THE SHIPBUILDING BUSINESS IN THE UNITED STATES OF AMERICA

VOLUME I

Written by a Group of Authorities

Editor

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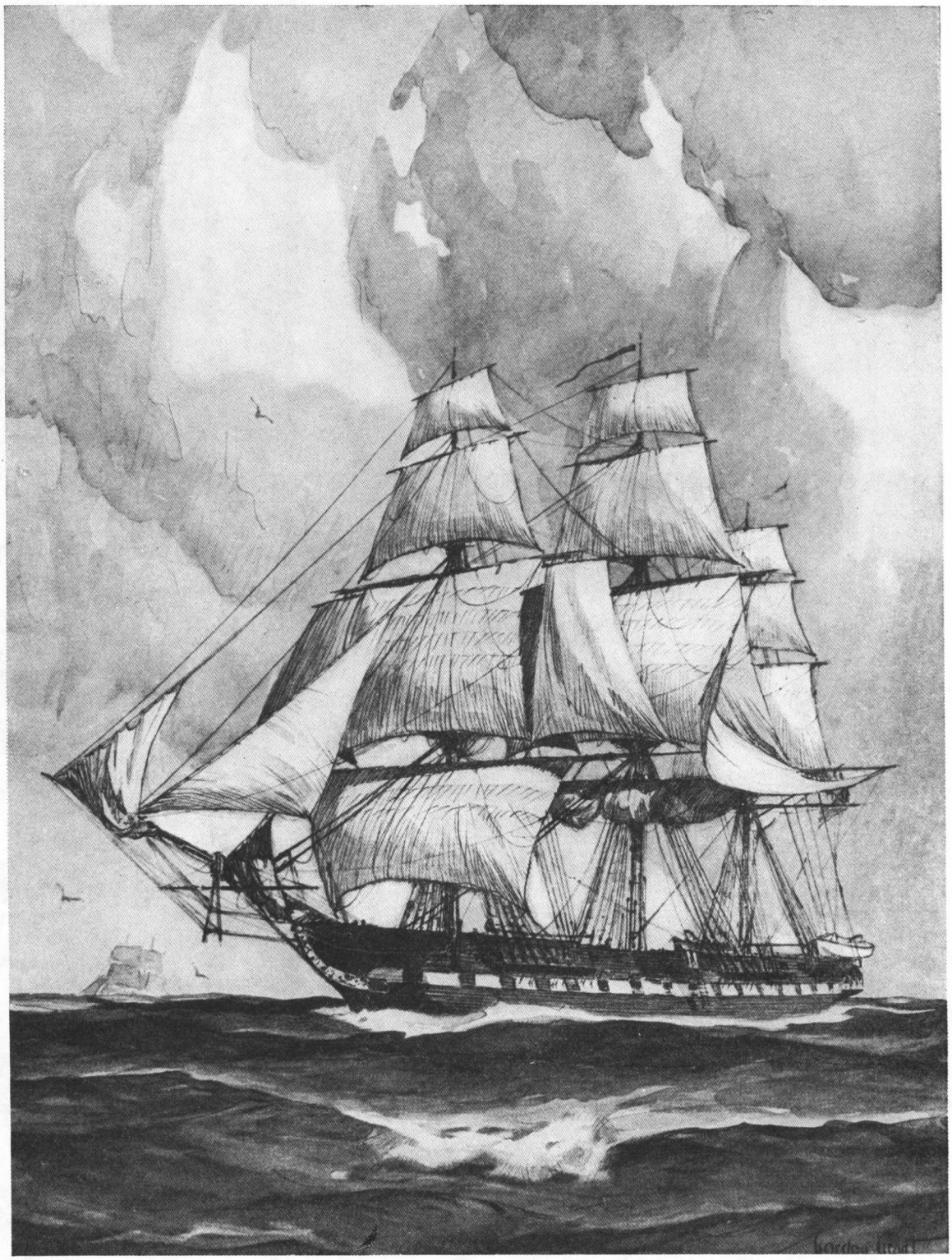
Published by

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 WEST 39TH STREET, NEW YORK 18, N. Y.
1948



U. S. FRIGATE "CONSTITUTION"

FOREWORD

TWICE within a quarter of a century American shipbuilders have been called upon for extraordinary effort to meet great world crises. In 1915, when the German submarine depredations of World War I and the mounting needs of the Allies demanded limitless sea transportation, American shipyards swung into action. An industry that in 1914 had produced only twenty-four new merchant ships of 130,000 gross tons and twenty-three naval vessels of 105,000 displacement tons, four years later turned out 714 merchant ships of 3,370,000 gross tons and 180 naval vessels of 233,000 displacement tons—an accomplishment little short of miraculous. This achievement was a controlling factor in winning victory for the Allies.

After this building program, the industry shrank to near prewar dimensions and for more than a decade survived precariously on diminished orders for new construction for the Navy and the Merchant Marine.

In the 1930's, vessels built for the Maritime Commission and the Navy in the post-panic years began to revitalize American shipyards. In 1939, the approaching war again challenged us. Twenty-eight merchant ships of 242,000 gross tons and twenty-seven naval vessels of 66,000 displacement tons were delivered by an industry employing 120,000 men in that year and the value of ships built and repair work done amounted to $250,000,000. Four years later 2,000,000 men and women delivered ships to the value of thirteen billion dollars. Eighteen hundred ninety-six merchant vessels of over 13,000,000 gross tons and 18,294 naval vessels of 2,586,000 displacement tons were built in that single year, dwarfing the record of World War I in supplying the demands of the Navy, of the Army, and of wartime commerce.

There is real romance in the creating of ships to meet the needs of war and of ever-changing world commerce. Through the long years when shipbuilding has been in the doldrums our faith in its future has heartened us, and when the call for gigantic effort has come it has been met with courage and enthusiasm. Few shipbuilders have made substantial fortunes, but many have experienced the satisfaction of work well done and of useful service performed.

