, building up new facility, introduction of new technology, establishing subsidiaries abroad and etc. It also meant that the financing was to be raised by shipyard and group; thus a shipyard or industrial group was responsible for its own financing. The system of responsibilities in the shipyard has changed with the advent of CSSC. Previously the profits of the industry were turned over to the State as a whole against an annual quota. Under the new system, tax is turned over to the state and the profit is retained by the corporation. The system applies on three levels: with CSSC as a whole, with the branch or group, and with the individual units.

Shipyard

Table 4.1 shows the facilities of the major shipyards. Dalian Shipyard belongs to Dalian Shipbuilding Industry Corporation which includes Bohai Shipyard, Dalian Marine Diesel Engine Works, Liao-Hai Machinery Factory and the Dalian Marine

Table 4.1: Building Docks In China[3]

Shipyard	Building Docks (m)	No. of employees (engineers)
Dalian	350 X 90 X 1	16400
	308 X 50 X 1	(3000)
	255 X 27 X 2	
Hudong	200 X 28.4 X 2	11400
	105 X 15 X 8	(1000)
Jiangnan	235 X 40 X 1	13000
	210 X 27 X 2	(1300)
Shanghai	228 X 27 X 1	10000
	212 X 22 X 1	(1000)
Zhonghua	145 X 21 X 1	6000
	145 X 17 X 1	(500)
	80 X 15 X 1	
Guangzhou	170 X 27 X 1	8000
	166 X 22 X 1	
	70 X 9.2 X 1	
Xingang	186 X 28 X 1	6500
	128 X 21 X 1	

Valve Plant. The industry corporation also engages in land machinery production as a foil to discontinuities in ship production. Among its range of products are rolling machines, steam turbines, industrial boilers, pressure vessels, die-casting machines, oil storage cars and metal furniture. Dalian shipyard is the largest in China, noted for the construction of large tankers. In 1993, it will deliver a 150,000 deadweight ton tanker. A 200,000 dwt drydock, the largest in China, will be completed in 1994[8] at Dalian New Shipyard. By then, China will be able to build ultra-large vessels of 200,000 to 300,000 dwt. Dalian also builds for domestic operation and for export various size bulk carriers, container and roll-on/roll-off ships, and oil rigs and platforms. Working with the Ministry of Defenses, Dalian helps to design and then builds warships such as the LUDA class destroyer and fast attack craft of various types for the Chinese navy. The principal items of equipment manufactured by Dalian Shipyard are main propulsion units. Prior to 1979 the yard manufactured their own design, and in that year negotiations to buy licenses with Sulzer and B&W were completed. At first they bought all the parts from Japanese licensees but have worked their level of home-made components up to 60%[40]. The Dalian Shipyard also supplies other shipyards in China with main engines.

The Shanghai Shipyard Complex includes Jiangnan, Hudong, Shanghai, etc. Shanghai is the hub of China's shipping and shipbuilding industries. In 1992 the Shanghai Port, the third largest port in the world, handled 160 million tons of cargo. Her shipyards are estimated to account for almost half of China's shipbuilding capacity[39]. Shanghai Shipbuilding Corporation is particularly interested in obtaining export orders - not only for the hard currencies they bring in, but to increase the development of its overseas market share. Jiangnan Shipyard whose origin goes back to 1865, is Shanghai's oldest shipyard. Japanese shipyard design and shipbuilding exports, under contract, have redesigned the shipyard, upgraded training of management and professional personnel, and introduced the latest technological equipment. Some existing facilities will be enlarged. After transformation, a 20,000 dwt capacity slipway in Shanghai's Jiangnan Shipyard will be able to build vessels of up to 70,000 dwt. It builds oil rigs, platforms and service vessels and contributes to China's defense by building the ROMEO class submarine and JIANGNAN class frigate combatant ship for the navy. Jiangnan also built space-event ships for the Ministry of Defense. It is one of the highest technology shipyards in China and participated in the building of the ships to test launch Chinese carrier rockets. Shanghai Shipyard was redesigned, restructured, and modernized in 1979. 20,000 dwt slipway in Shanghai Shipyard will be able to accommodate 35,000 dwt vessels. It builds and repairs ships, produces castings and forgings, and builds diesel engines and containers. Ship types constructed by Shanghai Shipyard include multi-purpose cargo ships, passenger ships for operation on the Yangtze River, and built carriers of 20,000 to 30,000 deadweight tons. it also constructs oil rigs and other equipment for the Ministry of Energy Resources and foreign oil companies, as well as small tugboats for export. Hudong Shipyard is a modern, complete shipbuilding complex. Its small and large building ways produce freighters of up to 10,000dwt and bulk carriers as large as 40,000 tons for domestic and foreign buyers. Research and computer institutes give backup for the development of more efficient and productive ship types. The Ministry of Defense looks to Hudong for the JIANGDONG class and JAINGHU class frigates and small naval craft such as auxiliary ocean tugs.

Three of South China's principal shipyards, Guangzhou, Huangpu, and Wenchong, are under the direction of Guangzhou Shipbuilding Corporation. They build freighters, bulk carriers, multipurpose cargo ships, container ships, crude oil and special products tankers, passenger-cargo combination ships, as well as special-purpose vessels and structures for China's oil industry and for export. They also build LUDA class destroyer. Among the other naval vessels ordered by the Ministry of Defense are JIANGNAN class frigate and small, high-speed patrol craft.

4.2.2 Structure of Shipyard

Structure of Shipyard

Organization for the entire shipyard is shown in Figure 4-2. Besides the Shipbuilding Division, other line units are: the Engine Division, the Material Supply Department, Civil Engineering Department, and the Chief Engineer's Office. Administrative and staff groups include the Chief Economist, Accounting Department, and the Personnel Department. On the production and production support side:

- The Engine Division designs, fabricates, and markets the low- and medium-speed engines, and associated auxiliaries. The unit also has large forging, fasting, and heat treating shops.
- The Material Supply Department is responsible for acquisition and transportation of all materials for the yard.

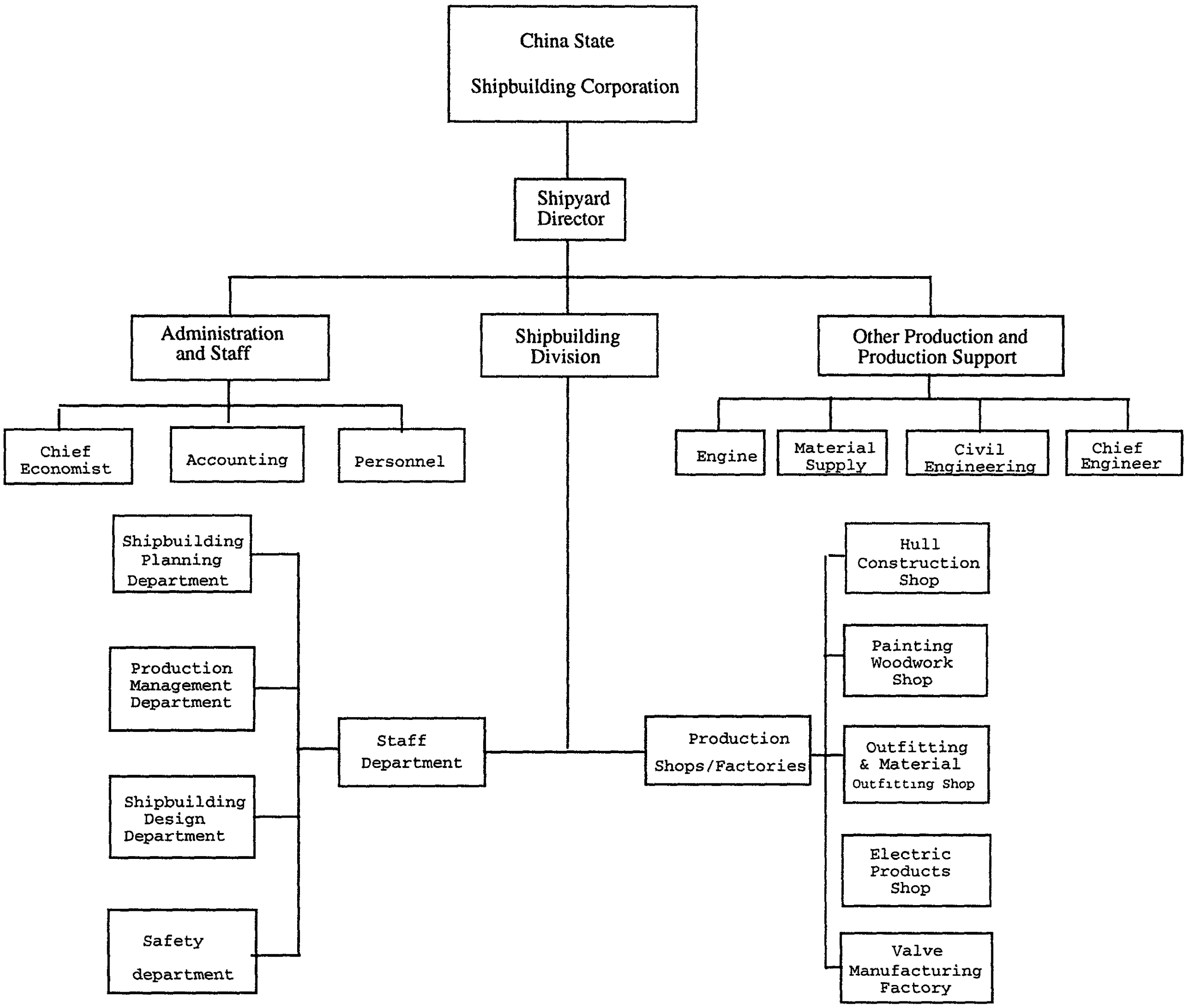


Figure 4-2: Shipyard Organization

- The Civil Engineering Department does all of the civil engineering projects for the yard, including employee housing. The group maintains all of the yard's facilities and all stationary equipment and tools. In addition, the department is responsible for the construction of all industrial projects that are fabricated and assembled at the yard.

- The Chief Engineer is responsible for quality control, metrology, and for all other technology management within the yard, including physical and chemical analyses. The unit directs the CAD/CAM developments and application program.

On the staff side, the Economics Officer is responsible for long term planning, labor balance coordination, and contract administration. The Chief Accountant deals with all financial matters. The personnel Division is responsible for training, education, personnel administration, and operation of the numerous support groups(like the hospital, visitor hostel, and children's nurseries). The Shipbuilding Division is the principal division in the yard. This division has approximately one-half of the yard's total workforce in its organization. There are four departments and six production shops/factories in the division:

- The shipbuilding Design Department designs the ships, including advanced concepts. It prepares production working documents, as well as material for regulatory approval.

- The Production Management Department handles the production management for the entire yard; it has responsibility for preparing production plans and coordinating of the shop production.

- The Shipbuilding Planning Department performs the work load balancing; it prepares the production instructions, and coordinates the milestone schedules.

- The Safety Department is responsible for safety in the entire shipyard.

- The Hull Construction Shop is one of the main shops for the division. It is responsible for all of the steel production for both ship and industrial product, and associated lofting.

- The Machinery and Electrical Workshop is responsible for installation of the main engines, the navigational equipment, the electrical equipment, and sea trials. This shop is also responsible for processing of pipe, and its installation aboard the ship.

- The Painting and Woodwork Fabrication Shop is responsible for all painting and coating operations and all woodworking jobs, including the manufacturing and installation of any wooden furniture.

- The Outfitting Material Fabrication Shop makes foundations, doors, boilers, small hatch covers, and aluminum doors/windows, and runs the galvanizing and oxide finishing operations. The shop does not perform any of the installation activities.

- The Electrical Products Factory fabricates switchboards, cabinets, steel furniture and ship models. Its products are also sold outside the shipyard.

- The Valve Factory manufactures all valves used on the ship. The casing are manufactured by the Casing Shop - a unit in the yard's Engine Division.

There is a labor union organization; however, it is structured differently than in Japanese yard. There is no focus on craft orientation by the union, and there are no work rules requiring that work be performed only by people with a recognized journeyman skill. As a result, workers can be cross-crafted in their assignments.

4.2.3 Management

Marketing

1. **Domestic Sales**

The China Ocean Shipping Company(COSCO) under the Ministry of Communications is the Chinese national merchant ship operator. This firm and its subsidiaries negotiate the purchase and construction of the majority of Chinese operated merchant tonnage. The largest Chinese shipyards, as I mentioned before, also build military vessels for the People's Republic of China navy as well as for export. Commercial sales to the COSCO are negotiated, primarily, between COSCO and CSSC at the headquarters level in Beijing. Once a purchase is agreed on. CSSC headquarters allocated that job to a yard with sufficient capacity and the technical know-how to do the job. After the contract has been assigned, the shipyard may at times negotiate further with the COSCO subsidiary accepting delivery. The additional negotiation may involve a number of issues including price, delivery date, or shipboard equipment[32].

2. **Foreign Sales**

Chinese shipbuilders had not much experience of selling ships to foreign customers, because it was only in 1977 that China exported its first vessel, a 37,000 dwt freighter to Malaysia though the shipbuilding industry has the experience of building ships for almost 40 years. In order to make up for this lack of knowledge, in 1982, the China Shipbuilding Trading Corporation, a subsidiary organization, was formed to administer all trading operations of CSSC such as export ships sales, equipment import and purchase, and now has its own agency offices around the world. In Hong Kong, China United Shipbuilding Co. Ltd (CUSBC) represents CSTC and handles a substantial volume of export and import trade. CSTC evolved into large organization which accumulated considerable knowledge of external markets and established a worldwide commercial intelligence-gathering network. Even so China can not compete with Japan in this respect. As we know in chapter 3, Japanese yards belong to zaibatsu in world Fortune-500 which are more prestigious in the world. A long history results in more complex network in the world and more market-sensitiveness. Furthermore, Cultural traditions in Japan emphasize close cooperation not only among units of large industrial companies, but also among industrial units of different companies in the same field. As a result, shipbuilding subsidiaries of Japanese governments usually share information.

