MERCHANT SHIP TYPES

R. Munro-Smith

MERCHANT SHIP TYPES

R. Munro-Smith
M. Sc., C.Eng., FRINA

Marine
Media
Management
Limited

Published for
THE INSTITUTE OF MARINE ENGINEERS
by
MARINE MEDIA MANAGEMENT LTD.
76 Mark Lane
London EC3R 7JN
(England Reg. No. 1100685)

ISBN: 0 900976 26 8
LCCCN: 74-79180

Frontispiece: The 250,000 dwt supertanker *British Pioneer* (courtesy of BP Tanker Co. Ltd.)

Printed in England by J. W. Arrowsmith Ltd., Bristol

Preface

The Boat, in various forms, was one of man's earliest inventions, coming as it did before the wheel and the utilisation of agriculture. The original boats were probably used more for hunting food rather than for the transport of goods.

About two-thirds of the surface of the globe are covered by the oceans and more than two-thirds of the world's population live within 300 miles (480 km) of the sea. It is significant that most of the major cities of the world are ports. In fact, the sea has always provided a means of sustenance for many people, but man's most successful use of the sea has been as a highway on which the ship is used as a mode of international transport.

The recent technological advances in ship design, construction, materials, automation, cargo handling, propulsion and operating techniques have greatly surpassed any earlier progress in these areas.

The many different kinds of cargo which need to be transported and the economic pressure upon shipowners to earn freights with the least expenditure, have resulted in the development of particular types of ships for specific purposes. The range of ship sizes is very great indeed, from the gigantic oil tankers to the small harbour tugs.

No ship type has yet reached finality of design; today's vessel is merely a link in the long chain of the constantly changing shape of ships.

In the last decade or so there has been a rapid growth in world trade in both raw materials and in manufactured goods, with a corresponding increase in the demand for more ships. Trade can be maintained only on the basis of the mass exchange of goods and such an economic exchange is possible through water transportation.

In spite of the developments which have taken place in all forms of transport, particularly in air transport, the sea route still remains the most important connecting link between nations and the ship is still an important vehicle of trade.

The impact of technological change in sea transport has been profound and this progress will doubtless continue. Materials of construction will change, and just as steel replaced iron, other materials will take the place of steel. Propelling units will become more efficient and automation will be intensified. Pipelines for oil and gas may prove to be more economical than bulk carriers. Ships will change as aircraft carry more cargo and passengers than hitherto and some ship types may cease to exist. However, it does seem likely that the general cargo carrier, even in a modified form, will not disappear. That could only happen if, as in the vision of St. John the Divine, "there was no more sea".

R. Munro-Smith

Acknowledgements

The author and publisher gratefully acknowledge the following organisations and publications as sources of illustrations and advice during the preparation of this book:

Ailsa Shipbuilding Co. Ltd.
Appledore Shipbuilders Ltd.
Austin & Pickersgill Ltd.
Blandford Shipping Co. Ltd.
Blohm & Voss AG
Blue Star Line Ltd.
BP Tanker Co. Ltd.
British Rail
Cable & Wireless Ltd.
Canadian Pacific Ltd.
Cochrane & Sons Ltd.
Corporation of Trinity House
Crane Fruehauf Containers Ltd.
Cunard Steam-Ship Co. Ltd.
J M Davies & Associates Ltd.
Gatx-Oswego (UK) Ltd.
Gem Line Ltd.
Glenlight Shipping Ltd.
Holland America Line
Hovermarine Transport Ltd.
IHC Holland
Leopoldo Rodriquez Shipyard
Lloyd's Register of Shipping
MacGregor & Co. Ltd.
Marine Engineers Review
Nystads Varv Ab
Oy Wärtsilä Ab
RNLI
P & O Ltd.
Power Lifts Ltd.
Robb Caledon Shipbuilders Ltd.
Robertsons of Gosforth Ltd.
Shell International Petroleum Co. Ltd.
Shipping World and Shipbuilder
Southern Ferries Ltd.
Stone Manganese Marine Ltd.
Stothert & Pitt Ltd.
Supramar AG
Swan Hunter Shipbuilders Ltd.
Thames & General Lighterage Ltd.
The Motor Ship
The Naval Architect
Townsend Thoreson Car, Ferries Ltd.
Waveney District Council

Contents

Introduction

Chapter 1

BACKGROUND

Shipping, Shipbuilding, Ships, Basic Design, Rudders and Steering Gears, Initial Stability, Free Surface, Load Lines, Tonnage, Crew Accommodation, Statutory Regulations, Classification, Specifications, Contracts, Registration, Screw Propellers, Propelling Machinery, Trials, Sea Transport.

