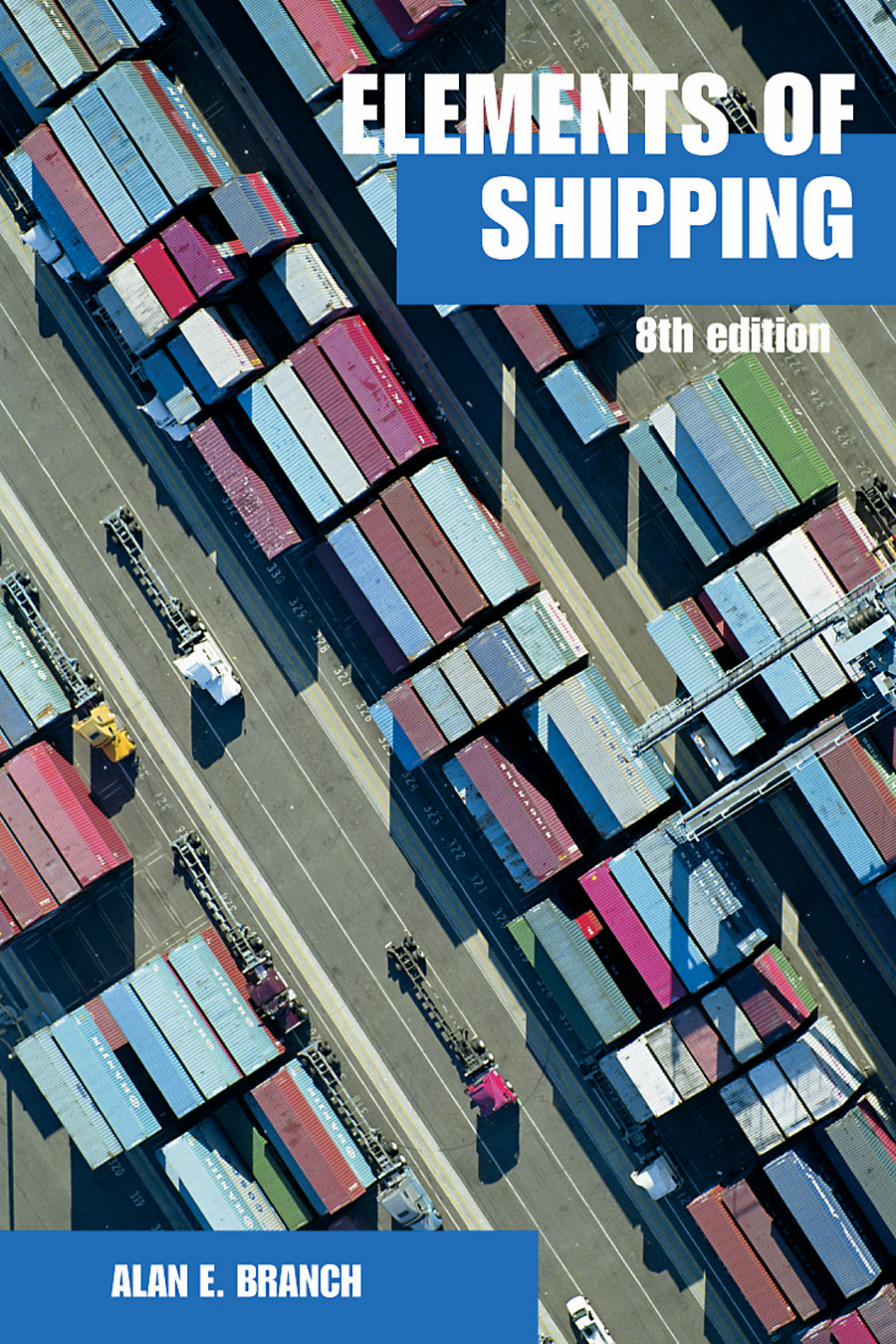

ELEMENTS OF SHIPPING

8th edition

ALAN E. BRANCH

Elements of Shipping

Since it was first published in 1964 *Elements of Shipping* has become established as a market leader over its many editions. The eighth version is entirely updated to take in the many changes that have occurred in the shipping industry in recent years and features new chapters on seaports and electronic data interchange.