Management Training

China's business school used to train accountants and bank clerks. It is only recently that they have adopted a curriculum similar to western business schools. The professors, who used to teach in economics department, do not have adequate training or any actual experience in business. Marketing courses are yet to be developed. To the average Chinese, "business" or "trading" has the implication of "dishonesty" and "cheating". People with a reasonably good education do not like the idea of "selling" things. Good sales people and sales managers are the hardest to find.

However, with the economic development, things has been changed a little bit. Talented people tend to join in the management position. Furthermore, the Chinese focus a great deal of their management training around western management training at every opportunity. The Chinese have established formal joint educational programs with several western universities, including the University of California at Berkeley, Stanford, the University of Houston, and others. In these joint programs China provides the students and the western university provides the professors.

The Chinese also encourage experienced western executives to share their knowledge. In 1983 Mr. Phillip Smith, the retired chief executive officer of Smith, Yuill, and Company (a U.S. steel manufacturer) went to China to give a series of strategic planning lectures to Chinese steel executives. In 1985 and 1986 he also served as Dean of the Senior Executive Program at the Dalian Institute of Technology(the national center for industrial, scientific, and technology management development). Mr. Smith's experience is not unique. The Chinese actively seek out these western experts to garner their knowledge. This search for knowledge by the Chinese is important because it provides a base of capable management to continue to develop Chinese shipyards and other industries, a pool that can then pass its knowledge to other Chinese. The western emphasis helps elevate Chinese shipbuilding to the advanced levels found in the west and to accomplish this more quickly than by working alone. And lastly, by training managers the organization creates the ability to direct the organization to more favorable environments and to managing and establish negotiated environments favorable to the organization.

Decision-Making

Before the reform, Chinese economic is controlled by the planning approach which is mostly about the use of the planning mechanism to replace market forces in the production of goods and services, and their distribution and exchange. After 1978, things changed a lot, but still unsatisfactorily. *Business China* points out that overall management of shipbuilding in China is centered at CSSC corporate headquarters[11].

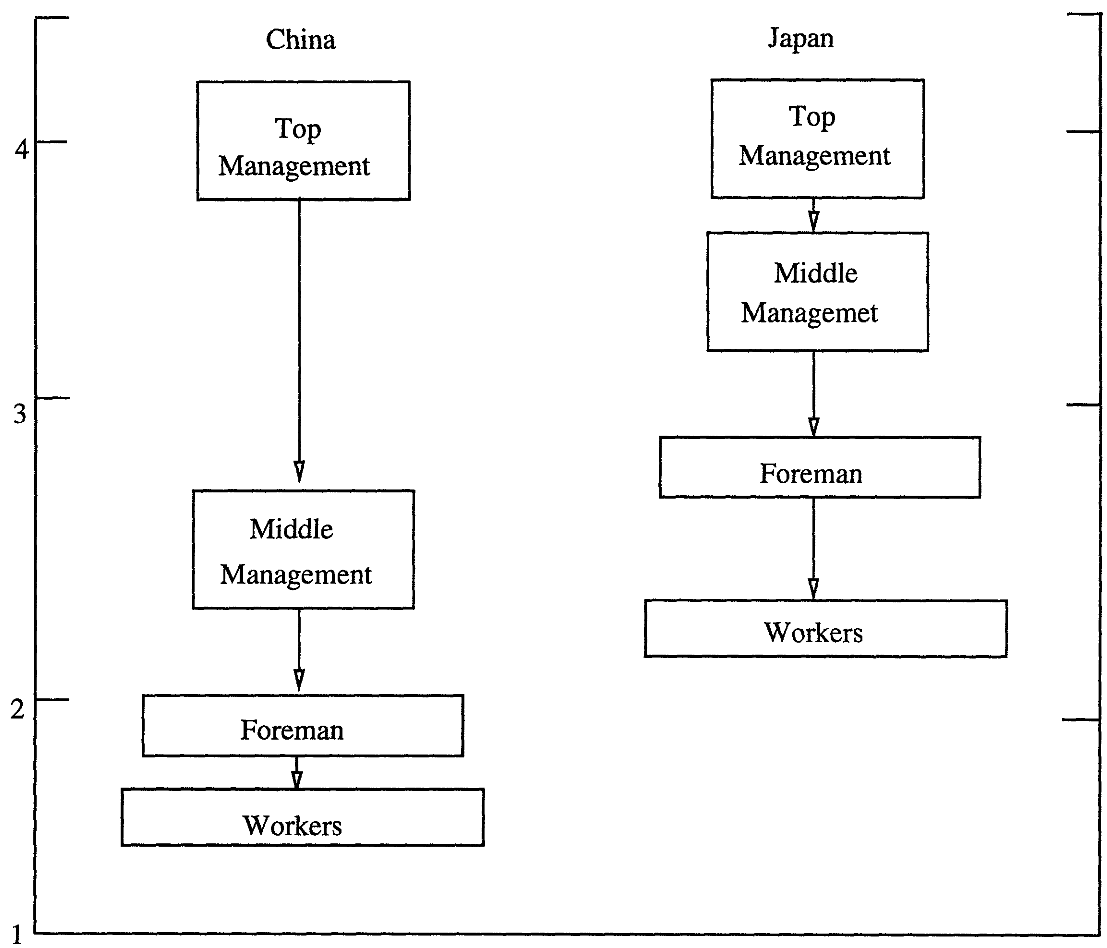
> The CSSC is a national corporation directly under the State Council, which places it on a level with the other Chinese state ministries(like Machine Building, Communication, and Finance). The CSSC is responsible for planning and supervision of the shipbuilding industry. It deals directly domestic and foreign companies, enterprises, and institutions.

The CSSC central offices in Beijing are where all major corporate decisions are made. There the bulk of marketing, sales(both foreign and domestic), contracting, finance, the hiring of all major shipyard management, and production decision activity takes place. The local shipyard takes the input supplied by Beijing and attempts to meet the production goals that were set. Local shipyard management and management of support organizations like research and design units and institutes of higher education are also under the Beijing bureaucracy. All coordination between units is handled by the central bureaus of the CSSC. Only after 1987, the decentralization allows the enterprises more room for independent action; under the unifies state plan, planned economy is integrated with market conditions. Shipbuilding industry is no exception. A regional corporation as an economic entity could negotiate directly with potential customers and takes care of the coordination among the factories. Decisions are made more effectively, since its headquarters is located at the region and there are representatives for each shipyard there. The top managers of regional corporation have their positions at the headquarters of CSSC, which makes the connection between CSSC and its subordinate closer. Shipyards now have the power not only in production organizing, but also in marketing and human resource management. Most of the top managers of different level in CSSC were expertises. In January 1987, the Chinese

Government announces new rules to " ... promote the system of factory directors assuming full responsibility for production and management of the enterprise...". From macro-management point of view, more decision-making power has been delegated to the enterprises, although in a limited way compared with Japanese enterprises. The top-down management often cause late timing of decision which is not properly coordinated with real need. The extent the enterprise responds to bureaucratic directives, rather than market signals would influence the efficiency of the enterprises.

From micro-management point of view, we could divide interest group into workers, foreman, middle management, top management. Let us study the influence of all the interest groups in decision-making[28]. Oiva Laaksonen gathered the data through interviews in different industries in China and in Japan. We could see from figure 4-3 that top management in China seems to keep nearly all the decision-making strings in its hands. The generally smaller influence of Chinese personnel groups can be a sign of traditional authoritarian and patriarchal Chinese culture. It can also reflect the whole structure of Chinese socialist society, where the most important plans and decisions are made centrally by "higher authorities". The influence of Chinese middle managers like "workshop leaders" in decision-making seems to be clearly smaller in different decision types compared to their Japanese counterparts. Chinese top management will decide matters which typically should belong to the responsibility area of foreman. In contrast, each level of the organization of the shipyard in Japan has well-defined decision-making powers and delegation of responsibilities. Profit sharing incentives usually assure not only peer participation and input into the decision-making process, but also full cooperation in the implementation of each decision. The only individual decisions where the Chinese foreman, or work group leaders, have more than "moderate influence" are replacement of personal equipment of workers and assignment of tasks to workers. The influence of workers in decision-making seems to be markedly slight in China compared with Japan. As the industry has become complex, this influence structure complicates its effect. Without any influence, workers have almost no motivation. In fact, motivating workers are one

Figure 4-3: The influence structure and power distance between different personnels groups in Chinese and Japanese Enterprises



of the important elements for improving productivity in shipyards. Usually in production sites, a situation interfering with smooth production occurs almost everyday. For example, equipment failure, material shortage, absence of workers, and product defects can occur anytime. The workers find those problems first. Unless they take necessary action with a positive attitude or report to their supervisors for solving the problems, the impact on production can not be minimized. It is important to continue motivating workers so that their positive attitude becomes a customs. It is obvious that if workers almost can not be in the circle of decistion-making, workers will get to feel that what happens in factory has nothing to do with them and their duty is only to work within the required hours.

In Japanese shipyards, there exists the suggestion system which provides opportunities to realize their ideas and makes themselves interactive. Suggestions from below are quite paid attention to. In terms of total management quality, this can expect a raise in workers' morale and increase quality and productivity. In contrast to China, normally, most of the decision plans are first provided by ordinary workers and foremen. They have several formal and informal discussions with other employees at the same level whose sectional interest may be related to this decision, and consensus among them is sought. A significant feature was workers shifting from a passive mode, merely waiting for suggestions, to an active programme for educating personnel concerning all aspects. This shift fits comfortably the typical commitment of Japanese management to developing the skills of all employees fully, and to recognizing that employees can make a real contribution to organizational effectiveness. Once they reach consensus, the decision plan is raised to the middle management. They repeat almost the same process and accumulate their ideas and consensus to the plan. In this way, the decision plan goes through a hierarchy of the shipyard up to top management. Although the final decision is taken by the top management, it is the result of many workers's consensus. Especially for lower level workers, this system provides an opportunity to participate in decision-making. Therefore, once a decision has been adopted, all the workers who are familiar with the decision cooperate and the objective can be achieved smoothly. Furthermore, the fact is that studies continue to tell us that employees worldwide want their views to be heard.

One of the main differences in management between Japan and China; the latter the labor union system does not function, as least openly, as a counter-power to enterprise management. There is only one labor union in Chinese shipyard, and 90 percent of the workers participate. Some of the workers are selected to represent all of the worker; they are called "Workers' Representatives." The union is under the leadship of the Communist Party. Although about twice each year the shipyard director is obliged to make a formal report to the Workers' Representatives, this is only window dressing. After this meeting the representatives will caucus in a series of small, special focus sessions to develop comments on the director's report, but there is no absolute requirement that management follow the suggestions/recommendations on any topic. In the positive respect, Chinese labor unions are the passive supporters of management. It could not result in the problem like in South Korea that the strike made the shipbuilding yard a mess to prevent the owners from making contracts in 1989.

Quality Control

Quality control in China is an issue much talked about, but its progress has been incredibly slow. The past few years China has been placing an increased emphasis on improving the quality of her manufactured products. Quality control leadership has come from the highest levels of the Chinese government. The head of China's government, Deng Xiaoping said, "we cannot only stress production quantity. We must also pay attention to production quality. In order to open our export market, the key issue is quality. When production quality is low, the products still become less competitive. In the past, we only stressed output value and quantity instead of quality. Actually, the most important issue is production quality". In support of this speech the State Economic Commission called on various districts and departments to earnestly study comrade Deng Xiaoping's view, truly adhere to the principle of quality first, quicken their pace in meeting international standards, and strengthen quality control in an overall manner. This concern for quality highlights the shift that Chinese industry, including shipbuilding, has recently made. Quality now has real meaning. While few real changes in the quality control program have occurred yet, the most important change is evidenced.

Chinese shipyards do have a quality control structure in place, even if it is not effective. Part of the shipyard administration includes a quality control department. This department is unique in that while under the shipyard's administrative organization, the department reports directly to the shipyard's chief engineer. The quality control department or section consists of a measuring division, a quality inspection division, and a quality control office. The department is responsible for developing quality control procedures, and maintaining an inspection program to confirm that the worker is building products to the assigned quality standards. The department is also the official liaison with the owner's representative and the various regulatory agencies who regularly inspect the ship during its construction.

In fact, quality control should involve every worker like in Japanese Shipyards. In Japan, workers themselves form groups to solve problems. The QC circle is defined as a small group which voluntarily performs quality control activities within the workshop to which it belongs, and the small group carries on continuously, as a part of company-wide quality control activities, self-development and mutual development, control and improvement with the workshop, utilizing quality control techniques. The concept of QC circles is well imbedded in the Japanese tradition, by which employees feel that they share a common destiny with the company. High-quality production systems and facilities can not guarantee a good production pace without workers' cooperation. But in China, the employees have no such strong feeling as the ones in Japan. The workers in Chinese shipyards try their best to pass through the check of the QC department in one way or another. In fact, they think that the quality of products has nothing to do with themselves. In my opinion, Chinese shipyard should educate the workers to increase the workers' awareness of the importance of the quality of their products to let them know that the quality decides the shipyard's success or failure which decide their benefits. If China is to be consistent in this area, we should expect to see more and more quality control emphasis in Chinese shipyards. Efficiency and profit maximization is the direction in which industrial management is now focusing, and quality control is now an important part.

Planning and Coordination

Comprehensive goals are formulated at central CSSC headquarters in Beijing. The regional corporation is responsible for formulating plans for each shipyard and local organization under its control as well as keeping CSSC headquarters informed as to the progress in carrying out the plans. On the local shipyard level, production planning is the principal planning done. This involves work load, production field, and manpower balancing. Shipyard planning is accomplished by establishing milestones for each individual job. Key milestones might include obtaining raw materials, laying the keel, launch, and delivery. Initial planning takes about one month and in done by production management. Each job is then coordinated in with the yard's overall plan developed by the shipyard planning section. At least monthly a shipyard-wide planning meeting is held. This meeting is attended by the planning representative from each shop and the shop heads, and is chaired by the shipyard's vice director. The meeting is used to resolve any planning conflicts and to try to improve yard efficiency. The local shipyard is responsible for keeping the regional shipbuilding corporation informed on its progress in carrying out all plans.