The mass production of ships of all types during World War II has resulted in a large surplus tonnage for peacetime commerce. The reduc-

tion in the number of shipyards today under way to contract operations to a peacetime basis is one of the most drastic industrial shrinkages and one of the gravest economic problems to be met in passing from war to peace.

The repeated experiences of 1915 and 1940 proved shipbuilding to be an industry essential to the existence of this nation. A liberalization of the laws and Government policies affecting its well-being and insuring contracts for enough work to maintain a healthy industry is amply justified, if we are to be ready should the necessity again arise.

Those who practice our craft have been closely bound together by choice and by circumstances. Fifty years ago we organized The Society of Naval Architects and Marine Engineers and from small beginnings the Society has grown in size and strength to become one of the powerful technical bodies of our day. Staffed and managed by leaders in the profession and backed by a generous Endowment Fund, it exercises its influence for the advancement of shipbuilding and shipping. The field is broad and the future promises great developments resulting from increased scientific knowledge and the application of new and approved methods and materials to shipbuilding.

Eight years ago the Society undertook to compile and publish a series of books dealing with various phases of shipbuilding. The first of these to appear under its sponsorship was *Principles of Naval Architecture,* published in 1939. It met with immediate favor and is now authoritative wherever ships are built. The second, *Marine Engineering,* issued more recently, stands equally high in that branch of the profession. Through the courtesy of the U. S. Maritime Commission, the Society has recently acquired rights to publish future editions of *Speed and Power of Ships* by the late Rear Admiral D. W. Taylor, (CC), U. S. N., (Retired). Already once revised in 1943 by a committee of members of the staff of the Maritime Commission and of that of the D. W. Taylor Model Basin, it will be re-edited by the Society as advances in knowledge may warrant.

There are in existence many textbooks treating of modern building operations. This Society will not attempt to enter this field, as individual technicians conversant with changing practices can provide adequately for the publication of works describing methods of construction of the structures of ships.

A survey of the entire field, however, shows a gap in the literature of the profession, to fill which this present book has been prepared. It analyzes the economic necessity and records the history and business statistics of shipbuilding, after which follow sections on labor wage systems, design, contracting, planning, scheduling, purchasing and accounting operations, and allied subjects essential to the orderly and economic completion of a ship.

In view of the fact that there are available today reserves of merchant cargo vessels and of many of the types of war vessels for service in World War II, there may seem to be no reason for such a work. But the method and procedure which have resulted in building in a single year about 13,000,000 gross tons of merchant shipping and nearly 2,000,000 displacement tons of war vessels are fresh in the minds of all the important actors in the current drama who are authors of this volume. To record and preserve the experience of this epoch there is no time like the present.

In this belief The Society of Naval Architects and Marine Engineers offers this study to all interested in its profession, in the conviction that it will be useful to present and to future generations of shipbuilders.

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CHAPTER I

ECONOMICS AND SHIPBUILDING

By Professor James W. Culliton

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The story of how ships are built, which will be told in detail in the chapters to follow, will concentrate largely on factors which are internal to the business of building ships. But businesses do not exist of or for themselves alone; they are set among countless other units such as business, social, political, or religious groups as part of the mosaic of life. For this reason, the story of the business of building ships will be clearer if consideration is given at first to the relationship of shipbuilding to things outside itself.

It is the purpose of this chapter, therefore, to look at shipbuilding not in the light of internal problems such as design, construction methods, labor training, or finance, but rather as the industry affects and is affected by the world in which it operates. Special emphasis will be given to aspects which help answer economic questions such as why ships are built, what needs they serve, why they are built in one location rather than another, by whom they are built, and what affects decisions to build or not to build them.

WHAT IS THE SHIPBUILDING INDUSTRY?

The shipbuilding industry is a combination of physical plant, labor, and management. The most spectacular part of the plant is the shipyards, which are made up of ways, shops, and supporting plants. Not all the process of building ships is carried on in shipyards nor is all of it carried on in companies commonly thought of as being part of the shipbuilding industry. Many industries, some quite remote from shipyards, furnish their products to the construction of a ship.

Shipyards, together with their labor and management, therefore, do not alone constitute the shipbuilding industry of a country. They perform the final assembly job of putting a ship together in the shipyard, but in doing so they use the products of many other industries ranging from raw materials to highly specialized component parts and appurtenances.

Adjacent to some ways where ships are assembled there are shops and highly specialized industries making some of the component parts, as for example propulsion equipment or pipe installations. Sometimes these shops are under the same management as the shipyard; at other times local industry under separate management supplies the needs of the shipyards. Not infrequently similar industries may be located miles from the shore, and in all instances some parts for ships will come from widely scattered industrial plants. Thus it is practically impossible and highly unreal to attempt to break the industry of shipbuilding into watertight statistical units, each performing well-defined parts of the whole process of building ships.

In practice there is little uniformity in the amount of work, other than assembling ships on the ways, which different shipyards perform. Some make their own propulsion machinery; others do not. Some make large numbers of component parts; others make but few. For our purposes here, however, this need not be a disturbing fact, since the economics of shipbuilding can be observed quite well in connection with the process of assembling ships on the ways. For practical purposes, therefore, this chapter discusses the shipbuilding industry principally as the process of assembling ships at shipyards. Some of these shipyards will do more of the shipbuilding process than others, but the shipways and the process of assembling ships on them are the part of the industry that is peculiar to shipbuilding. The other parts of the industry exist because of the shipbuilding process but can be carried on by industrial companies regardless of whether they are shipbuilders.

Shipbuilding and Ship Repair. There are many reasons why shipbuilding and ship repairing should be discussed together. Many companies engage in both operations; many companies which in peacetime were almost exclusively in the ship-repairing industry have done important shipbuilding jobs during World War II; both industries demand knowledge of naval architecture and the practical art of making ships work; many of their plant facilities are similar.