The book explains in a lucid, professional manner the basic elements of shipping embracing operating, e-commerce/computerization (shipboard/trade), commercial, legal, economic, technical, managerial, logistics and financial considerations. It also reflects major trends including the impact of globalization, current good practice and future trends. All twenty-two chapters have been updated and over two-thirds of the content is new. New emphasis is also placed on professionalism and the need to have the latest technology and professionally qualified personnel to operate a shipping service today.

This book fills a gap for the discerning reader who wishes to have a complete understanding of all the elements of the global shipping scene together with the interface with seaports, international trade and logistics. It remains essential reading for shipping executives along with students and academics with an interest in the shipping industry.

Alan E. Branch is International Business/Shipping Consultant, Examiner in Shipping, Export Practice and International Marketing and Visiting Lecturer at Cardiff University, Reading University, Plymouth University, Leicester University, London City College and the Rennes International School of Business France.

Also available from Routledge:
Maritime Economics Management and Marketing – Alan Branch (0–7487–3986–6).
Global Supply Chain Management and International Logistics – Alan Branch (2008).

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Global Supply Chain Management and International Logistics
Elements of Port Operation and Management
Dictionary of Shipping International Business Trade Terms and Abbreviations
Dictionary of Commercial Terms and Abbreviations
Dictionary of English–Arabic Shipping/International Trade/Shipping Terms and Abbreviations
Dictionary of Multilingual Commercial/International Trade/Shipping Terms in English French German Spanish

Elements of Shipping

Eighth edition

Alan E. Branch

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To my wife Kathleen

Contents

Preface to the eighth edition

It is appropriate that the eighth edition of this book – which today is firmly established as the standard work on the subject and market leader in its field – should be published on its forty-third anniversary. Much has changed in the years since the seventh edition was published. In fact throughout this period, 1995–2007, there have been more changes in this complex maritime industry than the previous 25 years. The eighth edition reflects such changes, the factors driving change and future trends all on an analytical strategic basis in a very competitive market.

The eighth edition has been completely updated, including 70% new material, and reflects the many changes which have emerged in the past ten years in a fast-changing, complex global maritime environment. Accordingly, it focuses attention on new tonnage developments, IMO conventions, ship productivity, (third-party) ship management, seaport privatization, documentation, customs, logistics, e-commerce, changing pattern of world trade/ship ownership, containerization, multi-modalism, INCO terms 2000, chartering, dangerous cargo, ships agents, international agencies, freight rates, cruises and ship operation. Many of the chapters have been enlarged, and the book is written in a simple but lucid style with analysis, pragmatism and professionalism. Moreover, it takes full account of future trends and contains numerous tables, diagrams and case studies to supplement the narrative.

The book reflects the author's shipping experience, spanning 50 years in terms of working in the industry, consultancy, lecturing and formulating courses in over 30 countries, reflecting different cultures, embracing governments, shipping companies, port authorities, shipper councils, universities/colleges, chambers of commerce and trade associations. It is read in over 200 countries by students/undergraduates and by shipping executives globally studying the subject and by international entrepreneurs who use it as an *aide-mémoire*.

Elements of Shipping treats the subject in a practical, professional manner and it is an ideal *aide-mémoire* to the shipping/export/seaport/logistics executive. It provides the reader with a basic understanding and knowledge of the international shipping industry, with emphasis on the salient economic, political, commercial, operating, management, logistic and e-commerce/

computerized application of the subject. Full cognizance has been taken of the e-commerce and logistic environment throughout. Emphasis has been given to adopting strategies which respond to situations and are capable of being executed and finally 'add value' at all times.

Such enrichment in the eighth edition will further its popularity in shipping/port/agents'/shipbrokers'/shippers' offices, together with colleges of higher education and universities throughout the world. It is ideal for students taking shipping, international trade, ship broking, maritime transport, international distribution, export, import, chartering, ship management, transport, seaports, logistics, containerization and international management examinations/research or training courses/seminars at degree/diploma level at universities and colleges. Such colleges/universities are situated not only in the UK but also in Hong Kong, Malaysia, Singapore, Scandinavia, China, India, the United States, Sri Lanka, South Africa, Pakistan, Jamaica, Jordan, Malta, Cyprus, Dubai, Brazil, Australia, New Zealand, Canada, the Middle East, Europe, the Pacific Rim nations and many less developed countries. The book is also popular with degree level undergraduates taking Maritime Transport, International Logistics, International Physical Distribution, International Marketing and International Business.