CSSC has a policy that Shipyards fabricate internally as much of the equipment as possible. As a result, a greater portion of their requisitions will be for "raw material". The remaining materials will be divided into two categories: (1) those materials (or equipment) that can be purchased form domestic sources within China, and (2) those materials that must be purchased abroad.

Materials acquired within the Chinese domestic system, either raw materials or finished goods, are ordered at specified time each year. The typical order months for shipyards are February and August; at those times the purchasing agents indicated to the central organization their material needs 6-12 months into the future. These requests are then forwarded to the specified supplier, or to a supplier of the central organization's choice if it is deemed necessary to make the supplier change. If for some reason it is necessary to acquire the material from abroad, the shipyard must first secure approval form the central organization. This process takes approximately three months; only after the approval is given will the purchasing agent be in a position to place the purchase order with the overseas suppliers. Approval of the central organization is only given if one of the following conditions exist[10]:

- The equipment is specifically requested by the owner.
- The material of acceptable quality is not available from a Chinese source.
- The material is not available from a Chinese source within the time period required.

This structure costs China's shipbuilding a lot. According to Fairplay[31], the 2716 ton Berlin Express is due to be handed over to her owner, Hapag-Lloyd during the second quarter of 1990. When this ship is finally delivered, she will be more than one year late on the initial delivery date. In this case, when the order for the vessel was first placed, in 1987, Hudong looked to Japan for the vessel's 15,000 tonnes of steel. The order then had to receive ministerial approval in China as I said before. By the time the contract for the steel was signed, three months had passed. By the time a ship was in Japan on charter to carry the cargo, several more months had passed. And by the time that ship was finally discharged at Hudong, it was six months after the order for the new ship was placed.

Let's compare the time which the procurement of major equipment and material needed(see 4.4.4 on page(85)) between Chinese Hudong(HSY) and Japanese Kobe

Table 4.2: Lead time requirements(months)for selected material for the PD214 [10] [9]

	Hudong	Kobe
Steel Plates	6	2
Auxiliary Machinery	12	9
Main Boiler	14	8
Bridge Console	10	8
Electric Generator	10	8
Main Turbine	14	10
Propeller	6	5
Propeller shaft	6	5
Steering Gear	12	10

yard belonging to Kawasaki Heavy Industries(KHI). Hudong requires much greater time than does Kawasaki to procure major material and equipment. This means HSY has longer lag between contract signing and the start of construction. The long lag delays the delivery of ship. The major milestone of laying keel depends largely on the lead time requirements of key equipment of key equipment. Both yards, HSY and KHI, based their keel laying date for the PD214 on the procurement of the boiler. Lead time are determined form the date of issue of purchase order and the time of delivery of equipment in the yard. In case of HSY, the lead time for the boiler is 14 months, while in the case of KHI , the lead time for the boiler is only eight months(4.2). The Hudong time period included an additional three months in each case to allow for the necessary approvals from the central organization.

4.3 Demand Condition

4.3.1 General Economic Condition

According to Porter's theory, the strength of an industry is decided by the interaction of four determinants. It is important for us to know the situation of China's economy in the world, especially for the shipbuilding industry, the demand of which is derived. How fast did China's per capita GNP grow in the 1980s? Table 4.3 compares the growth rates of GNP in 1980-1990 with those of earlier periods. There can be no doubt that the growth rate in the 1980s was substantially higher than in the pre-1980 period. Indeed, except for the early 1950s and the three years 1962-65, when the economy was recovering from war or economic disaster, at no time in the history of the PRC has the economy grown as fast as in the 1980s.

Today's China is very similar Japan in the 1950s and 1960s. During that period, Japan's home market demand was growing rapidly in industries in which other nations' markets had begun to level off. This produced some significant advantage. This demand gave the industries the conviction to invest aggressively in large, efficient facilities with the latest technology at a time when the industries in other countries were incrementally adding to existing, less efficient older plants. Now in China, the problems are the too hot economic development but not the recession like in the other countries.

As economic growth has accelerated, major changes in the economic structure have occurred, as shown in Table 4.4. Output and employment structure have shifted in favor of industry and services, suggesting a continuation of the industrialization process. During the 1980s the investment rate and the export-GNP ratio rose sharply. The rate of increase was much higher in the 1980s than in the 1970s. All in all, economic achievements in the last decade were quite impressive.

4.3.2 Shipping Industry

The government's stated shipping policy is to carry all of its domestic waterborne trade and as much of its foreign trade as possible in Chinese flag ships. It is not surprising , therefore, that Chinese-flag ships are carrying over 40 percent of all cargoes transported in China's total seaborne foreign trade, one of the highest percentage

Table 4.3: Average Annual Growth Rates 1952-90(%)[61][5]

Period	GNP	GNP per capita
1952-57	9.2	6.8
1951-62	2.1	1.3
1962-65	15.1	12.6
1965-70	6.9	4.2
1970-75	5.7	3.5
1975-80	6.5	5.2
1980-85	10.1	8.7
1985-90	7.8	6.2
1952-80	6.2	4.3
1980-90	8.9	7.4
1980-2000 (planned)	6.0	4.7

for any of the world's national-flag merchant fleets. foreign trade is a major factor in the development of a nation's merchant marine. With regard to international trade, its volume grew dramatically between 1980 and 1992, from $38.14 billion to $165.6(table 4.5) for an average rate of growth of over 12 percent. By comparison the rate of growth of world trade between 1980 and 1991 was 5.5 percent per annum[17]. Thus China's share of world trade, though small, expanded rapidly. According to the General Agreement on Tariffs and Trade, in the period 1979-89 China's ranking as a trading country increased more than any other country in the world[1]. Its share of international trade rose from 0.97% to 1.7% during the same period. In 1978, China was the world's thirty-second ranked exporting country. By 1992, China is already the world's eleventh largest trading nation with a volume of US$ 165.6 billion, placing herself ahead of Taiwan, Singapore and South Korea but behind Hong Kong[54](table 4.5). Such growth, however, poses a problem for China's ocean shipping sector.

China's merchant marine grew steadily larger from 1960 on. In 1991, China's mer-

[1]GATT, International Trade 1989-90, Vol. I pp.28-30

Table 4.4: Selected Economic Indicators 1970,1980 and 1990(%)[59]

	1970	1980	1990
Share in GDP			
Agriculture	47.4	30.4	23.3
Industry	36.0	49.0	52.7
Services	16.6	20.6	24.1
Share in employment			
Agriculture	80.8	68.9	60.0
Industry	10.2	18.5	21.4
Services	9.0	12.6	18.6
Rate of investment	26.3	31.8	37.1
Ration of exports to GNP	8.2	10.8	15.2

chant fleet consisted of 2382 ships, and totaled 14.3 million, 3.3 percent of world fleet[49](table 4.6). China's average annual growth rate of above 3 percent in ship gross register tonnage was one of the largest for any of the world 's merchant fleets.

China's merchant marine is state owned and controlled. Authority flows from the National People's Congress through the State Council to the Ministry of Communications, which directs the nation's domestic and foreign shipping activities. Forced to look overseas to expand her foreign trade and to reduce her reliance on foreign ship charters, the government determined to develop China's own nation-flag fleet of merchant ships. With the approval of the State Council, the Ministry of Communications, in April 1961, established the China Ocean Shipping Company(COSCO) as a commercial enterprise. Now it has the world's largest single fleet. Large numbers of bulk-cargo, freighter and container ships have been coming into the fleet from China's own shipyards. By the end of 1986, 18 percent of all the ships in the Chinese merchant marine were built in the nation's shipyards[2].

[2]Source: U.S. Maritime Administration. Special computer printout based on Lloyd's Register of Shipping computer tapes. October 13, 1987.

Table 4.5: China's Foreign Trade, 1980-1991(US$billions)[7]

Year	Total	Imports	exports
1980	38.1	20.1	18.1
1981	44.0	22.0	22.0
1982	41.6	19.3	22.3
1983	43.6	21.4	22.2
1984	53.6	27.4	26.1
1985	69.6	42.3	27.4
1986	73.9	42.9	30.9
1987	82.7	43.2	39.4
1988	102.8	55.3	47.5
1989	111.6	52.5	59.1
1990	115.4	53.4	62.1
1991	135.7	63.8	71.9
1992	165.6		

COSCO started in 1961 with four vessels totalling less than 30,000 dwt. Today, it boasts 620 vessels of various types, aggregating 14.54 million dwt. COSCO now owns and operates 71 full container vessels, seven semi-cellular container vessels, 69 multi-purpose vessels, 16 ro/ro vessels, 14 tankers, 14 timber carriers, two LASH ships and two passenger ships. "COSCO's fleet expansion aims to serve primarily China's growing foreign trade," says Chen Zhongbiao, deputy general manager of the state-owned company[2]. In the last five years the company has purchased 63 vessels totalling 1.8 million dwt to replace outdated ships. "Our improved service has attracted more customers and made us more competitive on the international shipping market," says Chen. One of measures that enhance COSCO's competitiveness is reflected in a set of service standards for its liner operation described as "pre-selection of specific ports, determination of fixed shipping routes, creation of fixed schedules, and assignment of specific vessels." This has made it possible for COSCO's liner services to maintain a punctuality rate of 100% and guaranteed prompt delivery of goods, Chen says. The size of its fleet will not see a remarkable increase in the near future but its structure will be further readjusted according to changing needs, Chen says. The development of COSCO will first give CSSC a chance to build new ships

Table 4.6: China-flag Fleet[49]

Year	No.	1000 grt/gt	% of world fleet
1960	201	402	0.3
1970	248	868	0.4
1980	955	6837	1.6
1981	1051	7653	1.8
1982	1108	8056	1.9
1983	1179	8674	2.1
1984	1262	9300	2.2
1985	1408	10668	2.5
1986	1562	11567	2.9
1987	1773	12431	3.1
1988	1841	12920	3.2
1989	1907	13513	3.3
1990	1948	13899	3.3
1991	2382	14299	3.3

and then only if CSSC can not, the order will go outside. Let's compare the age of China's merchant fleet and Japanese merchant fleet(table 4.7). The age of the Chinese merchant fleet is 1.8 times older than the age of the Japanese merchant fleet. Especially the general cargo ships are the worst case. It is obvious that China need new ships more urgently than Japan. Furthermore, Chinese economic development is the quickest in the world. The domestic demand is of much more potential in China than in Japan.

4.4 Factor Condition

4.4.1 Manpower

China has a population of 1.14 billion, about 20% of the total world population, according to 1990 census and a labor force of 697 million. The distribution of educated labor force is not even. There are more skilled labor along the sea shore where most of shipyards locate.

Table 4.7: The age of Chinese and Japanese fleet[49]

Ship type	Chinese age	Japanese age	C/J ratio
Oil tankers	16.2	10.4	1.6
Chemical tankers	11.3	9.2	1.2
Liquid gas tankers	14.7	10.1	1.5
Bulk carriers	15.9	8.5	1.9
OBO carriers	-	16.9	-
Container ships	11.4	7.7	1.5
General cargo ships	19.6	9.2	2.1
Passenger/Cargo ships	16.0	11.4	1.4
Average	17.9	9.7	1.8

Education

Education is very important for a country. High education will supply a potential for accepting high technology to improve productivity. In fact, China has its tradition of paying attention to education. Kids in China try their best to go to university, because education will decide their life occupations and social status. Many Chinese families are greatly concerned with the education of their children. Normally, after nine years of general education, graduates are faced with two choices: first, to go to general senior school and prepare to enter university; and second, to receive vocational education or training. Some graduates enter specialized secondary technical schools or vocational senior schools. while others to technical schools or to short-term training courses and undergo vocational training.

Employment training centers have been set up by labor Bureaus to train young job-seekers who are not able to enter higher schools providing various types of vocational training in cities and towns. The training period is mainly for a short time, from three months to one year. By the end of 1985, employment training centers run by labor service companies all over the country reached a total of 1,345, where 1.77 million persons had been trained, comprising 43 percent of the total employed people[42].

Apprenticeship training is the traditional form of training of skilled workers in China. Apprentices are trained by their masters at workplaces in production, and practice what they have learned right at the place where they are apprentising. The training period varies from two-to-three years, in accordance with the requirements of the skills in different trades. during the training period, all apprentices receive a living allowance and the same labor insurance and other material benefits as the regular workers. They may become regular workers only after they pass an examination at the end of the apprenticeship period.

The Chinese shipyards have their own technical schools. The training period for junior middle-school graduates is three years, and for senior middle-school graduates it is one or two years. Teaching consists of (a) general knowledge and theory of technology, and (b) practical work in workshops. The curricular include politics, general knowledge, basic technology and specialized technology such as welding, shipfitting, pipefitting, painting, chipping and etc. Practical work in each work shops is an important subject and generally accounts for 50 percent or more of the total hours of training.

The top graduates will go to colleges. Since 1980 the annual growth rate of students in all kinds of higher education institutions has been 8.3%. In 1991, 619,900 college students for regular and professional training courses were enrolled. Chinese education is expanding more rapidly than even the most optimistic projections. However, if the country is to quadruple economic production by the year 2000, the annual output from higher education is still far short of the demand for qualified manpower. To solve this problem, the Chinese government instituted some radical changes in the educational system. These changes give the educational system its flavor and provides the means for the shipyards and associated industries to train their personnel. The reform would involve government relinquishing (to the universities and industry) a degree of control over college enrollment and job assignment after graduation. The universities would gain the most power. Now for the universities would be the autonomy to accept any student sponsored by a funding organization or industry. The universities would also be given more authorities over educational matters, such as structuring curricular or selecting textbooks. The universities would also have more say over funds received form the state and, for the first time, could raise funds on their own. The universities were given control over their administrators to hire or fire as they saw fit. Finally, they were given the freedom to solicit and engage in joint research projects with industry or other organizations.