Nevertheless, the discussion here is not including ship repair as such because the economics of building ships is considerably different from the economics of repairing them. The functions of the two industries in the national economy are different in the same way that the automobile industry and the repairing of automobiles operate differently. The reasons why customers have ships built and ships repaired are also poles apart. Except, then, as ship repairing is one of the factors that contribute to an understanding of the shipbuilding industry, ship repairing will not be included in this chapter.

The Shipbuilding Industry. The products of the shipbuilding industry are peculiarly international. For this reason the economics of the industry in any one country cannot be examined solely in the light of domestic conditions. The shipbuilding industry of any country is figuratively as well as literally standing on the shore looking both inland and to the sea. It is domestic, employing domestic land, labor, and capital; it has keen foreign competition, the central theme of which is cost, but around which theme are countless overtones ranging from technical design to political intrigue.

Despite the fascination of the international aspects of shipbuilding and despite the temptation to generalize about the economic position of the shipbuilding industry in the United States, a real appreciation of both the international and the domestic position of the industry will be better obtained if, instead of generalizing, we particularize about what is peculiar to the shipbuilding industry as an industry no matter where it is found.

The discussion which follows, therefore, sets forth some of the universal characteristics of the shipbuilding industry. They are simple; they are well known to everyone even remotely familiar with the industry; they will be readily admitted by those who know nothing about the industry. In short, they are obvious. But, being obvious, they are extremely important to an understanding of the real relationships of shipbuilding to the rest of the community and, by the same token, they are frequently overlooked.

Shipbuilding and Politics. One of the most obvious characteristics of shipbuilding throughout the world, especially to one who would study its economics, is that its economics is so thoroughly mixed with politics that the two are almost inseparable. An examination of the shipbuilding industry of almost any country in the world, and certainly in all the major shipbuilding countries, shows that the governments have always interested themselves in the industry. There is almost no maritime country which has not at one time or another given subsidies or bounties to its shipbuilding, which has not attempted to build both its shipbuilding and shipping industries at the expense of other nations, or which has not argued that shipbuilding was of special significance to its national welfare and pride.

The result of this governmental interest throughout the world has been to put the shipbuilding industry into a political atmosphere. Shipbuilders at times have engaged in lobbying to influence the kind of government action which will be taken. On the other side of the picture, governments frequently have dictated the course of the shipbuilding industry of a country. The net effect is that shipbuilding throughout the world is highly sensitive to political influences, so that discussion of the economics of shipbuilding without recognition of political and governmental actions, with special reference to commerce and war, is unrealistic.

Shipyards. Leaving the question of politics in the background, however, the first thing to look at in order to get a picture of the industry is the shipyard where ships are put together. No matter where they are found, shipyards have obvious and important characteristics, three of which are mentioned here.

1. Shipbuilding Is a Producers' Goods Industry. Shipbuilding, as will be obvious throughout this book, requires a complicated and specialized plant, extensive knowledge of naval architecture, highly skillful workers, and a management that can combine effectively all these factors to the practical end of building ships. But none of these—the plant, the knowledge of naval architecture, the skilled shipbuilding workers, or shipyard managers—is of much value unless it is being used to build ships. Some of the plant and some of the knowledge and skills can be shifted to other pursuits, but as a shipbuilding organization they are quite valueless unless they are busy building ships. It is the product of the industry, therefore, rather than the industry itself that has value. In the language of the economist, it is a producers' goods industry; that is, one making a product for the use of another industry, a product which gains value only from what it can produce for that other industry. By way of contrast to producers' goods, so-called consumers' goods have value because they can immediately satisfy a want. You can eat a loaf of bread but you cannot eat a ship.

The fact that shipbuilding depends upon the demand for ships has an important effect upon both the people and the plants that build ships.

Idle plants and unemployment of both labor and management result if there is no demand for them to build ships. Shipbuilding labor can look for other jobs, where in all probability some of the skills learned in shipbuilding but little of the "know-how" of building ships will be used. Idle shipyards, on the other hand, can be used for little except for building ships sometime in the future, and so in all probability they will stand idle until more ships are built.

There are scattered examples of shipyards which have been used successfully to make other things. For several reasons, however, they are not of deep significance: Such other uses have only partially utilized the equipment of the shipyard; the number of yards thus used has always been small and is almost insignificant when compared with the number of wartime shipyards; and the use of shipyards for other things has been at worst a makeshift operation and has involved at best considerable rearrangement of shipyard equipment and installation of other supplementary facilities.

Parenthetically, it should be noted that this is an over-all and long-run point of view. Shipyards can and have been known to get orders for ships for whose services there was actually little demand. Someone's belief—right or wrong—that there will be a demand for the service of a ship can be sufficient to produce a demand for the product of a shipyard. Schemes to give employment by building ships for which there is no immediate need have the same effect. By and large, however, shipyards and the know-how of building them have little value if there is no real demand for their products.

2. Shipyards Have to be Near Water. This is so obvious that it needs only to be stated. Nevertheless, it is an important consideration in the economics of the industry in that it limits the freedom of choice of location, has much to do with the determination of what nations will be shipbuilders, and has some bearing upon the cost structure of the industry because it affects such costs as land, labor, and transportation.

3. It Takes a Lot of Money to Build a Shipyard. There is quite a difference in the amount of money required to enter various businesses. Peanut stands can be started with small capital; some retail establishments or small manufacturing activities require thousands of dollars. Shipyards require millions.

By way of example, a typical yard built by the government for the emergency of World War II cost $16,000,000 and even then did not contain some of the facilities usually found in a complete yard. Prior to World War II, one of the larger companies had plant valued at $17,000,000, and one of the smaller units had $1,300,000 in plant. These were all plant investments exclusive of the money needed to operate them and pay such current expenses as materials and labor.