The marine world is a speculative one subject to the ebb and flow of changing patterns in world trade. The development of trade in specific types of cargoes has led to the development of special types of ships. The use of the seas as a means of long distance transport to obtain commodities has played an important part in the technological development of many areas of the world.

Very exacting demands are made by the shipping industry on naval architects, shipbuilders and marine engineers. The shipowner and related associates are forever seeking more efficient ways to transport goods from one nation to another. World trade requires:

a) mammoth tankers to carry immense quantities of crude oil at speed and safety;
b) gas carriers to transport liquefied gases at very low temperatures and chemical carriers to handle corrosive, poisonous and volatile cargoes;
c) ships that can carry their cargo in containers or on trailers which can be driven on at one terminal and driven off at the other.

Many of these requirements have been realised. Whatever the tasks of the shipping industry, the naval architects, shipbuilders and marine engineers will meet the requirements. At the present time, there are about 160 different types of ships employed in seaborne trade.

The primary duty of a merchant ship is to convey cargo and/or passengers from one port to another where land transport is either uneconomical or impracticable. Air transport is now a very important factor in the conveyance of passengers and freight all over the world. However, the carriage of goods by sea has been little affected by other transport activities; this is clearly demonstrated by the 290 millions plus gross tonnage of all ships afloat in the world today which is made up of about 60,000 individual vessels, literally of all sorts, sizes and shapes.

SHIPPING

Shipping has always been by its nature an international business and recent trends indicate that it will continue in this way. There is, however, one aspect which is

important in that there is a growing nationalism which could be contrary to the best interests of both shipping and world trade.

The physical environment within which the shipping industry operates is made up of the seas and oceans, the forms of the coasts and the nature of the seaward approaches to the ports and harbours. The Suez Canal and the Panama Canal created ocean routes which were previously impossible. The technical environment of shipping includes the techniques of ship construction, propulsion methods and not least navigation.

A technological development which helped considerably the growth of shipping business was the submarine telegraph cable. Information on world surplus and deficiency could be rapidly communicated between owners and shipping agents throughout the world and the ships directed accordingly. Between the laying of the first trans-Atlantic cable by the *Great Eastern* in 1866 and the end of the century, a huge network of submarine cables was stretched across the oceans of the world. They linked the sources of food and raw materials.

Because of its particular economic environment, there is one consideration that makes shipping different from transport by rail or road: the sea as a highway is free to all without capital charges. This also applies to aircraft and it is important to note that the competition provided by aircraft has had a considerable effect on passenger traffic.

The oceans of the world are free in that any nation may operate ships on them without having to obtain permission from other nations. However, the ships are subject to the laws of the country under which they sail. Ships are also governed by international regulations relating to many items such as preventing collision, discharging oil into the sea, etc. Freedom of the seas does mean that ships have rights to use international waterways and certain straits without hindrance, but the tendency in recent years has been for nations to extend their jurisdiction over wider areas of the adjacent seas.

The freedom of the seas is accepted as the basic right of all people and nations to free access to the oceans and the unrestricted use of the oceans for their riches and as a means of communication. This freedom includes the right of sovereign nations to prescribe the laws and regulations that control the granting of registry of ships and the entitlement of ships to fly their flags. Sea transportation is undoubtedly international. A vessel owned by the national of one country can load a cargo in another country and discharge it in a third country, to be marketed in yet another country. Sea transportation has always been and should continue to be an international industry based on free enterprise and personal initiative.