The new autonomy given to the universities helped make industry a more active participant in education. Under the joint research program and industrial sponsorship of student's program, industry began to work more closely with universities to fill their educational needs. A direct interface was established between an employer, who funded the education of a worker, and the university, that provides the education. One program that evolved was commissioned enrollment, under which, shipbuilders and other industries contract with local and national universities for the education of selected employees. The contracts call for the university to train a set number of students in the skills the industry needs. These students are then employed by the client enterprise upon graduation. The student may or may not come from an existing employee of the enterprise. If the student is not sent by the enterprise, the university designates the student. In return, the enterprise pays the recurrent expenses for each student and a considerable portion of the capital cost. By participating, the university increases its capacity and creates a new source of funding. Besides better educated workers, the industry can work with the universities to tailor new programs to better fill industry's needs[24]. Using this method, the shipyards and their suppliers educate the majority of their workers who require post-secondary education.

There are three universities engaged in shipbuilding and two shipbuilding institutes. In all, 3000 men and women graduate with backgrounds in shipbuilding every year[50]. Shanghai Jiao Tong University is worth mentioning, which is one of the best universities in China. Many professors got educated from Britain, U.S.A., Japan, Denmark etc. A large department of it was wholly engaged in shipbuilding equipped with advanced facilities filled with students graduate from top schools. Chinese president, Jiang Zheming and the president of CSSC, Zhang Shou graduated from this university. It has its own towing tank which is a member of Advisory council of ITTC. Besides this university, there are lots of universities engaged in designing diesel engines, auxiliary machinery, navigation instruments, communication equipment and ship materials. Large shipyards also run their own ship designing institutes.

Compared with Japanese and South korea, I would say that Chinese education is not as bad as what westerns think. Graduates from Chinese universities could compete any graduates from all over the world. In Chinese shipyards the hired graduates are put into workshops in one year, where they learn skills and techniques from senior workers or supervisors. After one year, they have experienced in working in each workshop of shipyards. In the course of training not only skill acquisition but also moral training as one of the members of a communal body, an enterprise, are considered to be of great importance. Since the new employee weathers the reality shock easily and begins to learn how to work, deal with people, manage, resistance to change, deal with the boss and the peer groups and get a sense of identity in the organization, he or she is becoming a full-fledged member. And the big difference between China and Japan is the training after they hire the graduates. Normally, Chinese shipyards give a little chance of retraining those employees with university degree. In the meantime, in Japanese shipyards, employees keep on being trained through their worklife so that Japanese employees could get new technology. After a certain period such as five years, Japanese employees with university background will be more sophisticated than Chinese ones with the same background.

Labor System

Before reforms started, labor market in China was highly rigid. This was the result of job assignments by central authorities and life long employment. Workers enjoyed the "iron rice bowls" with complete security of employment. After 1978, the authorities recognized the need for a stronger link between compensation and productivity and the need to give enterprises more flexibility in managing their workforce. To enhance flexibility of enterprises, contract labor system was introduced in 1986. Under the system, newly employed workers and staff would enter into contract with the enterprises, usually for a duration of three or five years. In general, enterprises have been given greater autonomy in hiring and dismissing employees. In terms of geographical mobility, restrictions have been eased by issuing temporary residence limits which allow rural residents to work in the urban areas.

Under the Eighth Year Plan(covering the period 1991-95), the wage system of enterprise would be gradually moving from a uniform grading system to one based on skills and requirements. In fact, workers are difficult to change jobs in China now, because workers welfare program were enterprise-based and were not transferable. This is good for shipbuilding industry, because the know-how in the shipbuilding industry needs the accumulation of experience over time. This employment policy definitely helped build up the team of experienced working force.

Though the enterprises were given greater flexibility in terms of employment of workers, they were hesitant to exercise the autonomy. They were reluctant to dismiss workers due to the strong reactions and fierce resistance form the workers and sympathetic colleagues. In China's shipbuilding industry, the contract employee's status was as secured as that of a lifetime employee under the old systems. This led to the problem of underemployed in the shipyards. In contrast to China, Japan lacks workforce in shipbuilding industry, which unfortunately is a labor-intensive industry. In Japan, the image of shipbuilding during the past decade of decline is proving to be a major problem for Japan's shipbuilders as the industry experiences better times. The problem is often summarized in the three Japanese words kiken, kitanaei and kitsui, commonly known as the "three Ks", which describe the industry as being "dangerous" "dirty" and "hardwork". School leavers, more importantly, graduates no longer find the industry an acceptable career and thus the country's shipyards find that the average age of their workforces continues to rise, and that they are unable to recruit new workers to meet demand. To make the matter worse, during the depressed time, Japanese shipyards introduced a no-recruitment policy. Actually, most yards in Japan are looking into ways of increasing the level of automation and identifying what tasks robots could do. The objective is three-fold: more mechanization will make up for the labor shortage while also increasing, or maintaining, productivity and efficiency. It's introduction will also make the working environment more attractive to potential recruits. However, what every shipyard wants is the unobtainable–the robotic solution to building large sections. No one can envisage this concept happening so the yards have to confine themselves to the areas where robotisation is both practical and reliable.

The Japanese industry is facing increasing production costs, caused mainly by the serious shortage of skilled labor. With workers being lured away from shipbuilding into other areas of heavy industry such as car manufacture by higher wages, the Japanese shipbuilders have had to raise wages in order to keep their skilled workers. The age profile of Japan's shipyard workers is on average early forties[37]. This means that there is a vast of amount of expertise available, but clearly in 20-25 years time, around 2015, that will have worked through the system. For at least some years in Japan, shipbuilding was seen as a sunset industry by young people, who do find shipyard conditions of noise, dust, exposure to the weather unattractive working conditions but prefer office or light factory work.

There are three types of basic salary in Japanese companies, namely, basic salary based on job classification (SHOKUMUKYU), basic salary based on job capability (SHOKUNIKYU) and basic salary based on seniority (NENKOKYU). Most Japanese companies accept the combination of NENKIKYU and SHOKUNIKYU[25]. As wages are tied to years of service, obviously the increasing average age of the Japanese workforce inevitably increase the annual wage bill. It is clearly difficult to obtain an "average" wage level of a shipyard worker as it is dependent on so many factors; however the consensus appears to hover around 5 million Yen/yr which equates to about US$ 40,000/yr. However, there is a pro rota increase in the number of sub-contractors, now a figure of 17,124, even a little bit over regular craft and skilled workers, a figure of 15211[12]. This is seen to reflect the builders' policy of spreading the workload when busy, without increasing their number of full-time employees. Now in China shipyards, sub-contractors are also used because full time workers don't like to do some dirty and dangerous jobs.

Employee Profile

This section profiles the workforce in a typical Chinese shipyard by examining the workforce in a medium sized shipyard. The data are shipyard non-specific. Instead of illustrating the actual conditions found in one Chinese shipyard, the data presented are an average of conditions found in medium sized shipyards throughout China. The section emphasizes the character of the workforce instead of just listing skills employed. The section does not try to describe all the skills utilized in the Chinese shipyard.

Figure 4-4 provides an overview of the entire employee breakdown for medium sized Chinese shipyard. The administrators include managers, foremen, and staffs. The following points should be highlighted. Compared with other world shipyards, Chinese shipyards have a significant shortage of staff personnel and engineers[51]. Additionally, Chinese shipyards tend to have a proportionally large indirect labor force compared with other shipyards around the world. The shortage of staff personnel and engineers cause inefficiencies in that planning, coordination, and design work do not receive the optimum degree. This translates into more problems in operations. A large indirect labor force is inefficient because their role is strictly support. Because each worker is an added cost to production, if that worker does not add more to production than his cost, the efficiency of the yard is reduced.

Figure 4-4: Chinese Shipyard Employee Breakdown[51]

Employee type	number	proportion
Direct & Asst. Foreman	2376	0.72
Administrators	231	0.07
Technicians & Engineers	198	0.06
Indirect & Asst. Foremen	495	0.15
Total	3300	1.00

Ratio

Direct labor/Indirect Labor	2.6
Direct workers & Asst. Foreman/Indirect Labor	4.8
Administrators/direct Workers & Asst. Foremen	0.1
Managers & Foremen/Direct workers & Asst. Foremen	0.06

The employees can be broken down further to :

Employee type	number	proportion
Managers and Foremen	146	0.044
Staff and Engineers	316	0.096

4.4.2 Capital

Finance can be broken down into two general areas: shipyard finance for capital acquisitions and the capital to finance each shipbuilding project. Each is critical important to the well being of the shipyard. Without a source of funds for capital acquisitions, the shipyards would be unable to modernize and would lack the equipment and tooling required to build ships in a competitive fashion. Project financing applies principally to the buyers. Normally, shipyards do not engage in speculative building. The shipyard only begins a new project after it has a firm contract. But project financing is a major shipyard concern in that if buyers are unable to secure financing to purchase ships, shipyard orders will fall and the yards will sit idle, absorbing heavy losses due to fixed costs.

Chinese shipyards have four sources of funds for capital acquisitions:

- net after-tax shipyard income
- capital supplied by the CSSC/State
- bank borrowing
- capital supplied though joint ventures

Acquisitions from cash flows (after tax income) and bank borrowing are treated in the same way that such transactions are handled in the west. For cash purchases an asset is debited and listed on the balance sheet and cash(or its equivalent) is credited. For bank loans, the loan is listed as a liability and a schedule of payment is arranged for both principal and interest. Terms of most loans are very generous. Depreciation of assets is used in China with depreciation charges made against net income. Straight line depreciation is the most commonly used method of depreciation.

The Bank of China is a frequent source of loan capital. Additionally, regional trust companies tend to provide smaller loans but are important in that they help open up diversified channels for sources of funds. This loan source is important because it both speeds up loan processing and reduces the competition for smaller, more regional borrowers. Investment trust companies may be organized according to regions or industries or trades. The Dalian Municipality Investment Trust Company is one regional trust company that has been extremely successful as a new source of capital for expansion and modernization.

Capital supplied by the CSSC and the state is treated as an infusion of equity funds and no repayment is required. To get such an investment, the enterprise is required to submit a plan showing how the investment will increase profits, and return on investment to the CSSC/state. Of course, the more attractive the enterprise can make the investment look, the greater the chance it has of getting the funds. The CSSC does have criteria that it uses to allocate such investment funds with "return" or "interest on money" an important consideration. Another criteria includes the relative importance of the enterprise. The state will provide the necessary financial support to the technological transformation of the old industrial bases, but it would not be possible to depend on state support alone since, in reality, the state is unable to shoulder the whole burden. The final source of financial available to Chinese shipyards is from foreign corporations. In this type of venture China essentially allows a foreign corporation the chance to buy into the Chinese market with technology, training, and facilities[19]

4.4.3 Raw materials

The major portion (60-70 percent) of the total cost of a ship consists of inputs such as steel, engines, and other components. Steel is a critical material cost item in ship construction. Most steel used in merchant shipbuilding is low carbon, mild, or ordinary-strength steel. Higher carbon and other alloy steels are also used. Structural steels used for commercial construction in the world market must be certified by a certain ship-class society. Despite China is the third largest steel production country, since the major problem with Chinese steel production was that the mills just could not consistently produce batches of quality steel, most of this steel has to be imported from Japan or South Korea, because the ship owners are much in doubt about the reliability of the steel made in PRC. Rising costs of imported materials combined with erratic delivery of them conspired to lengthen completion times at Chinese yards. The drain on hard currency imposed by the need to pay for the 50-60 percent of equipment that still must be imported for the more sophisticated vessels, continues to place severe limits on the competitive position of China's yards in relation to shipbuilding industries in either the more affluent AICs or bountiful NICs. However, since China has had quality control program in steel production, overall steel quality will get better in the future.

Chinese government realized this problem and then decided to invest in new modern steel mill. The Baoshan Iron & Steel complex(BISC) is the largest single construction project to be undertaken since the founding of the People's Republic of China in 1949. BISC boasts an annual capacity of 6.5 million tons of pig iron, 6.71 million tons of steel and 4.22 million tons of steel materials. So, the complex's current capacity of some 7 million tons of steel a year represent no more than one tenth of the nation's total steel output. Furthermore, BISC's most important contribution to China lies not in the quantity of the steel it provides but in quality. Although China's steel output has continues to grow in recent years, the quality and variety are still lacking and the country has to import specific types of high quality steel material. Nearly all steel produced domestically is of an ordinary variety while steel demanded by shipbuilding, automobile, oil and other industries must be of a high quality. Since BISC has strict production standards, which are higher than those used internationally, and required all its products be of the same quality as similar foreign ones, its ship hull steel has been certificated by six ship-class societies which are Germany, Norway, British, the United State, French and China[26]. BISC will contribute much to China's shipbuilding industry.

4.4.4 Technology

Physical Characteristics of Shipyard

In fact, it is difficult to compare two shipyards in different countries. The reason is different shipyards build different ships in terms of size and type and sometimes luckily enough they build the similar ships but in different time. I think that we had better choose the latter choice. As I pointed out in chapter 3, shipbuilding industry is comparatively mature. So the improvement of product process in shipbuilding industry is not measured as by day or by month as in hi-tech regime.

The baseline ship which Chinese Hudong Shipyard (HSY) and Japanese Kawasaki Kobe Shipyard (KHI) built was the PD214 general mobilization ship described in the

Table 4.8: Size of production facilities at Hudong and Kobe Shipyard(ft^2)[10][9]
3mm

Production Category	Hudong (A)	Kobe (B)	Ratio (A/B)
Fabrication	310,680	83,510	3.72
Sub-Assembly	314,330	67,790	4.64
Assembly	335,190	139,800	2.4
Erection	203,480	230,400	0.88
Total	1,163,680	521,500	2.23

1978 MarAd report[1]. The problem is time. A contract signed on January 1, 1980 in KHI, while on January 1, 1986 in HSY. Some might argue that the six-year difference in when the ships were to be built would invalidate the comparisons. I would argue that six years is fine because the reason is law of diminishing returns that China's productivity will increase much faster than Japan's. There is a limit to the productivity improvements that can be achieved from compute-aided manufacturing and robotics in the near future because of the nature of ship construction. For example, Mitsubishi expects less manual involvement in welding and painting and hopes to automate these areas as much as possible. It feels that the modernization already carried out has reduced manhours by 50%, so the potential productivity benefits of any newly introduced mechanization will not have anything like the same effect. The easy welding work has already been automated but the more complex jobs will be much more difficult to mechanize. Furthermore, the objective of the comparisons is to get some idea of the relative difference between Japanese and Chinese shipyards.