Anyone who gets the notion to do so cannot easily start in the shipbuilding business. It takes money—big money.

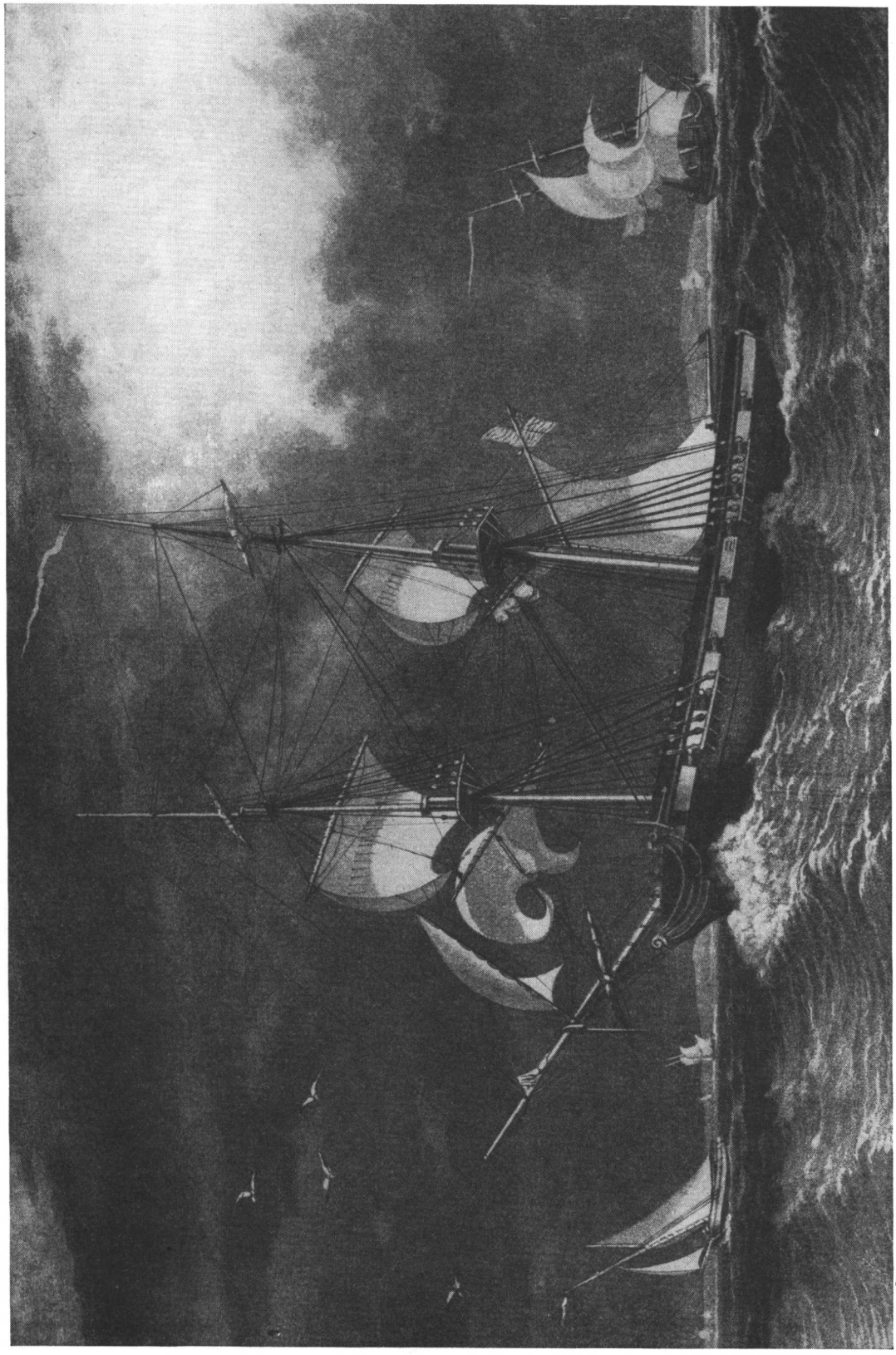
The Products of Shipyards. The characteristics of shipyards, just discussed, refer primarily to the physical plant, unoperating; that is, before it ever makes a ship and, in a sense, whether or not it ever makes a ship. The products of shipyards, too, have some very special characteristics that leave their indelible mark on the shipbuilding industry. Six of the most important are discussed in the following:

1. Ships, too, are Producers' Goods. Not only is the shipbuilding industry a producers' goods industry but, furthermore, the ships which it builds are also producers' goods which have little or no value unless someone wants goods or people moved over water. The main difference between ships and shipyards in this respect is that shipyards produce what are called goods and ships produce services. But neither ships nor shipyards have much value if there is no demand for their goods or services.

To use the analogy of the loaf of bread, a ship is similar to the bakery that makes the bread. You cannot eat the oven or the mixing machines but you can eat the product they make. On the other hand, the company that makes the oven and the mixing machines is in the same position as the shipyard. It will have no work unless people want bread, and unless bakeries want equipment for making that bread.

Economists have a name for such a phenomenon. It is that the demand for a producers' goods is a "derived demand." For example, if someone wants coffee moved by water from Rio to New York, there is an immediate demand for the service of a ship to carry that coffee. The demand for the products of shipyards is derived, in turn, from such derived demands for ships and therefore is called a "secondary derived demand."

It is because of these fundamental and obvious relationships between ships and the shipbuilding industry that any discussion of shipbuilding so quickly leads to a consideration of ships and through ships to the volume of waterborne transportation. If there were to be no more waterborne commerce (or waterborne fighting equipment), there would be no need for ships; and if there were to be no more ships or if there were already in existence enough of the *right kind* of ships to meet the needs of waterborne commerce



U. S. Brig "Porpoise" in a Squall

Courtesy, The Nautical Museum, Massachusetts Institute of Technology

and fighting, there would be no need for shipyards to build more ships.