The book is popular with a wide range of professional institutes, embracing the Chartered Institute of Logistics and Transport, Institute of Commercial Management, British International Freight Association, Institute of Chartered Shipbrokers, Institute of Export, Institute of Marine Engineers, Institute of Purchasing and Supply and Institute of Marine Engineers.

The eighth edition contains a much enlarged input from international agencies and shipping/port authorities/companies around the world, reflecting good practice, new strategies and current and future developments. This not only enriches the book but also enables the reader to have a better understanding of world cultures and strategies. The extent and breadth of such input is exemplified in the increasing number of organizations which have helped me so enthusiastically with each new edition over 40 years, as recorded in the acknowledgements, and for whose assistance I am most grateful. Also, I very much appreciate the interest shown by many colleges and universities.

In 1997 I received a Worldaware Business Award – part of the United Nations Organization – for my contribution to the developing world in writing, lecturing and training in the complexities of shipping, resulting in an unrivalled reputation as a leader in this field.

The reader who wishes to know more about export or import practice may wish to study the companion volumes, *Export Practice and Management* (fifth edition 2006) and *International Purchasing and Management* (2000). Similarly the reader who wishes to know more about ship management/marketing/logistics should study *Maritime Economics: Management and Marketing* (third edition 1997, fourth edition 2010); for logistics *Global Supply Chain Management and International Logistics* (forthcoming) and for documentation *Shipping and Air Freight Documentation for Importers* *and Exporters* (second edition 2000). Additionally, the popular dictionary of 18,000 terms published in 2005 entitled *Dictionary of Shipping International Business Trade Terms and Abbreviations* could further enrich the reader's knowledge as an *aide-mémoire*.

Finally, I would like to acknowledge with grateful thanks the generous secretarial help of Mrs Jane Salter and, as always, my dear wife, Kathleen Branch. Such a duo has provided me with encouragement, forbearance and, above all, complete professionalism to enable this enlarged and enriched eighth edition to be possible, for which I am greatly indebted.

Alan E. Branch
Reading

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International Maritime Organization
International Maritime Satellite Organization
International Organization for Standardization
International Petroleum Exchange
International Ship Managers Association

International Maritime Industries Forum
International Shipping Federation
International Tanker Owners Pollution Federation Ltd
Intertanko
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Norwegian International Ship Register
Norwegian Shipowners' Association
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Oil Companies International Marine Forum
Organization of Petroleum Exporting Countries
Panama Canal Commission
Passenger Shipping Association
Peninsular & Oriental Steam Navigation Company
P&O Ferries
P&O NedLloyd
Port of Rotterdam Authority
SITPRO
St Lawrence Seaway Management Corporation
Suez Canal Authority
United Nations Conference on Trade and Development (UNCTAD)
V Ships
Worldscale
WTO

1 Introduction

1.1 Scope of the book

Since this book was first written, over 40 years ago, the pattern and importance of shipping have changed drastically – probably more so in the past decade than in any era during the past hundred years. This is demonstrated by the fact that throughout this period of 40 years, 1965–2005, world seaborne trade has increased by over 450% from 6,000 to 28,000 billion ton miles (p. 3). The change has been fast moving and driven by many factors. Today we live in a global environment in which shipping and trade are inextricably linked as never before. The shipper is driving the shipping industry and the response is to focus continuously on ship productivity with a strong interface integrated with other transport modes: overland/inland waterways/air. Hence it is a high profile international business and high-tech in its management and operations. Moreover in recent years the trade growth has shifted to the Asian countries and this has been followed by the ownership of world tonnage. Today Asian countries are significant players in many sectors of maritime transport. They account for about half of the crews, two-thirds of global port operators, 83% of container ship building, and 99% of demolition/recycling. Twenty-eight of the world's 50 largest liner companies are based in Asia. Over 70% of the top twenty container seaports are based in the Asian region (p. 386). Today shipping has become more competitive than ever and more complex. Over 99% of world trade in volume terms is conveyed by sea and the need to have an understanding of all the elements in the conduct/mechanism of the maritime industry is paramount. Hence the eighth edition seeks to fulfil this objective.