Table 4.8 presents the square footage tallies for the different facilities for two yards. HSY has nearly 310,680ft^2 for prefabrication and fabrication operations; KHI has about 84,000ft^2 dedicated for this service. Hudong's space availability is 3.72 times that utilized by KHI. For the assembly operations Hudong again utilized significantly more space than does KHI. As table 4.8 shows, HSY's subassembly operations comprise 314,330ft^2 while KHI's subassembly activities requires only 68,000ft^2. This is a difference of 4.6 times in favor of Hudong. The final assembly operations have 335,000ft^2 of space; KHI utilizes only 140,000ft^2. Hudong dedicates over two times as much space to this production activities as does KHI. The only space that KHI uses more than Hudong is erection space, the ration is 0.88 in favor of KHI. Overall, Hudong production facilities encompass about 1,163,680ft^2 at HSY, and KHI facilities cover 522,000ft^2. The difference is significant in that KHI's space use is only 40 percent of Hudong's. It is obvious that Hudong's bottleneck has too small erection space.

There is significant ground movement of the blocks at Hudong. Depending on the type of block being manufactured, the travel distance is 6 to 15 times greater at Hudong than KHI-Kobe. KHI-KObe appears to have more of a consistency of capacity at each of the area than does Hudong. In Hudong, you will see the large amount of pipe and structural material in the storage lot because the national planning system permits the ordering of material only two times per year. So the inventory cost in China is much higher than in Japan. Moreover, that Hudong has less extensive covered structure results in lower productivity because of less comfortable condition.

Productivity

There are major differences in the shipyards'operational capabilities. The most significant differences are found in the cutting operations, welding operations, pipe shop operations, CAD/CAM operations and painting operation. Automatic and semi-automatic welding operations are more extensive at KHI than at Hudong. KHI's pipe shop is nearly fully automated; Hudong's pipe fabrication is mostly manual and is also segmented into three separate operating locations thus reducing potential benefits from economics of scale. KHI has utilized CAD/CAM throughout its operations satisfactorily. Hudong, on the other hand, utilized CAD/CAM software for a short time. KHI has adopted robots through its paint shop operations.

Hudong requires significantly more direct man-hours to build the PD214 than does

Table 4.9: Man-hours required to build five PD214, Hudong and KHI(000 M/H)

ACTIVITIES	SHIP NUMBER											
	1st		2st		3st		4st		5st		5-ship Average	
	HSY	KHI	HSY	KHI	HSY	KHI	HSY	KHI	HSY	KHI	HSY	KHI
Mold Loft & Prefabrication	141	32	122	12	121	6	121	4	121	1	125	11
Hull Assembly	491	130	478	126	471	122	462	119	457	118	472	123
Hull Erection	347	96	339	93	327	90	324	88	322	87	331	91
Fitting & Outfitting	204	56	196	54	190	53	189	52	189	51	194	53
Piping	170	116	162	112	157	109	156	107	155	106	160	110
Machinery (Sheet Metal)	261	58	247	56	245	55	243	53	241	53	248	55
Electrical	119	31	112	30	111	29	109	29	108	28	112	29
Painting (Insulation)	212	68	208	65	202	64	201	62	197	62	204	64
Testing & Trials	30	2	28	2	27	2	28	2	28	2	28	2
Design Engineering	248	51	25	11	22	2	20	0	17	0	66	13
Miscellaneous	103	70	80	44	82	37	77	34	73	29	83	43
Grand Total	2326	710	1997	605	1955	569	1930	550	1908	537	2023	594

KHI. The direct man-hour estimates for both yards for each of the five ships are shown in Table 4.9. For all the activities, Hudong requires an average of 2023 thousand man-hours for each ship, which is about 340 percent greater than KHI's requirements for each of the five ships. On the basis of the total direct man-hours, which includes both production and engineering, Hudong is about 3.27 times greater than KHI on the first ship (2326000 man-hours versus 710000 man-hours), and about 3.4 times greater for the five ship average. Relative to Table 4.9, it must be remembered that Hudong's estimate was based on production procedures in place as of January 1, 1986-nearly six years after KHI's contract date. During the six-year period, KHI has probably continued to improve its productivity making the actual difference in productivity for the two yards greater than shown in Table 4.9. However, the labor costs in China is almost around one-twentieth of those in Japan. Furthermore, China has such a huge labor resource that it seems to impossible for the wage to increase very quickly. So the difference of wage between two countries will last a definite long time.

The effects of learning on productivity improvement are shown in Table 4.10. The production activities show approximately the same rate-of-charge for the two shipyards over the five ship series, with the fifth ship requiring only 91 to 93 percent of the man-hours estimated on the first ship, except the hull production, where the estimated manpower requirements for the fifth ship is only 80 percent of the first at KHI, and 92 percent of the first at HSY. On a total man-hours basis, KHI's reductions are greater than Hudong's. The Japanese yard needs only 76 percent of man-hours for

Table 4.10: Effects of experience on productivity improvement[10][9]

Activities/Ships of Seriers	% of 1st ship man-hours				
	2nd ship	3rd ship	4th ship	5th ship	5-Average
Hull Production					
Hudong	96	94	93	92	95
KHI	90	84	82	80	87
Outfitting					
Hudong	95	93	92	92	95
KHI	96	95	93	91	95
Painting & Insulating					
Hudong	98	95	95	93	96
KHI	96	94	91	91	94
Design Engineering					
Hudong	10	8.8	8	6.9	26.7
KHI	22	4	0	0	25
Total Man-hours					
Hudong	86	84	83	82	87
KHI	85	80	77	76	84

the fifth ship as for the first, whereas Hudong's reduction is only 82 percent of the first. In the hull production, KHI's budget decreased greatly from the second ship's 90 percent of the first ship to the third ship's 84 percent of the first ship, while Hudong's budget decreased mildly from 96 percent to 94 percent. In the design engineering, KHI spent 22% man-hours of the first ship design on the second ship, but HSY needed 10 percent man-hours on the second ship. After the second ship, KHI was confident about its design and almost did not change the design, while HSY had to improve the design to the similar degree as the second one. Japanese improvement for the follow-on ships was greater than Hudong's on the basis of percentage improvement. As Table 4.10 shows, KHI projected that the third ship would have a total man-hours expenditure of about 80 percent of the first ship; the estimate for the same ship at Hudong was about 84 percent of the first ship.

Research and Development

CSSC operates 37 research institutes. In all, CSSC employed a work force of about 300,000 ranging from laborers and shipyard workers to naval architects and scientists.

Important contributions have been and are being made by CSSC's research institutions. A major one is the China Ship Scientific Research Center(CSSRC) in Wuxi, Jiangsu province, east China. As the largest shipbuilding research and development center, it has been engaged in ship hydrodynamic and structural experiments and research for nearly 30 years. It is now equipped with the following major facilities:

- Deep water towing tank: total length 474 m; width of the middle portion 14 m; water depth 7m; maximum speed of the two carriages 20 and 15 m/s respectively.

- Rotating arm facility: diameter of basin 48 m; water depth 4.5 m; maximum angular velocity of the arm 1 rad/s.

- Seakeeping basin: length of the basin 69 m; width 46 m; water depth 4m; maximum speed of the carriage 8 m/s.

- Cavitation tunnel: length of the working section 3.2m; diameter of working section 0.8 m; maximum velocity of flow 20 m/s; minimum cavitation number 0.15.

- Low-speed wind tunnel: length of the test 8.5 m; diameter 3m maximum wind speed 100m/s; routing testing speed 60 m/s.

CSSRC also has a ship structure testing facility, ship structure vibration testing facility, impact and vibration basin, photoelastic laboratory, simulation facilities for deepsea environment tests, etc. at its disposal. As a member of the Advisory Council of ITTC, it has formed close ties through technical cooperations and established academic exchanges with worldwide research and development.

A major ship design center in China is the Marine Design and Research Institute of China(MARIC), based in Shanghai. With a technical force of over one thousand specialists, this institute has been providing the shipbuilding industry with ship designs for decades. It has designed more than five hundred types of ships for domestic clients over the past 30 years. Recently, it has designed bulk carriers, containerships

Table 4.11: Research, Selected Indicators, 1980-90[18]

	Share in GNP R&D (%)	R&D personnel (1,000)	Major R&D achieved (no.)	Major inventions (no.)
1980	1.4	323	2,687	109
1981	1.3	337	3,371	123
1982	1.3	372	4,186	153
1983	1.4	328	5,397	212
1984	1.4	335	10,615	264
1985	1.2	336	10,472	185
1986	1.2	366	14,915	26
1987	1.0	314	11,800	225
1988	0.8	307	16,552	217
1989	-	297	20,278	150
1990	0.7	291	26,829	224

and offshore anchor handling/supply tugs for foreign owners[13].

Technological progress is now the feature of world economic development. Notable achievements in R&D have been made in China since 1980, although its contribution to output growth appears to have been quite limited. R&D funding as a percentage of GNP was relatively low by international standards and declined from 1.4 percent in 1980 to 0.7 percent in 1990. The shares for Japan, South Korea were 2.8 percent and 1.8 percent. Table 4.11 also shown that the technical manpower engaged in R&D was in decline from 1986. However, despite the slow growth of inputs, the system has been productive and the rate of increase in the number of major R&D achievements for exceeds that of its funding. Current design studies focus on seven ship types, including LPG carriers, chemical tankers and VLCCs with energy-saving features. Other areas of interest are selfdischargeing vessels and hovercraft[38]. Improvements in design and production efficiency are sought from computers. In the early 1980s the CSSC initiated the first phase of CASIS-1, a project establishing an integrated computer system for shipbuilding. The system involves a range of disciplines, including price quotations, preliminary designs, hull construction, piping, power calculations and power units, propeller design and the ship's critical path productive analysis.

The wide adoption of CASIS-1 is claimed to have improved quality and shortened design and production periods. It also allows the CSSC to respond more readily to changing market conditions and demands. The CASIS-1 price quotation system allows two personnel to estimate the price for a project and print out a quote with standard information an diagrams in 30 minutes. By September, 1988 the system had been applied to generate quotations for 100 newbuilding enquires, including bulkers, tankers and multi-purpose cargo vessels. The CSSC believes the speed and quality of the response have a significant influence in translating the inquiry into a contract. Compute-aided methods have helped reduce overall design times by one to three months. Different proposals and layouts can be easily assessed, promoting a more optimum final result. Most of the major Chinese yards have installed compute-based hull building and piping generation systems. The former element is capable of producing hull outlines, expanding hull plates, designing sections and computing for digital-control paper tape cutting. The piping element can automatically design pipe layouts, check for interference and produce construction diagrams for component parts.

The two system elements in conjunction with digital control cutters and pipe bending machines have reportedly shortened the preparation period by two to three months. The process enables a 15-20% saving in the time for hull assembly and welding, and achieves saving of 150-200t of steel plate. Computers have also allowed the yards to hand over complete sets of drawings and documents simultaneously with the delivery of the ship. (The former manual method often meant that the material was not available until some weeks later; some yards even had to subcontract the work overseas)

4.5 Related and Supporting Industries

. Shipbuilding industry uses materials and goods from more than 50 other industries, including machinery, iron and steel, electronics, chemicals, and furniture. So the overall industry background is important for shipbuilding industry.

4.5.1 Industry Milieu

In 1949, China's economy was overwhelmingly agricultural. Her few dozen mechanically powered factories and mines, some controlled and managed by foreigners, provided only a minute fraction of total product. Today, China is a rising industrial power whose economy displays many features associated with Kuznets's concept of modern economic growth. Industry is now the largest economic sector in terms of output value, although agriculture continues to dominate in employment(table 4.4).

Industry between 1949 to 1978

China had changed from being an essentially rural, peasant economy in 1949 to one in which industry was very significant. The share of industry in national income had grown from 20 percent in 1952 to 49 percent in 1978.

The first decade after 1949 was one of rapid output growth, massive investment, and marked expansion of the potential for qualitative change in China's producer sector. The producer industries, including the machinery, metallurgy, chemical, building materials, energy, and mining sectors, are industries whose output consists primarily of intermediate and capital goods. In reviewing these years, both Chinese and foreign observers have stressed the contribution of former Soviet technology, advice, and managerial systems to industrial progress. The 156 heavy industrial projects carried out with the assistant of the former Soviet Union[47]. Gradual completion of industrial construction projects, brought forth a steady stream of products that China had been unable to manufacture in the past. The key feature of industrial development during the 1950s, however, is neither the sharp rise in output volume nor the equally

Table 4.12: Increase in national income per 100 yuan of accumulation[45]

(current prices)	Year	Increase(yuan)
	1953-57	32
	1958-62	1
	1963-65	57
	1966-70	26
	1971-75	16
	1976-80	24
	1981-85	41

striking costs of this expansion. Together with the experience acquired during the FFYP years and the new technology embodied in imported equipment, these institutional changes represent a gathering of forces with a potential for qualitative gains extending far beyond the limited achievements of the FFYP years. Industrial growth has continued since 1957, but at a less rapid pace than was achieved between 1949 and 1957 because of the break with the former Soviet Union and the poor policy. Actually, China at that time overemphasized heavy industries, but at least the industrial base was built to make economic development possible.