2. Ships are Complicated to Design and Build. This whole book is evidence of the truth that ships are complicated to design and build. Not only are they complex structures subjected to unusual strains from heavy seas but likewise they have to be self-propelled and, to a large extent, self-contained units capable of existing and supporting a crew and sometimes passengers for long periods of time without outside help.

The most obvious example of complicated design and building is in naval ships and is best illustrated in the battleship. The continued development of electronic devices adds to the mazes of pipes and wires already included in fighting ships a whole new series of sensitive mechanisms difficult to design and install as an integral part of a highly integrated unit.

One measure of the complicated nature of ships was published recently showing an estimate of the number of manhours required to perfect the design of a ship, as follows:

	Manhours
Liberty	105,000
Victory	150,000
Submarine	240,000
Destroyer	400,000
Cruiser	1,200,000
Battleship	2,000,000

3. Ships are of High Unit Value. Ships vary in cost tremendously with variations in design, from one yard to another, and especially from one country to another. Exact statistics are not necessary, however, to demonstrate that they are high-cost structures. Frequently, $100 per deadweight ton is taken as a rule of thumb figure for the value of a commercial ship. At this price a 1,000-ton ship (the smallest usually recorded in the statistics of shipbuilding) would cost $100,000, and a 10,000-ton ship (about the size of a Liberty) would cost $1,000,000. As will be seen, these costs are considerably below the actual cost of constructing ships in the United States.

At the upper end of cost there is almost no limit to the unit cost of a ship. Superliners such as the *Queen Mary* and the *Normandie* are reported to have cost $33,000,000 and $55,000,000, respectively.

The fact that unit cost is high is of importance because frequently the economic problems of an industry bear a direct relationship to the unit value of its product. The problems of a company making a $1 hammer are different from those of one making a $1,000 lathe; the problems of a company making a $1,000 automobile are different from those of a company building a $50,000,000 dam.

4. Ships Usually are Custom-Built. The type of service required of various ships varies tremendously. Some areas must be served by ships burning coal; others find oil cheaper or more satisfactory. Coastwise ships usually are smaller and have different loading facilities from those of transoceanic ships. The variations from one ship to another, even when basic designs are similar, are well known to shipbuilders and ship operators.

In order to meet the needs of the service in which a ship is to be operated, each merchant ship in ordinary times is designed and built principally for that service. Frequently there are even variations for particular service within a trade. The most highly specialized ships, such as tankers and other bulk carriers, are mainly useful in carrying only those cargoes for which they were designed.

The specialization of design and the custom building procedure is most obvious in naval ships. Battleships, cruisers, aircraft carriers, for example, are all special types of design with peculiar characteristics. Within each type, furthermore, there are many variations from one to another and even with "standard ships" there are great differences between the last and the first ship of a given design, as changes which are desirable become known in the light of both the construction and operation of the ship.

The variation in the design of "standard ships" is subtly illustrated by a picture which hangs on the wall of an office in the Navy building in Washington. During the emergency construction for World War II, a non-shipbuilding company was persuaded to build LST's largely on the strength of the argument that it would be able to build fifty ships all alike. When the fiftieth ship was finished, the company sent to the Navy Department pictures of the first and the fiftieth ship, mounted in one frame, with the title, "Fifty ships, all alike!" The ships looked alike, yes, but the recipient of the picture understood the full meaning of the company's sarcasm.

5. Ships Have a Long Life. Being producers' goods, ships are not immediately used up as a loaf of bread is. Instead they are built to render service over a period of time, and, typically, that time is long.

Disaster can, of course, end the life of a ship prematurely, but otherwise the life of a ship extends over a period of years. It is sometimes accepted, especially in legislation, that the life of a ship is twenty years. Experience seems to indicate that physically at least ships last much longer than twenty years. Ships thirty, forty, and even

fifty years old are not uncommon, and it has been said that no one has yet found out how long a ship will last on the Great Lakes where water conditions are much more favorable than on the high seas.

Apart from the physical life of a ship, there is also the possibility that obsolescence will end the economic useful life of a ship. It is not easy to prove that any given ship is obsolete in the sense that the operator would be better off financially to scrap it and replace it with a new one. Frequently, too, a ship which is obsolete for one service can be transferred to another where competition is not so keen, much in the same fashion as automobiles with useful life were typically traded in by some people who replaced them with new ones, while the old automobiles continued to be used by someone else. As a matter of fact, a situation very similar to the prewar pattern of automobile ownership in the United States exists in shipping, where certain nations, such as Greece, have been able successfully to use older and less efficient ships than have some of their competitors.

The condition of the United States merchant fleet immediately prior to the outbreak of World War II indicates that a whole fleet of old vessels is not so efficient as newer fleets. On the other hand, from a business point of view, obsolescence does not take place until an old ship is so much less efficient than a new one that it becomes profitable to replace the old with the new. Some very successful operators prior to the war were using ships forty and fifty years old and could rightly claim that they could make more money with the old ships than with new. Two factors largely explained this phenomenon. One was that the ships had been well maintained in excellent physical condition; the other was that the operators had purchased the ships at extremely low prices, well below cost.

The question of whether ships are obsolete has been complicated in the past by the fact that some were purchased after World War I at those low prices. Almost any ship which is in good physical condition, regardless of how old it is, can compete with a new one if the capital charges are low enough. There are examples of ships purchased twenty years ago for less than $100,000 which by 1940 were completely depreciated on the books and were in theory obsolete but which, unless they were damaged during the war, were still physically useful. When faced with the prospect of having to pay over $1,000,000 for a new ship, an operator is inclined to think that the "obsolete" ship will do for another few years at least. Sometimes the operator is perfectly right and at others he is making excuses for being unwilling to take the risk of investing $1,000,000 in a new ship even though doing so would prove profitable businesswise.