The eighth edition of this book is written primarily for the student/undergraduate/international shipping business executive who has limited knowledge of the shipping industry but wishes to gain a basic and fundamental knowledge of the way it works today and likely future trends. It deals with the economic, political, commercial, logistics, operating, information technology, finance and legal aspects, together with focus on seaports. Furthermore it embraces a full integration of e-commerce throughout the text and identifies key areas of management and strategy in the industry.

The latest edition, containing 75% new material, is completely updated throughout. It features the growing development of multi-modalism, logistics and containerization, role of e-commerce, including Bolero, development of logistics, growth of globaliztion, update on IMO regulations, changing ship design/survey methods/cargo vessels structure embracing new technology, new chartering documents and changing role of ship broker, and Baltic Exchange, increasing role of BIMCO, Intertanko and other international agencies, structure of shipping companies, third party ship management and changing role of politics. It also focuses on current challenges facing the industry and possible solutions and areas of structure it changes. Basically, it is more analytical in content and focuses on the broader picture of factors driving its development. This embraces trading blocs, the WTO and EU. Overall, it features a strategic role.

Overall the book is written in a simple but lucid style and reflects the author's experience in the industry spanning 50 years, which includes not only work and consultancy on a worldwide scale in the industry itself, but also that of lecturer/chief examiner at home and overseas.This has involved overseas governments and multinational industries together with many conferences/ seminars at which he has delivered papers on the subject. This book treats the subject in a pragmatic and professional way. It places particular emphasis on the fact that shipping today is a complex operation and all the ingredients of the subject must be fully understood to ensure the business is conducted both efficiently and profitably. The 'value added benefit' concept is particularly significant whereby the shipper will choose the maritime service which yields the highest benefit both to the exporter and importer.

1.2 Function of shipping

The function of shipping is the conveyance of goods from where their utility is low to a place where it is higher. Goods may consist of raw materials conveyed in bulk cargo shipments or purpose-built containers, equipment components/parts for assembly at an industrial plant or on-site capital project like a power station, or the whole range of consumer products many of which are durable and may be shipped in containers, on swap bodies or by an international trucking operation. A growth area in recent years is out-sourcing. This involves manufacturers relocating their industrial plant from a high labour cost economy such as Germany or the UK to a low labour cost environment as found in many Far East countries. Components are sourced locally or from neighbouring countries to the industrial/assembly plant. Subsequently the products are marketed locally to the major trading centres such as Europe and North America. It is logistically driven and relies primarily on containerized shipment. It examplifies how shipping is contributing to the growing volume of international trade, the relocation of industry from the developed to the developing economies, and finally to the changing pattern of international trade.

The factors influencing the shipper's choice of transport mode has changed dramatically during the past decade. Today it is based on the total product concept embracing all the constituents of distribution logistically driven. These include reliability, frequency, cost, transit time, capital tied up in transport, quality of service, packaging, import duty, insurance and so on. It favours more strongly multimodalism with sea transport undertaking the major leg of the overall transit. Logistics, just-in-time delivery, supply chain management and distribution centres/'distriparks' play a major role in the decision-making process. All these aspects will be re-examined later as the basis of how the shipowner can best meet the needs of the shipper in the foreseeable future. The paramount consideration is for the shipowner to empathize with the shipper and strive to become flexible and responsive to the shipper's needs on an innovative value-added basis in a competitive logistic global environment. The freight rate is not the only paramount factor, it is the value-added benefit the shipper gains from the service, which is usually a combined transport operation road/sea/rail

1.3 World seaborne trade and world fleet

(a) World seaborne trade (Table 1.1) reached 27,635 billion ton miles in 2004, reflecting an increase of 6.9%. The average transport distance also increased, thereby improving ship productivity. Demand for haulage of crude oil and oil products rose by 6.2%. This indicates crude oils are moving longer distances – for example from sources in the Barents, Baltic and Black seas to destinations in Europe and North America. For

Table 1.1 World seaborne trade, selected years (billion ton miles)