Industry After 1978

Serious reform of the Chinese economy can be dated from the historic Third Plenum of the Eleventh Central Committee of the CCP in December 1978. Between then and the late 1980s substantial changes occurred. The overall industrial growth rate changed little after 1978. However, major changes occurred in the balance of industrial growth, of which the most striking was the reversal in the growth rates of heavy and light industry, reflecting China's move away from a Stalinist economy. Much capacity shifted from heavy to light industrial production. Moreover, the overall productivity of capital almost certainly increased(table 4.12) so that less output was required of the capital goods industries to produce a unit of final product. However, China didn't go to extremes like before. China also pay attention to investment in heavy industry. In 1991, China produced 71 million tons of steel ranking 4th among the steel producers of the world after the former Soviet Union, Japan and the United States[48]. In fact, steel is necessary for lots of industry, especially for shipbuilding industry.

China has nine major plants and hundreds of smaller facilities spread across the country. A majority of these plants were built with Soviet technology in the 1950s(which was not modern even at the time of construction) and are relatively inefficient by western standards. The three largest facilities are Anshan, Shanghai and Wuhan. The Baoshan Iron and Steel complex, located near Shanghai, was to be China's showcase of modern iron and steel technology. The plant was contracted to be built in 1979. Now it can produce special steels which had to import from aboard before.

According to the 1985 industrial census, China's industrial capital was relatively young: 38.9 percent had been built in the 1980s, 43 percent in 1970s and only 18.1 percent before 1970. However, in China's case, this may not be a reliable indicator of quality. Although the bulk of equipment is relatively new, it does not embody up-to-date technology. Equipment built in the 1970s actually uses technology of the 1950s, and also the quality of machinery produced during the Cultural Revolution was poor. Consequently, only one-third of the equipment was technologically advanced, with two-thirds obsolete.

4.5.2 Marine Engineering

Marine engineering is very important for shipbuilding industry. There are two reasons, one is cost and the other is delivery time. The ship's engine accounts for about 15% of the total production cost of a ship. It is difficult to imagine how a major shipbuilding country can face the problem that most of engines and other stuffs have to be imported from other country. In that case, the shipyards will be difficult to control the delivery time, and the fluctuation of the exchange rate.

CSSC's 18 marine diesel and diesel accessory plants are designed to produce high-, medium-, and low-speed diesel engines. There are also factories making marine power stations, navigational equipment, deck equipment, instruments and meters and all other auxiliary ship machinery.

CSSC has begun to produce diesels and marine equipment with technology imported since 1978 from industrially-developed countries under manufacturing licenses. The new engines and machinery have been approved by international classification societies, and are now being fitted on ships for export. The up-to-date technology introduced under 15 license agreements and three co-production contracts including equipment for manufacturing of low, medium and medium-high speed marine diesel engines purchased from Sulzer Brothers of Switzwerland, Societed' Etudes de Machines Thermiqurs of France, B&W Diesel A/S of Denmark, M.A.N of the federal Republic of Germany and Daihatsu of Japan; exhaust-gas turbochargers from Brown Boveri & Company of Swizwerland; coupling, dampers and deck cranes from Dr.-ING. Beislinger & Co. and Liebherr-Work Nensing Ges. of Austria; marine gearboxes from Lohmann & Stolterpoht of the Federal Republic of Germany; forging technology of continuous grain flow for crankshaft from Japan Steel Works; cargo-handling equipment form MacGregor Cargo Handling of France; marine hydraulic deck machinery and hydraulic steering gear from Ishikawajima-Harima Heavy Industries Co. and Kawaski Heavy Industries of Japan; alternators for ship power stations form siemens of West Germany; cartridges and hydraulic cylinders from Sperry Vickers of the United States; and sewage treatment systems, incinerators and marine system boilers from A/S Atlas and Alborg Vaerft A/S of Denmark. Over 40 licences have already been arranged in the 1980s[38], allows, for example, the local production of leading engine designs, transmissions, deck cranes, propellers and cargo access gear. According to the 1992 Chinese Machinery Statistics, most of the 12 export ships in new order except the special technology required, will adopt diesel engines made in China. However, in the global shipbuilding industry, Japanese suppliers play an important role in determining the competitiveness of shipbuilders else in the world. Because of long-established relations, Japanese suppliers are believed by many observers to supply products to their own nation's shipbuilders at lower prices than those offered to foreign shipbuilders.

4.6 Government Intervention

Shipbuilding is an integral part of China's maritime policy. Zhou Enlai, whose influence motivated every aspect of that policy, saw the development of domestic shipbuilding as a highly labor-intensive industry that China required for economic growth. In his speeches he pointed out that ships built in national shipyards would

- strengthen the domestic transportation structure;
- contribute to the transportation of China's foreign trade;
- earn and conserve foreign exchange by helping to reduce dependence on charters of foreign-owned ship; and'
- eventually, become an export commodity of increasing importance to the nation's economy.

In the late 70s China began a program to catch up with the rest of the world technologically. The essence of the program involved acquiring foreign technology through purchase. But, foreign exchange was a scarce resource in China. In shipbuilding China saw the opportunity to develop an existing industry and to generate badly needed foreign exchange[27]. If China could sell ships in world markets, it could use the revenues generated from those sales to fund the modernization effort. Former Chinese Premier Zhao Ziyang stressed the need to increase exports to generate foreign exchange in support of the modernization: "Earning more foreign exchange by increasing exports is the key to expanding economic trade and technological exchange with foreign countries". Shipbuilding, then, was part of the answers to China's dilemma of trying to catch the rest of the world economically and technologically. Shipbuilding exports would generate the foreign exchange that China would use to buy new modern technology as well as to educate the Chinese who would be able to implement that new technology into Chinese life and the economy.

For years the world shipbuilding industry has been seriously hurt by a glut of overbuilding. In this climate new ship prices have fallen because of significant financial provided by the builder or the builder's government. Additionally, credit terms have become very favorable to the buyer in an effort to attract new orders. For any nation to seriously compete in the world market they must conform to this marketing policy of low prices and generous credit(Lloyd's List, 1986-1987). Essentially, five sources of financing exist for buyers of Chinese ships. These sources are the Chinese government, the CSSC, the regional shipbuilding corporation under the CSSC, the Bank of China, and foreign banks or financial institutions. Terms of financing are very similar for all sources. Typically, the financing institution provides a low interest, fixed rate loan that covers 75 to 85% of the shipbuilding contract. A typical arrangement is the agreement negotiated in 1983 between the Bank of China and the Express Shipping Management Company of Hong Kong. In this agreement

> the Bank of China provided a buyer's export credit(to)... the Express Shipping Management Co... The credit is to facilitate a U.S. $20 million order for four ships of less than 10,000 dwt each, placed with the Zhonghua Shipyard in Shanghai... The credit...covers 75-85% of the shipbuilding contract. The loan is to be based in U.S. dollars and is repayable every six months at 8.5% fixed annual belongs to the buyers.

The China State Shipbuilding Corporation is committed to the idea of assigning first priority to fulfilling the needs of COSCO, the monopoly domestic shipping organization. Furthermore, the government's stated shipping policy is to carry all of its domestic waterborne trade and as much of its foreign trade as possible in Chinese flag ships. CSSC is a state-owned company which is obviously controlled by the government. In China, navy needs new ships. Navy's building could adjust the relation of the demand and supply. CSSC contributes to China's defense by building the ROMEO class submarine, the JIANGNAN Class frigate combatant ship, the JIANGHU Class frigates, the KANZHU Class auxiliary-type vessels for the navy. China's participation in the select nuclear-submarine club (with boats built at the Huludao Shipyard near Dalian) could prove that its capability has improved a lot. Not to be overlooked is the sale of warships to outside. For example, Hudong Shipyard pulled off something of a coup during 1989 in selling four Jianghu V-class missile frigate to Thailand.

4.7 Conclusion

The condition which exist in China are somewhat similar to those which existed in Japan in the early fifties, that is, plentiful low-cost labor and a market which seems to have no end. For China, an appreciable market consists of needs for its own coastal, riverine, and ocean-going service. With such work opportunities, conditions are perfect for developing shipbuilding industry as happened during the sixties in Japan.

Though national advantage in shipbuilding is a reflection of a well-functioning "Diamond", the whole system is rarely in place at the start. An advantage in a single determinant or two often provides the initial impetus for formation of a comparative advantage for the shipbuilding industry formation in one nation. As a starting point of view, China has advantage compared with Japan and Korea in shipbuilding industry at least in labor cost. In 1950s when Japan entered the shipbuilding market, the average salary of a shipbuilding worker was much lower than that of the West European countries. In 1976, when South Korea started their export drive in shipbuilding, the average hourly earnings of shipyard workers were 1/4 of West Germany and about 1/6 of Japan. Even today, average hourly earnings of shipyard workers in China is only 1/20 of that in Japan. Furthermore, comparing with the situation at the early stages of shipbuilding development in South korea and other NIC countries, the shipbuilding industry in China was already established through the effects of several decades in buildings for its own needs. When China started to export new ships, it could get steel plate supply from its own plants, not like South Korea, at the beginning it depended on the import from Japan. And also China had already built its own ships for forty years, the workers had experience in shipbuilding, although at that time,only domestic ships were built. Meanwhile, at a similar stage of development, Korea shipyards only produced simple boats, most of them wooden. In short, China has a higher starting point than other countries, which gain comparative advantage in shipbuilding.

Applying Michael Porter's theory, we could see two very important strengths in the China's shipbuilding cluster. One is special domestic and foreign trade demand. The other is endless source of inexpensive labor. In fact, in China's case, with such a rich source of population, the market seems infinite. The growth rate of foreign trade and domestic market show that there is great potential for shipping. In my opinion, the economic recession in Japan, U.S and Europe helps China attract lots of foreign capital to invest in China, because there are few places outside China, where the return of capital investment is better than in China. That China will benefit from the capital from outside will result in the investment environment being more attractive to the world. Even though the world economy recovers after a certain period of time, the investment milieu in China will have been at least as good as elsewhere in the world because of the economic development during the recession period. So that the demand of shipping will be huge will supply the source of the shipbuilding. Home market demand is growing rapidly in shipbuilding industry in which other nations' markets has begun to level off. Booming domestic demand is stimulating the industry to invest aggressively in large, efficient facilities with the latest technology while other countries are slowing down because of the world economic recession. While world shipyards are plagued by overcapacity in shipbuilding facilities, Chinese shipyards do not have sufficient capacity to meet the nation's present requirements for new ships. The heavy investment will decrease the gap of productivity from other shipbuilding nations. In fact, China's planners have set a target for shipyard capacity to reach 4 million tons by the end of the century[21]

On the other hand, shipbuilding is a labor-intensive industry. According to Mr. Yoshio Miwa, Managing Director of Hitachi Zosen, over 50% of ship construction could not be automated[58]. So at the present of level of technology, labor in shipbuilding is very important, although automation could increase productivity to compensate labor shortage or high cost of labor to some degree. But the modernization already reduced manhour a lot, so the potential productivity benefits of any newly introduced mechanization will not function to the same degree like before. In anther words, at present technology, labor is still a very important factor that decides the competitiveness in shipbuilding. As I said before, large source of labor will make it impossible for the wage to increase very quickly like in South Korea. The reason is simple: it is like that the temperature of sea water is more difficult to change than one in lakes or in streams. The low labor cost will last longer and in the meantime, the speed of productivity is comparatively lower. This is where China's comparative advantage lies.

Although the related and supporting industry in China are not as strong as the two factors I mentioned before, it is not too bad. Furthermore, it is growing rapidly. According to the 1993 Chinese Machinery Statistic, most of the export ships have adopted engines made in China. In 1991, Sulzer 5RTA52 made in the Shanghai Yard and Dalian Yard exported to German yards. This is the first time for China to export diesel engines to foreign yards. Besides, the steel made in Baoshan Iron and Steel Complex has been certificated by six ship classification societies. Furthermore, lots of advanced production process are being adopted by Chinese shipyards, namely, zone outfitting method, CAD outfitting and dynamic production management.

In terms of government intervention, China has a great advantage. As we analyzed before, shipbuilding industry does need protection when it is young. In fact, Chinese shipping policy is to carry all of its domestic waterborne trade and as much of its foreign trade as possible in Chinese flag ships. Chinese government does allow shipowners in China to build the ships that Chinese shipyards are able to build. This will guarantee the large domestic demand in Chinese shipyards. As a would-be superpower taking the place of the former Soviet Union, China's need for a navy can protect and support its commercial interests and defend its major coast. This will guarantee the government's commitment to supporting the shipbuilding industry.

However, there is lot of room for Chinese shipbuilding to learn from advanced shipbuilding nations in areas such as quality control, productivity, and production management. Competitive advantage can come quickly if a nation either possess advantages in several determinants right from the start or rapidly develops them. Taking all into consideration, we could conclude that China has potential in the development of shipbuilding industry and will challenge Japan in the near future.