It is well to note that fighting ships, too, become obsolete and have to be replaced before their physically useful life is ended. The measure of obsolescence, of course, is not in their economic earning power but rather in their fighting power, especially in comparison with the fighting power of the ships of other nations.

6. Few Ships are Sold. In the normal course of business relatively few new ships are sold. Whereas the automobile industry of the United States counts its output in millions, the shipbuilding industry in peacetime years counts units and even in peak war-production years counted hundreds. The best peacetime production record for the whole world never exceeded 2,000 oceangoing ships.

The fact that few ships are sold illustrates that the characteristics of the products of shipyards which have been discussed in the foregoing are not independent of each other. Nor are they an unusual grouping of characteristics. It is so natural to find them together in certain types of industrial products that it becomes difficult to distinguish cause from effect. Are ships high priced because few are built, or are few ships built and sold because they are high priced? Are ships hard to build, and therefore high priced, because they are custom designed? If they were not custom designed, could more be sold because of the lower prices which could be put upon them?

The answers to these questions will be discussed, at least indirectly, later in this chapter, but the important point here is that, when the products of an industry are producers' goods with a derived demand, and by nature high priced, complicated, and expensive, and have a long life, it is not at all surprising to find that few units are sold. Furthermore, that portion of the cost of a ship which can be allocated to the cost of bringing one pound of coffee from Rio to New York is so insignificant that none but drastic cuts in the price of new ships would have much effect on either the price of coffee or the number of new ships which would be bought.

Building Ships

We have seen the characteristics of both shipyards and ships, more or less in their static state. Are there any peculiar characteristics involved in the process of building ships? There are, and they flow directly out of the characteristics previously mentioned. Three, however, are of sufficient importance to be discussed separately.

Ships Require Large Amounts of Steel and Other Industrial Products. The modern ship is a highly mechanized structure and requires large amounts of steel both in the form of plates and structural forms and also in fabricated and assembled forms in motors, engines, pipe, and the like.

Whether the amount of steel and other industrial products used in ships bulks large in relation to other demands for those products in a country depends chiefly of course on the number of ships built. But one thing is certain: A single ship takes large quantities of the products of industry, and unless those products are readily available at reasonable cost it is almost impossible to build ships economically. If they are not available in a country, it is almost impossible to build ships at all. Thus, shipyards are not the only requirement for building ships; they must be supported by a highly industrialized nation, capable of building the component parts which are assembled into a finished ship at the water's edge on the ways of a shipyard. The truth of this statement is illustrated by the history of shipbuilding in the United States in the nineteenth century. When sailing ships were supreme, the United States was a leading shipbuilding nation principally because it had a plentiful supply of the main raw material of sailing ships—wood. With the advent of steam and steel ships, however, the United States fell behind in shipbuilding in part at least because it did not at that time have the steel and industrial facilities to support the new shipbuilding industry.

That the use of steel in ships can be important in the total demand for steel is indicated by the fact that according to estimates the shipbuilding industry of the United States in 1943 and 1944 took 18 per cent of all the steel that was produced in the United States, and during the war production program, from 1942 through April 1945, shipbuilding took 13 per cent of the total.

Building Ships Requires Large Amounts of Skilled Labor. In addition to large quantities of industrial materials, building ships demands large amounts of skill. This fact of course means that the industry employs relatively large numbers of highly skilled workers who are trained in the art of shipbuilding. The small number of units produced (which was discussed previously) together with the large expansion in the number produced during World War II (which will be discussed in the following) throws considerable light on the need for skilled workers. In some peacetime years certain shipyards in the United States, if they operated at all, produced one ship or less per year. There was no opportunity for mass production of a number of parts for several units. There was some opportunity at times for making more than one part that was used several times in the same ship but, by and large, the job was custom done, requiring workers with skill at a wide variety of tasks and with an understanding of ships.

An illustration of the importance of skill in the construction of ships is found in a report prepared by the National Council of American Shipbuilders in 1928.[1] An exhibit prepared to show wage rates in the United States and foreign countries listed thirty-five different jobs, almost all of which were skilled. As an example, some of the various trades listed were acetylene burner, boiler maker, carpenter, coppersmith, electrician, machinist, patternmaker, pipefitter, plumber, riveter, shipfitter, tinsmith, welder, and wood calker. All of these skills, and more, go into the production of a ship.

During the war, on the other hand, 1,000 ships of one design and nearly 2,700 of another were built. This situation gave opportunity for using workers with less skill, because it was possible to break jobs down into their component parts. In some yards, for example, there were hundreds of workers who did nothing but welding under the simplest conditions and who, in a real sense, knew nothing about shipbuilding. They were excellent welders at elementary welding jobs and did excellent work, but it was possible to use them only because of the large volume of elementary welding work engendered by the large number of similar products being made. In the normal economic state of industry, on the other hand, the application of such simplification and specialization is limited by the small number of products.

Improvements in Ships Come Slowly. The long life of ships, their high unit value requiring large capital on the part of operators, the complicated nature of a ship, and the fact that few are sold all contribute to the fact that developments come slowly. A shipbuilder is not able to experiment extensively on ships of new types and build many merely for experimental purposes. His customers require so many different characteristics, too, that he is not able to put out a yearly standardized model and sell identical ships to all customers at a predetermined and published price.

Shipbuilding in the United States

The characteristics reviewed in the foregoing are presented as being true of shipbuilding, no

[1] Statement of conditions of the shipbuilding industry in the United States, by H. Gerrish Smith, Vice-President of the National Council of American Shipbuilders, before the Committee on Merchant Marine and Fisheries of the House of Representatives, February 29, 1928.

matter where it is found. The industry as it exists in the United States has all these and others which grow out of the relationship of shipbuilding to the economic realities of the country.