	Oil								
Year	*Crude*	*Products*	*Crude plus products*	*Iron-ore*	*Coal*	*Grain*[a]	*Five main dry bulks*	*Other dry cargoes*	*World total*
1970	5,597	890	6,487	1,093	481	475	2,049	2,118	10,654
1975	8,882	845	9,727	1,471	621	734	2,826	2,810	15,363
1980	8,385	1,020	9,405	1,613	952	1,087	3,652	3,720	16,777
1985	4,007	1,150	5,157	1,675	1,479	1,004	4,480	3,428	13,065
1990	6,261	1,560	7,821	1,978	1,849	1,073	5,259	4,041	17,121
2000	8,180	2,085	10,265	2,545	2,509	1,244	6,638	6,790	23,693
2001	8,074	2,105	10,179	2,575	2,552	1,322	6,782	6,930	23,891
2002	7,848	2,050	9,898	2,731	2,549	1,241	6,879	7,395	24,172
2003	8,390	2,190	10,580	3,025	2,810	1,273	7,454	7,810	25,844
2004	8,910	2,325	11,235	3,415	2,965	1,325	8,065	8,335	27,635

Source Fearnleys, *Review 2004*.

Note [a] Includes wheat, maize, barley, oats, rye, sorghum and soya beans.

all dry cargoes the ton mileage rose by 7.4% whilst tonnage carried rose by 4.4%. All five main dry bulks cargoes' ton miles increased by 8.2%, reflecting rising Chinese industrial demand. The remaining dry cargoes embracing minor bulks, and liner cargo supply lines were also extended and reflected an increase of 6.7%. This reflects longer distances between cargo origins and destinations and the lasting effect of relocated industries in the Far East.

(b) Development of international seaborne trade (Table 1.2) rose by 4.3% to 6.76 billion tons of loaded goods in 2004, but the growth rate is likely to slacken in subsequent years owing to the slow-down in the Far East economies, especially China. Africa's share of world exports was 8.6%, America's 21.4%, Asia's 38.4%, Europe's 22.7% and Oceania's by 8.9%. Tanker shipments rose by 4.2% to 2.32 billion tons, 76.4% of which was in crude oil. Natural gas production reached 2,618.5 billion cubic metres (bcm) – an increase of 3.4% in 2004. Producers are the Russian Federation 578.6 bcm, United States 549.5 bcm, Canada 180.5 bcm, UK 102.7 bcm, Algeria 82.8 bcm, Iran 70 bcm and Indonesia 72.6 bcm. Other producers are located in the Middle East, Latin America and Asia – often obtaining natural gas as a result of oil production. About 20% of natural gas is exported, mainly by pipelines, which carry 75% of all exports. Many LNG tankers are now in the range of 150,000 m^3 instead

Table 1.2 Development of international seaborne trade: goods loaded, selected years[a] (goods loaded)

			Dry cargo					
	Tanker cargo		*Total*		of which *main bulk commodities*[b]		*Total (all goods)*	
Year	*Million tons*	*% change*	*Million tons*	*% change*	*Million tons*	*% change*	*Million tons*	*% change*
1970	1,442		1,124		448		2,566	
1980	1,871		1,833		796		3,704	
1990	1,755		2,253		968		4,008	
2000	2,163		3,821		1,288		5,983	
2001	2,177	0.7	3,844	0.6	1,331	3.3	6,020	0.6
2002	2,146	–1.4	3,981	3.6	1,352	1.6	6,127	1.8
2003	2,223	3.6	4,257	6.9	1,475	9.1	6,480	5.8
2004[c]	2,316	4.2	4,442	4.4	1,587	7.6	6,758	4.3

Sources Estimated by the UNCTAD secretariat on the basis of annex II and data supplied by specialized sources.

Notes

a Includes international cargoes loaded at ports of the Great Lakes and St. Lawrence system for unloading at ports of the same system.

b Iron ore, grain, coal, bauxite/alumina and phosphate.

c Estimates.

of traditional 125,000 m^3 (p. 67). Designs for a new type of vessel, the compressed natural gas carrier (CNG) were under inspection in North America and Norway. This carrier would provide a cost-effective solution for supplying gas from remote locations too small to warrant full scale LNG projects. Oil pipeline construction continues in many oil-producing countries. A recent example is the commissioning of the 1,770 km pipeline from Baku (Azerbaijan) to Ceyhan (Turkey) on the Mediterranean Sea, which will reduce the transit of tankers through the Dardanelles Straits.