Shipping is also tending to follow recommended routes, prescribed by international agreement, as they pass through straits and channels. Compulsory routeing of all ships in the English Channel and other areas of high traffic density is essential to reduce collision risks. Ships in the 250,000 deadweight class cover about 1·5 miles from full ahead—at 16·5 knots—to full astern before they can be stopped. In a crash stop on trial, the *Globtik Tokyo* of 480,000 tonnes deadweight, from full ahead at 17 knots to full astern, was dead in the water inside 2·75 miles. As a vessel reduces speed in coming to rest it also reduces the ability to manoeuvre.

The importance of shipping can be seen from the fact that 75 per cent of international trade by mass and more than 65 per cent by value moves by sea. For transporting large quantities of goods over long distances the freight rates by sea are the least expensive.

The movement of ships on the seas of the world is considerable. On any one day there could be about 15,000 ships crossing the waters of the world. This only becomes apparent at certain points such as in the Straits of Dover where 800 ships pass in 24 hours.

At the beginning of the present century, the United Kingdom owned about 50 per cent of the total world tonnage and carried about half of all the world's ocean traffic. By 1914 the British share of world trade was declining and an era was coming to an end. Today, in comparison with the period of British shipping supremacy—1870 to 1914—the British fleet is relatively small.

For generations the principal maritime countries of Europe had almost a monopoly of world shipping. This was in keeping with the international trade itself, which was made up largely of supplying Europe with raw materials and exporting the finished products.

The United States Supreme Court in 1953 confirmed the principle that each state under international law may determine for itself the conditions on which it will grant its nationality to a merchant ship and thus accept responsibility for it and acquire authority over it. Nationality is evidenced to the world by the ships papers and its flag. A state may authorise vessels to fly its flag even if they are the property of foreigners. This is international law and practice.

FLAGS OF CONVENIENCE

The term "Flags of Convenience" is commonly used to describe the flags of such countries as Panama, Liberia and Honduras whose laws permit ships owned by foreign shipowners to fly these flags. Although Liberia has the largest merchant fleet in the world (1972)—2234 ships, 44·4M gross tonnage, 81·2M deadweight—very few vessels are owned by Liberian nationals. The basic reason for registering in Liberia is reduced taxation. Nevertheless, such ships must be acceptable for insurance and meet the requirements of all ports they may use.

In ships registered under Flags of Convenience, sometimes called Flags of Necessity, no deviation from international standards is permitted whatever the vessel's flag. Ships classed with a classification society and which sail under Flags of Convenience must conform to the standards set by the society in order to remain classed.

Flags of Convenience came into existence because of economic necessity. The shipping industry of the maritime nations was hampered by governmental restrictions and excessive taxation.

Wartime Casualties

The casualties in the Merchant Navy during World War II were severe; 33,000 seamen lost their lives; 800,000 tons of shipping were lost in the first nine months of the war.

SHIPBUILDING

Most shipyards are well established and originally were located at a site suitable for building small ships by methods which have now been superseded. Many British

shipyards are located on riverside sites in areas of industrial and housing developments. Difficulties have arisen in changing the layout to facilitate the operation of computer-controlled methods of modern ship construction.

Rarely has it been possible in the United Kingdom for a shipbuilder to select a new site and adopt an ideal layout. The Japanese have had several advantages in shipbuilding in that partly through government assistance, they have established very efficient new shipyards on green-field sites during the last two decades. They have become the leading shipbuilding nation in the world as is clearly shown in Table 1.1, which summarises the ships launched in 1972.

TABLE 1.1. World Shipbuilding—Ships Launched, 1972*

Country	Number of Ships	Gross Tonnage (Millions)
United Kingdom	125	1·23
U.S.A.	251	0·61
Denmark	59	0·90
France	66	1·13
Germany (Federal Republic)	153	1·61
Italy	55	0·95
Japan	868	12·87
Netherlands	116	0·76
Norway	133	0·97
Spain	161	1·14
Sweden	39	1·81
World	2561	26·71

*Taken from "Lloyd's Register of Shipping—Statistical Tables" 1972.