Chapter 5

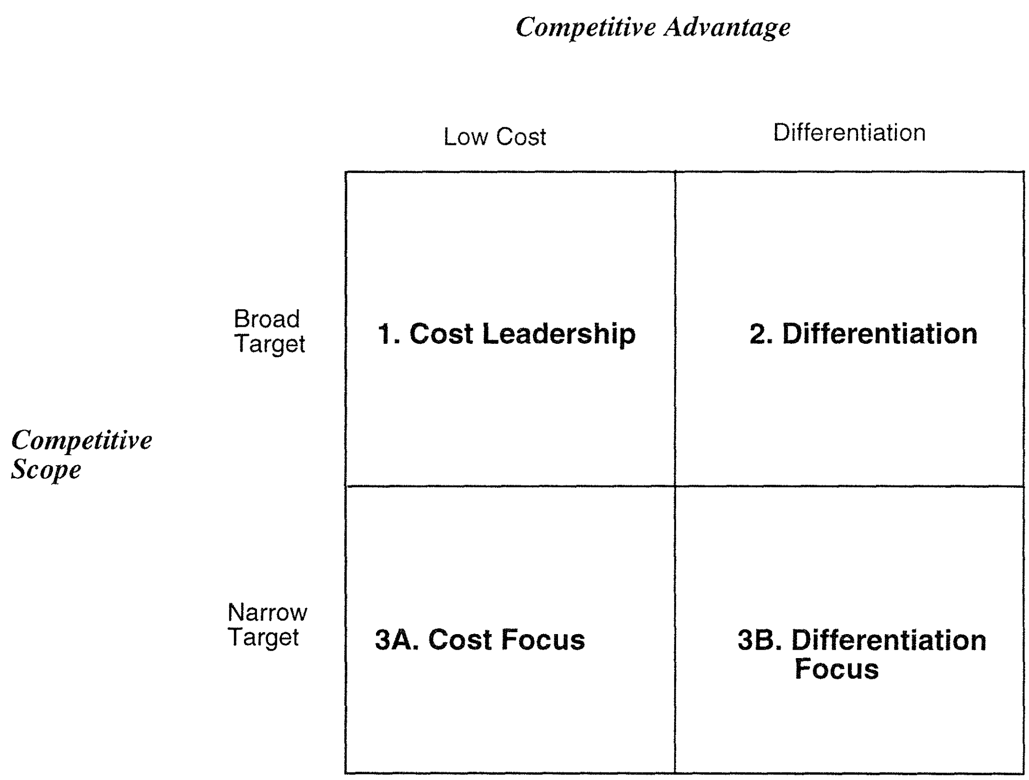
China's Competitive Shipbuilding Strategy

5.1 The Theory of Competitive Strategies

Though one nation can have a myriad of strengths and weaknesses vis-a-vis its competitors in shipbuilding industry, there are two basic types of competitive advantage a nation can possess: low cost or differentiation. These two basic types lead to three generic strategies for achieve above-average performance in an industry: cost leadership, differentiation, and focus. The focus strategy has two variants, cost focus and differentiation focus. The generic strategies are shown in Figure 5-1.

Each of the generic strategies involves a fundamentally different route to competitive advantage, combining a choice about the type of competitive advantage sought with the scope of the strategic target in which competitive advantage is to be achieved. The cost leadership and differentiation strategies seek competitive advantage in a broad range of industry segments, while focus strategies aim at cost advantage (cost focus) or differentiation (differentiation focus) in a narrow segment. The specific actions required to implement each generic strategy vary widely from industry to industry. While selecting and implementing a generic strategy is far from simple, however, they are the logical routes to competitive advantage that must be probed in any industry.

Figure 5-1: Three Generic Strategies[44]



The notion underlying the concept of generic strategies is that competitive advantage is at the heart of any strategy, and achieving competitive advantage requires a nation to make a choice: if a nation is to attain a competitive advantage, it must make a choice about the type of competitive advantage it seeks to attain and the scope within which it will attain it. Being "all things to all people" is a recipe for strategic mediocrity and below-average performance, because it often means that a nation has no competitive advantage at all in shipbuilding industry.

5.1.1 Cost Leadership

Cost leadership is perhaps the clearest of the three generic strategies. In it, a nation sets out to become the low-cost producer in its industry. The sources of cost advantage are varied and depend on the structure of the industry. They may include the pursuit of economics of scale, proprietary technology, preferential access to raw materials, and other factors. A low-cost producer must find and exploit all sources of cost advantage. If a nation can achieve and sustain overall cost leadership, then it will be an above-average performer in its industry provided it can command prices at or near the industry average. At equivalent or lower prices than its rivals, a cost leader, however, cannot ignore the bases of differentiation. If its product is not perceived as comparable or acceptable by buyers, a cost leader will be forced to discount prices well below competitors, to gain sales. This may nullify the benefits of its favorable cost position.

A cost leader must achieve parity or proximity in the bases of differentiation relative to its competitors to be an above-average performer, even though it relies on cost leadership for its competitive advantage. Parity in the bases of differentiation allows a cost leader to translate its cost advantage directly into higher profits than competitors'. Proximity in differentiation means that the price discount necessary to achieve an acceptable market share does not offset a cost leader's cost advantage and hence the cost leader earns above-average returns.

5.1.2 Differentiation

In a differentiation strategy, a nation seeks to be unique in its industry along some dimensions that are widely valued by buyers. It selects one or more attributes that many buyers in an industry perceive as important, and uniquely positions itself to meet those needs. It is rewarded for its uniqueness with a premium price. A nation that can achieve and sustain differentiation will be an above-average performer in its industry if its price premium exceeds the extra costs incurred in being unique. A differentiator, therefore, must always seek ways of differentiating that lead to a price premium greater than the cost of differentiating. A differentiator cannot ignore its cost position, because its premium prices will be nullified by a markedly inferior cost position. A differentiator thus aims at cost parity or proximity relative to its competitors, by reducing cost in all areas that do not affect differentiation.

5.1.3 Focus: Global Segmentation

This strategy is quite different from the others because it rests on the choice of a narrow competitive scope within an industry. The focus strategy has two variants. In cost focus a nation seeks a cost advantage in its target segment, while in differentiation focus a nation seeks differentiation in its target segment. Cost focus exploit differences in cost behavior in some segments, while differentiation focus exploits the special needs of buyers in certain segments.

5.1.4 Protected Market

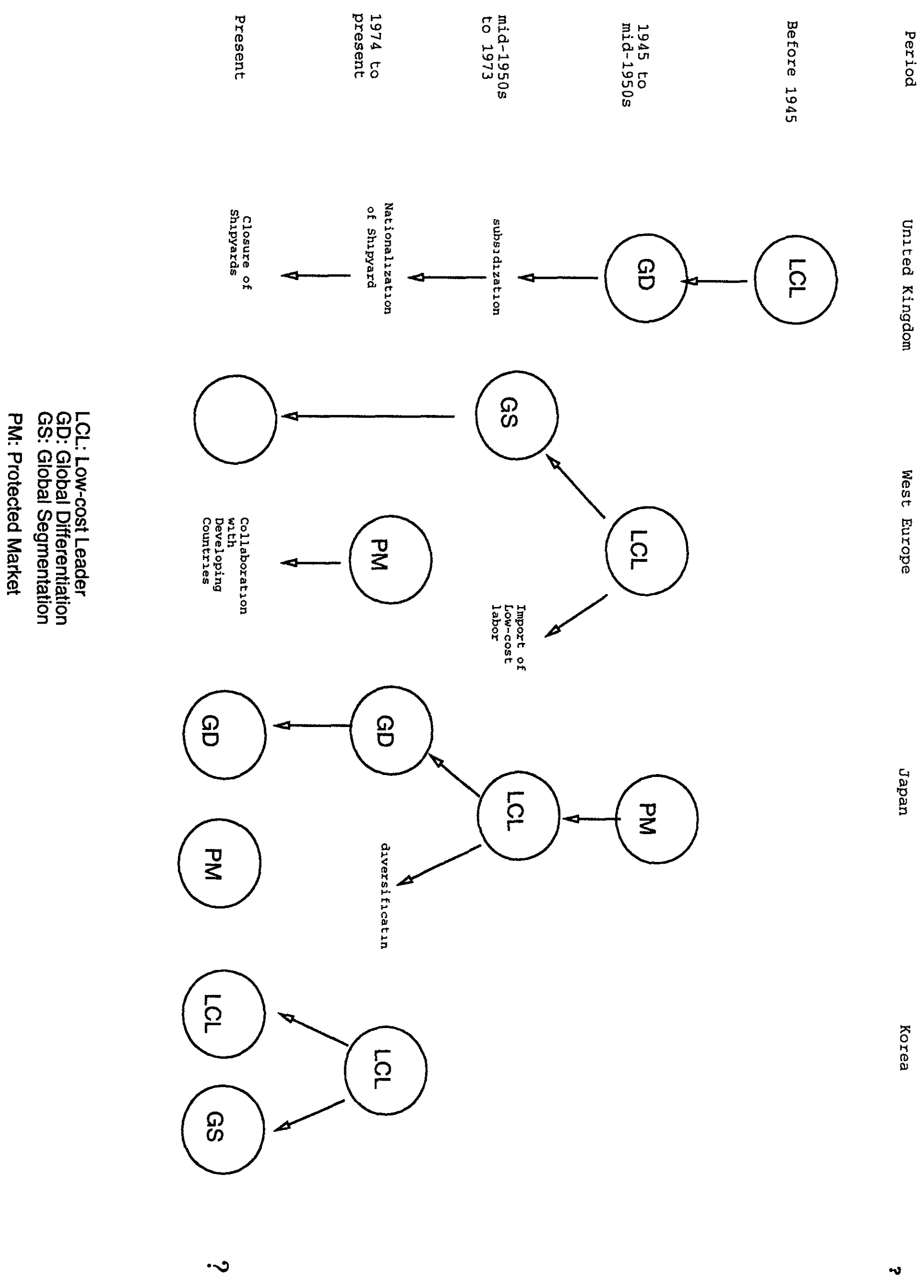
This strategy focuses on a certain countryy. In this strategy, however, a nation's unique position in the global industry is not based on its economic advantages but on the willingness of the local government to protect it. Any shipbuilder capable of coercing governments to forge an artificial demand for ships through price-support schemes, credit measures and downright conjuring up of orders on national account would clearly benefit in the new, competitively charged environment. Soon almost all main nations were calling for government aids as a matter of course. Whichever country cancels subsidies will lost this industry in the competitive world. The U.S shipbuilding is the self-explaining example.

5.2 Global Strategy by Major Shipbuilding Nations

A review of the history that a number of shipbuilding industries took turns as industry leaders(figure 5-2). As we know in chapter 2, British shipbuilding based on the steel and overall industry became a low-cost leader before 1945. With its technology went into comparative maturity at that time, English shipbuilders competed with "global differentiation" strategy. In this period, western countries invested in automatic machines and greatly increased their productivity, so the cost of production were less than British shipbuilders. The market share lost made British industry rot away its advantage of differentiation.

The Japanese in the 1950s took the advantage of its low cost labor and its new technology competed western European countries with low cost strategy. A clear pattern emerges in terms of changes in national strategies over time. Both western European countries and Japan show a succession of strategies from low-cost leadership to global segmentation or global differentiation and then to protected market. This change of strategies does not necessarily coincide with a shrinkage of market share; it did in Western Europe, but not in Japan, which held a constant market share of about 45%(table 1.1). The locus of low-cost leadership has moved from the the United Kingdom, to western Europe, to Japan, and then to Korea. This change suggests that simple factor-based comparative advantage has been shifting over time and that

Figure 5-2: Changes in Strategy by Major Shipbuilding Nations[15]



strategies predicted purely on factor cost advantage are difficult to sustain.

Today, shipbuilders in the major nations are pursuing very different strategies. Western European shipbuilders are pursuing global segmentation strategies(differentiation focus) and are noted for their superior quality and workmanship on particular vessel types. The world's most sophisticated ships, such as icebreakers used in the Arctic or luxurious passenger cruisers, and LNG are invariably built in the shipyards of West Germany, Finland or other European countries. Successful western European shipbuilders are employing a "global segmentation" strategy in complex vessel categories. Although Japan builds almost forty percent of the total tonnage in the world, the order for *Crystal Symphony* the sistership to the Mitsubishi-built *Crystal Harmony*, had gone to Kvaerner Mass-Yards. Clearly price difference was the reason. Japanese NYK could not ignore a 30% cheaper ship, especially as it would be built by an acknowledged expert yard in cruise ship building. LNG ship orders have also been lost to Finland[37]. KMY have the contract for the construction of four, 135,000 cube meter LNG carriers for the Abu Dhabi National Oil Company.

Japanese shipbuilders are competing based on overall differentiation. Japanese shipbuilders can be counted on to keep delivery dates. Their technology allows them to build even the most sophisticated vessel while their quality standard, especially in finishing, is high enough to satisfy any ship buyer. Japanese shipbuilders can utilize a "global differentiation" strategy. Although they do not possess an absolute advantage in any of the criteria considered in ship purchasing, but their combined position appeals to certain differentiated customer group. In the low-sophisticated vessel categories, they can focus on quality sensitive customers to edge out Korean shipbuilders or other NICs. In high-technology categories, they can focus on price-sensitive customers to beat the western Europeans. Japanese shipbuilders' critical weakness lies in labor costs and in their adherence to yen-based contracts. In lots of cases, the contract would have been signed by Japanese shipyards without yen appreciation. Korean shipbuilders basing on their low labor cost are competing old shipbuilders in

Table 5.1: Buyers' Major Buyer Purchaser Criteria by Ship Type[15]

Vessel Category	*Price*	*Delivery*	*Quality*
Oil Tankers	8	2	0
Bulk Carriers	7	3	0
General Cargo Ships	6	3	1
Container ships	4	3	3
LNG Carriers	2	2	6
Passenger Ships	1	2	7
Oil Rigs	1	3	3

oil tankers, bulk carriers, general cargo ships, and even container ships, all of which are price-sensitive.

5.3 China's Global Strategy for the Shipbuilding Industry

The review of shipbuilding industry has a number of broad implications for global competition. First, global competition must be viewed in a dynamic fashion so that a nation can reshape and refocus its strategy periodically in accordance with the changes in the economic environment. No one global strategy succeeds for an indefinite time, and a nation must reposition itself to sustain its position as the Japanese have done. Second, cost leadership is often the preferred entry strategy for new nations, while global differentiation and global segmentation strategies are limited to existing participants with accumulated capabilities.

Due to huge shipbuilding capacities compared to a depressed demand market,the shipbuilding industry belongs to a buyers' market. In this case, satisfying buyer needs is at the core of success in the shipbuilding industry. Ship buyers consider various factors when selecting a builder. For any type of ship, the three major considerations are price, delivery and quality. The relative weight placed on each factor varies by type of vessel. As a general rule, price is more important when buying less-sophisticated vessels, such as oil tankers, bulk carriers, and general cargo ships. Quality is more important when buying more sophisticated vessels, such as container ships, liquefied natural gas tankers, and passenger ships. Delivery date is moderately important for most vessel categories, but very important for those vessels used by merchant shipping companies that want to reduce risks associated with fluctuating freight rates. Table 5.1[1] summarizes the opinions of industry experts: one British, two Japanese, and one Korean[15].