Eight of the important ones are discussed in the following. The first five are more or less permanent phenomena, or at least have existed throughout the twentieth century and probably will continue to exist for some time; the last three are current realities which will change, one way or another, in the years ahead and which, by the same token, have an important bearing upon the industry in the United States today.

1. There are Both Government-Owned and Privately-Owned Shipyards. The shipbuilding industry of the United States differs from many others in that normally both the Federal Government and private corporations own and operate shipyards. During peacetime years the Government operates Navy yards. It is commonly accepted that the principal function of Navy yards, as it applies to shipbuilding, is the repair and maintenance of the fleet. For many years, however, Navy yards also have built fighting ships. World War I gave impetus to construction in Navy yards, and between the two world wars legislation provided that under certain conditions Navy ships had to be built in Navy yards rather than in private yards. During World War II, also, important construction work was done in Navy yards, many of which were expanded in order to build more ships.

Privately owned yards have built both merchant and Navy ships. Navy ships obviously are bought and paid for by the Government. Some government interest and assistance always have been given directly or indirectly to private shipbuilders to help pay for or to stimulate the construction of merchant ships and particularly since 1916. Thus, private yards have had not only direct competition from the Government in the construction of ships but also government aid and interest in their business.

During World War II a new type of yard was introduced into the picture in the emergency yards which were built and owned by the Government but operated by private corporations under contract with both the Navy Department and the Maritime Commission. Thus, at the end of World War II there were in the United States three distinct types of yards, as follows:

(a) Navy yards, owned and operated by the Government and equipped to build and to repair ships; these facilities were greatly expanded during World War II.

(b) Private yards, owned and operated by private corporations. Many of these were expanded partly with private funds and to a larger extent with government funds resulting in what is known as "scrambled" facilities.

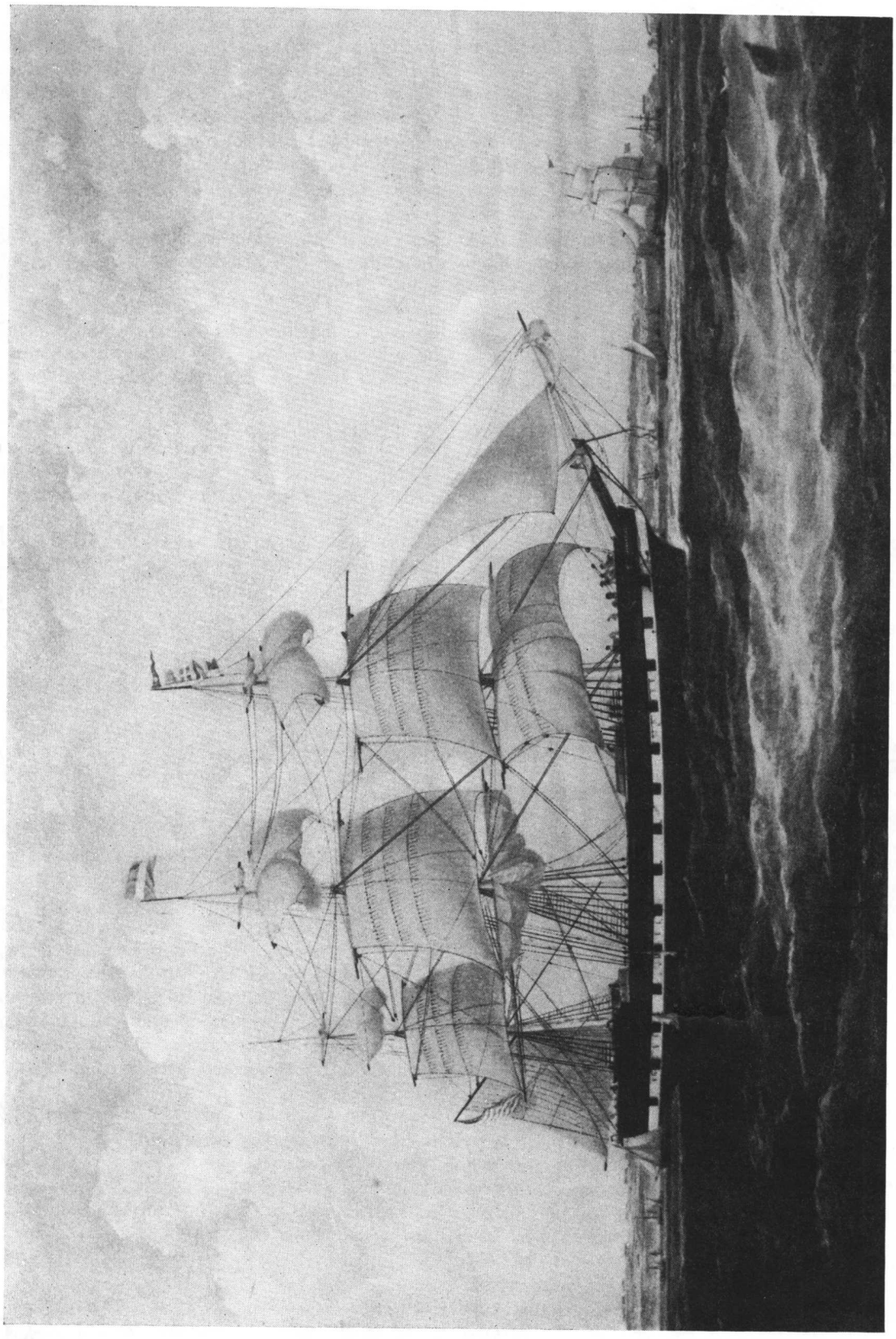
(c) Emergency yards, built and owned by the Government and operated during World War II by private corporations.