The enormous losses in ships during World War II—22 million gross tonnage of allied and neutral and 10 million gross tonnage of enemy—were offset by the launching of 40 million gross tonnage of new ships in the U.S.A. This included more than 2700 Liberty ships built with pre-fabrication and welded methods at yards in New England and California. These vessels, known as the "Ugly Ducklings" of World War II, played numerous roles in the Allied war effort. These standardised Liberty ships were built in an unprecedented display of assembly-line production in which the average construction time per ship was 44 days. See also p. 84.

The main concern in a shipyard is the steel hull production set-up. The ship's hull is the shipbuilders product, much of the remainder is installed from equipment obtained from outside sources. The entire construction and installation is partly an art and partly a science, although shipbuilding is to some extent an assembly industry. A good ship is the result of excellence both in design and methods of production. Shipbuilding technology presents special problems in production engineering. Ships have to float upright, they are built on dry land and transferred to water, they are built on a contract time basis and the builder must make a profit. To do all this is no mean achievement.

During the years 1945 to 1969, the U.S.A. flag fleet declined by about 74 per cent. According to the President, the building costs for American vessels at the end of that time were about twice those in foreign yards and production delays were excessive. In a single decade only 215 merchant ships were delivered by U.S. yards and of these, 131 were built with government aid. It has been recognised that a strong and profitable merchant marine fleet, competitive in the world market, is an integral part of national and international economy.

There has since been an upsurge in U.S. commercial shipyard activities. A great deal of capital has been invested in new facilities and equipment in the 30 plus shipyards which build most of that country's self-propelled, ocean-going tonnage. These are known as the "salt-water" yards. More than 40 other yards build tugs, barges and other vessels generally less than 1000 gross tonnage each.

Japan is the dominant force in the international shipbuilding industry. It not only provides (1972) half the world's new merchant tonnage, but has a merchant fleet of its own (35M gross) which ranks as the second largest in the world. The expansion of Japan's merchant fleet has been closely linked to its requirements for raw materials. It was a natural sequence to develop a national shipbuilding industry to provide the ships to support the economic growth.

Japan, at present, controls the world seaborne trades in iron, coal and ore and uses more transport to move these commodities than the rest of the world together. In the year 1972, Japan launched 48 per cent of the total world tonnage and nearly twice the combined national output of the shipbuilding industries of Sweden, West Germany, Britain, Spain and France. This output was made up almost entirely of large oil tankers and bulk carriers.

Japanese Shipyards

Very few Japanese shipyards remained at the end of World War II. Consequently, the industry was built up from scratch and for many years now Japan has achieved the highest level of production in the world. At present Japan produces nearly one half of the world's ships and many of the yards in that country specialise in the development of mammoth tankers and bulk carriers. Many of the ships are built in dry docks.

Shipbuilding is an industry subject to the fluctuations in world trade, which in turn affects the demand for tonnage.

The world production of ships takes place in a restricted number of economic blocks which may be classified as follows:

Japan
Western Europe
U.S.A.
Rest of the World

During the past decade, as stated above, Japan held a dominating position in the total production of merchant ships in the world.

Hull production starts with the raw material of shipbuilding—steel plates and sections—entering the yard where it is stored in the stock-yard to await cleaning and delivery to the plate shop. This material is handled by magnetic or suction lift cranes

and fed to shot blasting and spray painting machines. Next, the plates are cut to shape by burning machines which are computer controlled by magnetic tape; these shaped plates, together with the steel sections, are welded into sub-assemblies. These sub-assemblies, which may have a mass of several hundred tonnes, are then taken to the assembly site by travelling cranes. The ship may be assembled on a sloping building berth for subsequent launching or assembled in a building dock, a simplified procedure, which is flooded when the steel hull is complete.

SHIPS

Before dealing with the Family Tree of Ships shown in Table 1.2, it is of interest to have some idea of the tonnage and number of ships attached to the leading maritime nations. Table 1.3 gives some information for several countries for the year 1973. It will be seen from this table that Japan has the largest number of ships and Liberia has the greatest gross tonnage.