Dry cargo shipments recorded an increase of 4.4% to reach 4.44 billion tons in 2004. The five dry bulk trades iron ore, coal, grains, bauxite/alumina and rock phosphate attained an increase of 7.6% to reach 1.59 billion tons. The remaining dry cargo trades, minor bulks and liner cargoes, increased at a slower rate to 2.65% to 2.86 billion tons. The share of dry cargo shipments in world seaborne trade was 65.7% of total goods loaded during the year.

An analysis of dry cargo shipment in 2004 established the following. World crude steel production rose by 8.8% to 1,054.6 million tons, world pig iron production rose by 10.8% to 753.9 million, steel consumption rose by 6.1% to 918 million tons, iron ore shipments reflecting steel production rose by 12.6% to 590 million tons with Australia and Brazil accounting for 70% of world exports; coal shipments rose by 5% to a record of 650 million tons with thermal coal representing 70% of shipments; grain shipments rose by 4.2% to 250 million tons and were split equally between wheat and coarse grain such as maize, barley, soya beans, sorghum, oats and rye; and shipments of bauxite and alumina – primary inputs for the aluminium industry – rose by 6.3% to 67 million tons. Containerized shipments totalled 1.94 million tons, embracing the east–west (trans-Pacific, Europe–Far East and transatlantic), north–south and regional routes.

(c) Referring to Table 1.3, world output growth from 2001 to 2004 rose by 3.8% in 2004. Overall, it reflected the fact that virtually all regions of the world recorded positive economic growth at differing paces. Tables 1.1 and 1.2 give an analysis of the impact of this growth in the maritime industry, particularly the developing countries. Future growth depends on many factors, especially inflationary oil prices and the trade deficits in major developed economies which long-term are unlikely to be sustainable.

(d) An analysis of the structure of the world fleet (Table 1.4) indicates in 2005 it reached 895.8 million deadweight tons (dwt) on 1 January 2005, realizing an increase of 4.5% over 2004. New building deliveries represented 49.4 million dwt while 10.6 million dwt were broken up and lost, resulting in a net gain of 38.8 million dwt over 2004. Oil tanker tonnage in 2004 rose by 6.1% and that of bulk carriers by 4.2%. These two types of ships represented 73.3% of total world tonnage. The world

Table 1.3 World output growth, 2001–2004[a] (%)

Region/Country[b]	*2001*	*2002*	*2003*	*2004*[c]
World	1.3	1.8	2.5	3.8
Developed countries	1.0	1.3	1.7	3.0
of which:				
Japan	1.0	1.3	1.7	3.0
United States	0.3	2.4	3.0	4.4
European Union	1.7	1.1	0.9	2.1
of which:				
Germany	0.9	0.2	–0.1	1.0
France	2.1	1.2	0.5	2.1
Italy	1.8	0.4	0.3	1.0
United Kingdom	2.1	1.7	2.2	3.1
South East Europe and CIS	5.6	4.9	6.9	7.5
Developing countries	2.4	3.5	4.7	6.4
Developing countries excluding China	1.5	2.7	3.9	5.7

Source UNCTAD secretariat preliminary estimates.

Notes

a Calculations are based on GDP in constant 1995 dollars.

b Region and country groups correspond to those defined in the UNCTAD *Handbook of Statistics, 2004*.

c Preliminary.

fleet of fully cellular container ships continued to expand substantially in 2004 both in ships and their TEU capacity. In January 2005 there were 3,206 ships with a total capacity of 7,165,352 TEU – an increase of 5% in ships and 11.3% in TEU capacity. Average carrying capacity per ship rose from 2,108 TEU in 2004 to 2,235 TEU in 2005. Vessels of over 4,000 TEU capacity account for 74% of the current order book; 165 vessels on order were larger than 7,500 TEU capacity, more than three times the current number of vessels above that size.

1.4 Challenges facing the shipping industry in the twenty-first century

As we progress through the contents of this book it is important to focus now on the major challenges facing the shipping industry in the twenty-first century and in so doing provide the reader with the opportunity to reconcile these challenges with current practice in an objective analysis and identify possible future trends.

(a) The growing development of a global logistic environment, thereby moving away from the port-to-port operation to the combined transport supply chain embracing road/sea/road,rail/sea/rail,rail/sea/canal (p. 409).
(b) The continuing liberalization of trade through the GATT/WTO global agreements, thereby providing more trading opportunities (p. 169).