5.3.1 Position

Before we choose a global strategy for the China's shipbuilding industry, it is very important to have a clear idea where its position is now. According to Table 1.2, China is in the third place in terms of new building on order which is 6.5% of the total world order, just following Japan, 38% and South Korea 20%. Most of new buildings on order are bulkers and tankers, less-sophisticated types(Table 5.2). In the past decade, CSSC has built a total of 7.73 million dwt of vessels, with 40% for shipowners in countries and regions such as Norway, Sweden, Germany, Italy, Denmark, Hungary, Poland, Romania, Belgium, the United States, Cuba, Chile, Australia, Japan, Singapore and Hong Kong.

At present, CSSC could build for domestic operation and for export bulk and general cargo carriers, container and roll-on/roll-off ships, oil rigs and platforms, even small LPG carriers. A dry 200,000 dwt drydock, the largest in China, will be completed in 1994 at Dalian. By then, China will be able to build ultra-large vessels of 200,000 to 300,000 dwt tankers. In terms of marine engineering, China is capable of build-

[1]In each vessel category, the total of 10 points is assigned to the four purchase criteria according to their relative importance. Vessel sophistication is from Low to high.

Table 5.2: **Newbuilding orders for China's largest shipyards**[52]

Yard	*Shipowner/Flag*	*Type of Vessel*	*Delivery*
Jiangnan	Pacific basin/Belgium	62 000 dwt tanker	10.92
	Pacific Basin/Belgium	62 000 dwt tanker	1.93
	Island Nav/Hong Kong	65 000 dwt bulker	1.93
	Island Nav/Hong Kong	65 000 dwt bulker	7.93
	Lasco Shipping/US	70 000 dwt bulker	10.93
	Lasco Shipping/US	70 000 dwt bulker	3.94
	Lasco Shipping/US	70 000 dwt bulker	6.94
	COSCO Guanzhou/PRC	70 000 dwt bulker	10.94
	COSCO Guanzhou/PRC	70 000 dwt bulker	12.94
	COSCO Guanzhou/PRC	70 000 dwt bulker	3.95
	COSCO Guanzhou/PRC	70 000 dwt bulker	6.95
	COSCO Guanzhou/PRC	70 000 dwt bulker	9.95
Hudong	World-wide/Hong Kong	68 000 dwt tanker	11.92
	BOMTA/PRC	68 600 dwt tanker	7.93
	BOMTA/PRC	68 600 dwt tanker	12.93
	BOMTA/PRC	34 600 dwt tanker	6.94
	BOMTA/PRC	34 600 dwt tanker	11.94
	Oak Steamship/Hong Kong	70 000 dwt tanker	11.93
	Oak Steamship/Hong Kong	70 000 dwt tanker	4.94
	Far East Ent/Hong Kong	70 000 dwt tanker	5.94
	Far East Ent/Hong Kong	70 000 dwt tanker	9.94
	COSCO Qingdao/PRC	70 000 dwt tanker	11.94
	COSCO Qingdao/PRC	70 000 dwt tanker	3.95
	COSCO Qingdao/PRC	70 000 dwt tanker	6.95
	COSCO Qingdao/PRC	70 000 dwt tanker	9.95
Dalian	BOMTA/PRC	60 000 dwt tanker	6.93
	COSCO Dalian/PRC	60 000 dwt tanker	3.94
	COSCO Dalian/PRC	60 000 dwt tanker	12.94
	BOMTA/PRC	60 000 dwt tanker	7.93
	Pertamina/Indonesia	35 500 dwt tanker	8.93
	BOMTA/PRC	34 000 dwt tanker	12.93
	BOMTA/PRC	34 000 dwt tanker	5.94
	Wah Kwong/Hong Kong	60 000 dwt tanker	12.94
	Cobelfret/Belgium	150 000 dwt bulker	12.93
	Exmar/Belgium	150 000 dwt bulker	6.94
	Far East Ent/Hong Kong	150 000 dwt bulker	12.94
	BOMTA/PRC	60 000 dwt tanker	12.92
	BOMTA/PRC	60 000 dwt tanker	3.93

ing heavy-, medium- and light-duty diesels with high-, medium- and low-speed. The Baoshan Iron & Steel Complex could supply quality steel. Evidence shows that China is ready to compete with main shipbuilding nations in the building of less sophisticated ships.

It is clear that China will have two main competitors: Japan, and South Korea. For the time being, western Europeans are not the main competitors because they mainly build more sophisticated types of vessels. At present, the global environment favors China's shipbuilding industry. First, Japan is in economic recession, while the Chinese economy is developing exceptionally fast. From 1980-1990 (Table 4.3) in China, the average annual GNP growth rate was 8.9. Such fast economic development in China must result in increased demand for shipping, while economic recession in Japan causes the reverse. The demand for shipping decides how big the fleet should be. In fact, domestic demand for shipbuilding plays an important role in main shipbuilding nations. Moreover, the average age of the Japanese fleet is 9.7 years, while that of the Chinese fleet is 17.9 (Table 4.7). Especially, the age difference in general cargo ships is the biggest, 19.6 for China and 9.2 for Japan. It is obvious that the Chinese fleet needs new ships more urgently than the Japanese fleet. Coincidentally, general cargo ships are China's target segment in which Chinese shipyards already enjoy comparative advantage. It is clear that the new ship order from domestic demand favors Chinese shipyards. Another disadvantageous factor for Japanese shipyards is that the appreciation of yen has made it difficult for Japanese shipyards to compete in terms of price-sensitive types of ships which are China's target segments. Furthermore, the world economic recession has brought about a depressed shipping market which has resulted in buyers' focusing attention more on price rather than on ship quality and prestigious yards. It is difficult for Japanese yards to get premium prices by global differentiation strategy to make up for its high cost of labor. In the meantime, the Chinese government has been supporting shipbuilding industry with heavy investments while other nations have cut back. The rebounding world economy will come soon because the recession has already lasted a long time. Once the better time comes China will have the capacity in place like South Korea in 1975.

Second,China's another main competitor, South Korea has depended on low labor cost, low machinery and low steel costs and the relatively low value of the Korean won against the world's major currencies. These advantages are changing. South Korea is no longer a low-wage country. Wages have doubled in the past three years[4]. This will result in increases both in labor and material. In fact, the wages are rising faster in South Korea than productivity. New building prices quoted today are at the same level as those in Japan. In 1970s, China's shipbuilding industry had lost the chances of competing with other countries because of its closed door policy. Another chance for China seems to be opening.

5.3.2 The Proper Strategy for China

Today, Japanese shipbuilders are pursuing differentiation, South Korean shipbuilders are competing based on cost leadership and segmentation, while western European shipbuilders are adopting differentiation focus strategy. Technology allows the Japanese to build even the most sophisticated vessels. In the meantime, shipbuilding capacity makes it possible for Japan to pursue a differentiation strategy. The wide scope in South Korea's shipbuilding industry and comparative low labor cost allows them to compete based on cost leadership. The prestigious reputation and sophisticated technology of western European shipbuilders allows them to compete based on segmentation. As a new shipbuilding nation, China has none of Japan's advanced technology, none of South Korea's large scale, let alone western Europe's reputation. Differentiation is obviously unsuitable for China's shipbuilding industry at the present time. So is the differentiation focus strategy. That China can not choose cost leadership at the present time is not as obvious as the two strategies mentioned above. Cost leadership requires a very wide scope in the industry. Until now, China has no capability for building very sophisticated ships. For example, China still has to order big box ships from foreign shipyards, for example, COSCO ordered 3800 teu capacity box ships from Japan and Germany[35]. Cost leadership demands large volume to amortize the cost over a great sales volume. South Korea can build the largest container ships and sophisticated LNG, while China can not.

In its present stage, China should choose the cost focus strategy emphasizing less-sophisticated types of ships. From the comparison in Chapter 4, we know that productivity in China's HSY is much lower than in Japan's KHI. As can be seen in Chapter 4, Chinese HSY needed 3.27 times more man-hours in building PD124 than Japanese KHI even though KHI was 6 years ahead of HSY. During these six years, KHI would increase productivity greatly, which means that 3.27 really underestimates the Japanese productivity compared with that of the Chinese shipyards. But Chinese labor is almost as low as one-twentieth of Japanese labor. Even if the difference of productivity were as much as ten times, Chinese shipyards still would have the competitive advantage in cost-sensitive types of ships.

However, shipyard should not just depend on low labor cost to neglect investment in automatic machines to increase productivity. Competitive advantage on low labor cost is unsophisticated and often fleeting. Sometimes this advantage will result in disadvantage because shipyards do not employ labor efficiently. Shipbuilding illustrates that simple factor advantages such as labor costs are rarely sufficient to gain or sustain a strong international position. Brazil, Spain, and Poland did not succeed despite it. Although the labor cost in China is as one-twentieth as much in Japan now or even the relative difference will last a long time because of special endless source of inexpensive labor in China, the gap will be getting smaller and smaller. In fact, Chinese workers' wages will increase more sharply than Japanese ones, because wage in Japan has been saturated. If China does not invest in automation machines to increase the productivity based on the contemporary cheap labor, China will lose the comparative advantage in labor cost because of the big productivity difference. In the other direction, the labor cost of other poor countries is much lower than in China. In terms of the cost of labor, Japan's today will be China's tomorrow. Only productivity is the true source of comparative advantage in shipbuilding industry. As we knew, the simple labor cost advantage can not sustain a long time.

In export market, China as a new shipbuilding nation should place their emphasis on the price-sensitive and labor-sensitive types of ships which possess over 70% in terms of deadweight ton(table 3.1) in the world shipbuilding output. As we can see in the table 5.1, oil tankers, bulker carriers and general cargo ships are price-sensitive. They are less-sophisticated, so Chinese shipyards are capable of building. Furthermore, buyers like to order from low-price shipyards, because of the poor shipping market.

In the low-sophisticated vessel categories, China could compete Japan depending on the low cost labor, in the meantime, it could compete South Korea based on its increasing quality and productivity. Cost focus strategy will lead China to specialization in shipbuilding. Specialization may be conducive to comparative advantage whereby the shipyards either gains a reputation for excellence in those types of ships or commands attention by virtue of the competitive prices it can charge for those ships. As we knew in the case of PD214, Chinese HSY spent only 82 percent total man-hours(table 4.10) of the first ship on the fifth ship. It is obvious that productivity could also result from the learning curve which could help sustain the advantage of Chinese low labor cost. For example, a lot of owners are interested in a new type of panamax vessel China shipyards. The main reason for burgeoning interest from abroad is an increase in productivity which results in the $30m competitive price.

In the meantime, the concentration should be put on ship quality and make good reputation. Because sometimes the shipowners would rather pay premium for the shipyards with good reputation than take risks saving some money. If the ship is not acceptable by buyers because of the low quality problem, a cost focuser is forced to discount prices well below competitors' to gain sales. This may nullify the benefits of its favorable cost position in the target segments. Improvement in the ship quality could be achieved through such measures as using joint ventures to bring in improved manufacturing techniques, licensing agreements to bring in proven, well engineered designs to improve the quality of the shipyards. In fact, licensing agreements from Japan are more difficult than from Europe. Because Japanese yards have more new shipbuilding orders than European counterparts so that they are unwilling to transfer new technologies to their competitors compared with European ones. Japan has a clear idea how their shipbuilding industry prospected depending on technology transfer from Europe and U.S.A. To make the matter worse, that Japan will tend to invent more technologies than Europe will result in a little bit more difficulties in technology transfer in shipbuilding industry than before. In that case, China should spend more money on R&D to short the technological gap with Japan.

During the cost focus strategy phase, China should develop its overall capability of building various kinds of ships through technology transfer and joint ventures. Joint ventures provided China with an operational capability that may not have existed. Joint ventures also provided a quick, inexpensive way to close the gap between China and the established market, both in terms of technology and structure. In a joint venture the operation took the name of the established firm, and since that firm both set-up and managed operations, China will realize an increase in credibility in an area where it may have been previously deficient. With the help of the joint ventures, China could squeeze into more sophisticated types like liquefied gas tankers in a short time. For example, a Sino-Germany joint venture has been set up in Shanghai, which will concentrate on liquefied gas and chemical product ships. Two 15,000 cube meter liquefied gas ships are planned to build, which will be exported[36]. One advantage with license agreements is that it helps China establish a credibility that did not previously exist. These two methods are helping significantly improve China's reputation in the production area.

In the domestic market, Chinese shipbuilders should target all segments of ships. In fact, the large domestic market, which any shipbuilding nation would envy especially during the trough of a sever worldwide shipbuilding down-cycle, allows Chinese shipbuilders to achieve cost efficiency through efficient production and learning and accumulate some level of technology before going to the export market. The experience acquired in the domestic market will benefit Chinese shipbuilders. In fact, China has completed the research of developing 2800-3500 etu container ship, which will set up the foundation of designing and building this ship by themselves. Reefer has been regarded as one important type of ships by CSSC and lots of researchers have begun to develop during the Eighth Five-Year Plan. With the efforts of government and CSSC, China will have been capable of building various types of vessels by the end of this century.

In less sophisticated vessels, China has gradually been regarded as a nation with good quality. Sir Yue-Kong Pao, ex-chairman of World-Wide shipping Group, one of the world's largest shipping operators, whose companies have bought Chinese-built ships, commended, "Chinese shipyards are capable of building top-class vessels which can be compared favorably with those produced by yards anywhere in the world in design, workmanship and performance". However, China still needs a certain time to establish the reputation which is very important to bid in sophisticated ships because of the requirement of high quality. After more ships are exported, the reputation will be set up. By then, China's shipbuilding will have gone into maturity because of both the easy technology transfer in shipbuilding and their own efforts. At that time China will compete other nations with cost leadership strategy because of the capability of building various types of ships and good reputation. With the rapid economic development, China needs not only various types of ships but also large demands because of her would-be superpower in the world. China will be the leader in shipbuilding, the only question is the time.

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