As a first analysis merchant ships can be divided into two classes—cargo ships and passenger ships. Cargo ships in broad terms are tramps or cargo liners.

A tramp is a dry cargo ship which does not keep to a fixed route or sail to any particular schedule. The routes and ports of call are governed solely by the availability of suitable

TABLE 1.2. The Family Tree of Ships

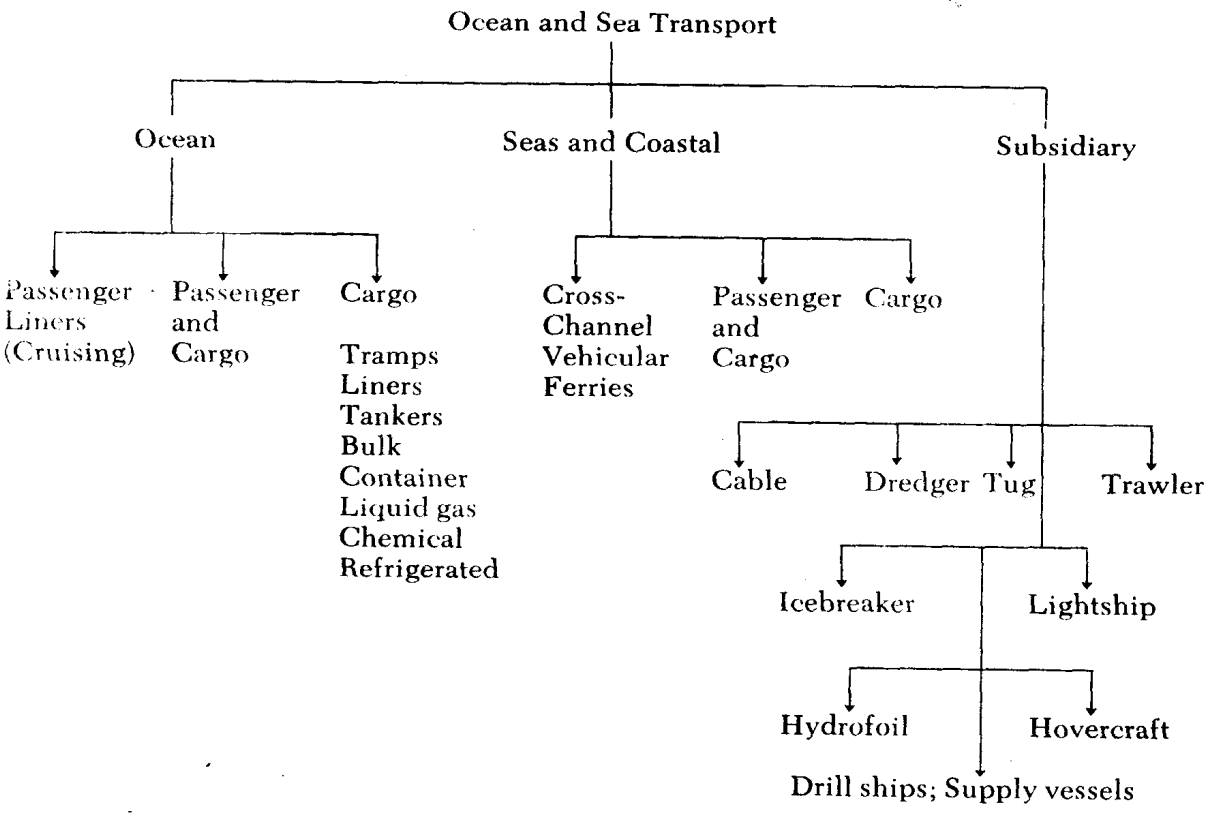

TABLE 1.3. World Shipping[1]

Country	Number of Ships	Percentage of World Gross Tonnage
United Kingdom	3628	10·4
U.S.A.	4063	5·2
France	1376	2·8
Germany (Federal Republic)	2234	2·7
Greece	2536	6·7
Italy	1726	3·1
Japan	9469	12·7
Liberia	2289	17·2
Norway	2758	8·2
U.S.S.R.	7123	6·0
World	59,606	Gross tonnage 289·9M

*Taken from "Lloyd's Register of Shipping—Statistical Tables", 1973.

cargoes. Accommodation for passengers is not usually provided in tramps since they seldom ply on a fixed route. The average tramp has a speed in the region of 14–16 knots.