Table 1.4 Structure of the merchant fleets of the main country groups as of 1 January 2005[a] (dwt million and percentage shares)

	World fleet		*Developed market-economy countries*		*Open-registry countries*		*Developing countries*		*Central and Eastern Europe*		*Socialist countries of Asia*	
Type of vessel	*Million dwt*	*%*	*Million dwt*	*%*	*Million dwt*	*%*	*Million dwt*	*%*	*Million dwt*	*%*	*Million dwt*	*%*
Total fleet	895.8	100.0	241.7	100.0	404.0	100.0	202.3	100.0	14.5	100.0	33.4	100.0
Oil tankers	336.2	37.5	108.4	44.9	145.1	35.9	73.1	36.2	2.9	20.3	6.6	19.6
Bulk carriers	320.6	35.8	60.6	25.1	169.7	42.0	73.4	36.3	3.0	21.0	13.9	41.6
General cargo ships	92.0	10.3	20.4	8.5	29.8	7.4	27.2	13.5	5.7	39.8	8.8	26.3
Container ships	98.1	10.9	34.0	14.0	43.0	10.7	17.6	8.7	0.4	2.9	3.0	9.0
Other ships	49.0	5.5	18.3	7.6	16.4	4.1	10.8	5.3	2.3	16.1	1.2	3.5

Source Compiled by the UNCTAD secretariat on the basis of data supplied by Lloyd's Register – Fairplay.

Note

Ships of 100 grt and over, excluding the US Reserve Fleet and US and Canadian Great Lakes fleets.

(c) The changing political scene through the emerging markets and their influence in global trade negotiations (p. 169).
(d) The growth of the Chinese, Indian and Brazilian economies, especially the former, and the extensive programme in China of infrastructure development, especially container ports (p. 383). India is likewise developing its container ports (p. 360).
(e) The changing trade flow emerging from the Far East as consumer/industrial plant is relocated, with Europe and North America the prime consumers. This is the result of outsourcing manufacturing and consumer industries from the developed economies of Europe and North America to developing countries of the Far East, many involving joint ventures.
(f) The growing importance of energy as the vehicle for industrial/consumer demand expansion, especially oil and gas. Gas will grow at double the rate of oil (p. 65).
(g) The need to improve ship productivity (p. 24). This is being realized through third party ship management (p. 472); development of the hub and spoke system, especially through containerization (p. 346); port modernization/privatization (p. 382); the tendency to build larger vessels such as in container vessels, cruise tonnage; auto carriers and LNG carriers to exploit economies of scale, continuous improvement in ship management (p. 458), development of longer voyages; continuing improvement in marine engineering especially in propulsion (p. 17), shipboard management (p. 298), and longer voyages (p. 3). Fleet planning and computer technology play a major role to improve ship productivity.
(h) The continuing expansion and increasing influence of economic blocs/customs unions in opening up markets and trading opportunities.
(i) A key factor is for the shipowner to develop strategies to continuously 'add value' to the shipping service provided. This embraces the total product, including all the ingredients featuring ancillary activities. It is driven by the shipper, and a synergy must be developed between the shipper and shipowner in a market research-driven environment.
(j) The changing pattern of the world's mercantile fleet, embracing type of tonnage, the diminishing age of many sectors, and ownership. The trade expansion in the Far East has caused ship ownership to move from Europe to the Far East, a trend which continues, especially in China (p. 50).
(k) Another key factor is for the shipowner and port operators to adopt strategies which are innovative and flexible in responding to the changing market environment and the challenges it offers.

Recommended reading

UNCTAD annual maritime transport review, www.transport.section@unctad.org
BIMCO annual review, www.bimco.dk
WTO annual international trade statistics, e-mail publications@wto.org

2 The ship

2.1 Main features of hull and machinery

There are two main parts to a ship: the hull and the machinery. The hull is the actual shell of the ship including the superstructure, while the machinery includes not only the engines required to drive it, but also the ancillary equipment serving the electrical installations, winches and refrigerated accommodation.