2. Volume Fluctuates Widely. A review of Chapters II and III of this book will give all the evidence necessary to support the statement that the volume of shipbuilding in the United States fluctuates widely. The difficulty is not in proving the fact but rather in comprehending it. The fluctuations are so wide that it is almost impossible to believe or understand the fact. For instance, the number of merchant ships built in one of the bad years of the 1930's was almost zero—a mere three in 1935—and in the year 1943 United States yards produced 1,930 ships with a gross tonnage of nearly 19,000,000 tons. The volume of naval shipbuilding followed the same pattern from a low of one ship in some years to 568 in 1943.

Not only does production in the United States fluctuate widely, but it fluctuates more widely than does production in the rest of the world. War conditions make it impossible to obtain statistics to prove this point with reference to either merchant or naval shipbuilding. Yet, in view of the tremendous expansion of the United States naval and merchant fleets there should be little doubt that it is true. For example, during the course of World War II the United States increased its percentage of the merchant tonnage of the world from 16 per cent to 62 per cent.

3. The Industry is Especially Active in Time of War. It is merely a corollary of the fact that volume fluctuates widely to note that the high points of activity come in time of war. It is true that the peak of World War I construction was not reached until 1920. The relative shortness of World War I and the Government's decision not to shut down war production quickly at the end of the war allowed some of the construction to take place in nominally peacetime years. Nevertheless it was war production.

4. Products Tend to Accumulate in Times of High Activity. A logical and real result of the characteristics discussed so far is the fact that the large number of ships built during the peaks of war activity tend to accumulate. As we have seen, ships are supposed to last at least twenty years, and disaster is the principal means of shortening that life. Disaster occurs more frequently during war than in peacetime, but one of the assets



SHIP "JAMESTOWN" OF NEW YORK, 1,151 TONS, BUILT BY PERINE, PATTERSON & STACK, 1847

of the Allied countries in two world wars has been that they were able to build ships faster than disasters could sink them. At the end of World War II there were more ships afloat than at its beginning.

The accumulation of ships is even more pronounced in the United States than in the world at large. The United States was more fortunate than the world at large in two respects that led to an accumulation: (1) It built more ships; (2) it had relatively fewer ships sunk. Thus at the beginning of the war the United States merchant fleet numbered some 1,400 ships; at the end of 1945 it was closer to 5,500.

The growth in the size of the United States Navy is just as startling even though the wide variation in types of ships built makes over-all statistics somewhat misleading. Everyone knows, however, that the United States ended World War II with the largest Navy the world has ever seen. There were built more than 1,000 LST's, a type which had not even been designed when the war started, and over 500 destroyer escorts specifically designed for protection against submarines. Some of the new ships were lost, but not a very large proportion. An idea of the huge size of the Navy can be got from the fact that in mid-1945 the Navy had nearly 100,000 vessels of all kinds (excluding aircraft). Some of these obviously are not ships in the accepted sense of the term, but the accumulation of the product of shipyards is obvious.

5. The Cost of Shipbuilding in the United States is High. That shipbuilding costs in the United States are high, and have been higher than those in many important countries for at least forty years, has never been seriously challenged. It is accepted by anyone who has looked into the situation, and it has been recognized by Congress on several occasions in maritime legislation.

In 1936, Congress passed the most recent of a series of Merchant Marine Acts designed to strengthen the United States Merchant Marine. Because it was recognized that building costs were high in the United States, the Maritime Commission by the 1936 Act was authorized under certain conditions to buy ships at cost from United States yards and to resell them to private operators at reductions in price to bring the cost to operators in line with the cost of similar ships built in foreign yards. The Commission was authorized to give such reductions in price—called "the construction differential subsidy"—up to 33⅓ per cent of the cost, and where the Commission had "convincing evidence" that the actual cost differential was greater, it could with the affirmative vote of four members grant up to 50 per cent of the cost in American yards as a construction differential subsidy. Apparently there has been convincing evidence that United States costs have been higher than foreign costs, because the actual reduction in price from United States cost granted by the Commission from 1939 through 1943 equaled approximately 48 per cent.[2]

Difference in Costs. The fact that United States costs exceed foreign costs is readily admitted, but the extent of the difference is not easy to determine. Measurement is complicated by the usual problems of converting foreign money costs to United States dollars as well as by the difficulties of collecting accurate information about foreign costs. In one of its annual reports the Maritime Commission stated: "The task of securing adequate data on the estimated foreign construction costs of a vessel to be built in the United States is not an easy one even in times of peace. Each country has different standards of construction and favors types which may not necessarily be built in other countries." Nevertheless, some useful figures were collected, especially by the Maritime Commission in the years before the beginning of World War II.[3] One set of figures on the cost of building a C-2 type ship is given below:

ESTIMATED COST OF C-2 IN 1938 IN FOREIGN YARDS COMPARED WITH ACTUAL UNITED STATES BIDS

Yard	Estimate	Ratio of United States bids to foreign estimate
British	$1,487,437	1.4 to 1
German	1,013,650	2.0 to 1
Italian	1,406,000	1.5 to 1
Dutch	1,322,200	1.5 to 1
United States (3 yards)	2,044,000 [a]	

[a] Average of 16 ships—actual bids.

It is not necessary for our purposes to argue the exactness of the figures. Variations one way or the other could not be large enough to destroy the validity of the generalization that in recent peacetime years the cost of building ships in the United States has been considerably higher than in important foreign shipbuilding countries. The important points here are: (1) Costs are higher in the United States; (2) the amount of the difference is substantial.

Labor Costs Higher. The usual explanation of the higher costs in the United States is high labor costs. The same study by the Maritime Commis-

[2] Calculated from unpublished statistics of the Maritime Commission.

[3] Report by Mr. Harvey Klemmer of the United States Maritime Commission dated November 23, 1938, regarding shipbuilding costs in European yards transmitted by the United States Ambassador in London to the Secretary of State of the United States.