The cargo liner is a ship which sails to a schedule on a definite route between specified ports. Frequently they have accommodation for a small number of passengers. The number of passengers has to be limited to 12 if the rigorous passenger ship construction rules are not to be invoked. The average speed of these vessels is between 14 and 20 knots.

Any British ship which carries more than 12 passengers must have a Passenger Certificate issued by the Department of Trade. Such a ship is classed as a passenger ship and may also carry cargo. To qualify for a Passenger Certificate the ship must be surveyed annually and conform to certain minimum standards for hull structure, watertight subdivision, lifesaving appliances, fire protection, fire-fighting and radio equipment. These standards are modified to some extent in certain vessels such as cross-channel ships, vessels plying in sheltered waters, etc.

Cargo ships carrying less than 13 passengers do not require a Passenger Certificate but must conform to the Load Line Rules as laid down for all sea-going ships. They are generally built to the standards laid down by the classification societies for the purpose of insurance and must conform to certain minimum legal standards of accommodation, life-saving, fire-fighting and radio equipment.

BASIC DESIGN

In ship design the economic factor is of prime importance. The shipowner requires a vessel that will give the best financial return for the initial investment and subsequent running costs. This means that consideration must be given not only to existing

economic conditions, but also to what may develop within the following 20 years. The building of a ship involves the investment of large sums of money—in some cases, millions of pounds.

Ships are becoming larger, faster, more complex and costly. A large tanker or container ship can cost £25M and a gas carrier £35M or more. With the trend towards contracts of chartering for bulk movement and container and other unit load systems for general cargo the tendency is to order ships in batches rather than singly.

In making an investment decision the owner commits his company to an expensive vehicle with a life of from 20 to 25 years over which a satisfactory return must be made.

For a basic design to be prepared, the owner will normally state the type of ship desired, deadweight, speed, possible routes, ports to be used and the classification and accommodation to be provided.

Many of the requirements which a ship must fulfil are common to all types—cargo, passenger and special purpose ships. Some of these requirements are set out below:

1) At the maximum draught permitted the ship must be able to carry the specified load and have the cubic capacity required for the cargo, fuel, etc.
2) The ship must be stable in all normal conditions of loading. Stability means that when the ship is inclined from the vertical by some external force it will return to the vertical when the external force is removed.
3) The hull to have adequate strength to withstand all the stresses encountered in service and remain in a condition of seaworthiness. This is ensured if the vessel is built to the rules and regulations of a classification society.
4) The specified speed to be obtained with the minimum use of power and consequently low consumption of fuel. Service speed is the average speed at sea at normal service power and loading under average weather conditions. Trial speed is the average speed at maximum power over a measured mile course in calm weather with a clean hull and specified load condition. This speed may be a knot in excess of the service speed.

In addition to these requirements, there are special demands, such as the need to make passage through various canals. Locks in the Panama Canal limit the ship size to about 305 m length, 31 m breadth and 11·25 m draught. For the St. Lawrence Seaway the maximum ship dimensions are 222 m length, 22·8 m breadth and 7·6 m draught. In the Manchester Ship Canal the limitations on maximum size are 171 m length, 19·3 m breadth and 8·7 m draught in fresh water. There are also bridges over this canal which limit the height of structure above the waterline to 21·25 m.

The dimensions of a cargo ship are primarily influenced by the volume required for the specified cargo. In a passenger ship the dimensions are controlled by the extent of superstructure required for the accommodation.

The length should be a minimum in keeping with the specified speed and the hull form. Breadth has to be such as to provide adequate transverse stability. The minimum depth is controlled by the draught plus the statutory freeboard.

The mass of the ship itself, called the *light mass*, is made up of the hull structure, equipment, and propelling machinery. The load is known as the *deadweight* or *dead load* and includes cargo, fuel, fresh and feed water, stores. Total deadweight is the