The hull is virtually the shell of the ship and usually designed for a particular trade in accordance with a shipowner's specification. A vessel is constructed of a series of transverse frames, which extend from the fore to aft of the vessel, rising at right angles to the keel. In reality they form the ribs of the ship. Statutory regulations exist regarding the distance between each frame. Each vessel, depending on its classification – passenger, container, tanker, bulk carrier – must have a number of bulkheads which are virtually steel walls isolating various parts of the vessel. This is necessary in the interests of containing a fire or flooding following a collision. Ocean-going vessels must have at the fore end a collision bulkhead installed at a distance of not less than 5% of the ship's length from its bow. The obligatory after-peak bulkhead function is to seal off the stern tubes through which run the tailshaft driving the propeller.

The rear portion of the ship is termed the after end or stern. When moving stern first, the vessel is said to be moving astern. The front portion of the ship is termed the fore end, whilst the extreme forward end is called the bows. When moving bow first, the vessel is said to be moving ahead. Fore and aft are generally used for directional purposes. The area between the forward and aft portions of the vessel is called amidships. The maximum breadth of the vessel, which is found in the amidships body, is known as the beam.

The engine room houses both the machinery required to drive the vessel and the generators required for lighting, refrigeration and other auxiliary loads. Engines are usually situated aft, thus releasing the amidships space – at the broadest part of the vessel – for cargo and passenger accommodation. Today a new era of the electric ship is being developed (p. 17). The ship's funnel, painted in the shipping line colours, is situated above the engine room. In modern passenger liners, it is specially designed to keep fumes and smuts clear of the passenger accommodation. The propeller shaft, linking the propeller with the engines, passes through a shaft tunnel and is usually a single controllable pitch specification. The ship's anchors and the windlasses used to lower and raise them are found in the bow section. Additional anchors might also be provided on a large ship. All tankers and bulk carriers are constructed of a double hull formation.

Modern tonnage, particularly tankers, container ships and passenger liners, have transverse propulsion units in the bows termed bow thrusters. A number of vessels have side thrusters situated at the stern of the ship. Both bow and side thrusters are situated on the port and starboard sides (p. 19). Their purpose is to give greater manoeuvrability in confined waters, e.g. ports, and so reduce or eliminate the need for tugs. The rudder which enables the vessel to maintain its course is situated aft. Some ships have an additional rudder in the bows for easier manoeuvrability in port. A recent development is the Azipull propeller (p. 19). Stabilizers are in appearance similar to the fins of a fish, and are fitted to modern passenger liners and container ships to reduce rolling in heavy seas. They are fitted in pairs, and when in use protrude at right angles from the hull, deep below the water line. Their number depends on the size of the vessel. The provision of a bulbous bow can also improve passenger comfort, as it can reduce pitching in heavy seas and has also been provided in tankers, bulk carriers and modern cargo liners to increase speed when in ballast.

The modern tendency is to have large unobstructed holds with electrically operated hatch covers, for the speedy handling of cargo, and to reduce turn-round time to a minimum.

Their actual design and the number of decks will depend on the trade in which the ship plies. A vessel comprises various decks with the upper-most decks being called the navigational, boat and promenade decks. A continuous deck in a ship would run throughout the length of the vessel from fore to aft.

The transverse bulkheads run from the tank tops or floors of the hold to the deck. The longitudinal framing consists of steel sections running the length of the ship into which are fixed the skin plates forming the hull. Nowadays, with the development of the welded construction, vessels are constructed on the combined system which uses the longitudinal system in the double bottom, and at deck level uses transverse framing for the sides. Basically the combined system is better for welded construction.

Scantlings basically are the dimensions of the structural parts of the ship embracing size of frames, beams, steel plating, bulkheads and decks. A vessel built to the full scantlings would be based on the maximum draught when the freeboard measured from the loadline to the deckline (the upper side of the continuous main-deck or freeboard deck which is equipped with permanent means of closing all openings to the elements) is at its minimum.

Single deck vessels fall within this category such as an ore carrier which needs the strongest type of ship construction to convey such heavy deadweight cargoes with low stowage factors. Such vessels are built to the highest specification of the classification societies such as Lloyd's Register of Shipping, American Bureau of Shipping, Bureau Veritas, etc., as regards strength of the component parts of the structure.

To give access to cargo holds, openings are cut into the deck of the vessel which are termed hatchways and are surrounded by coamings which are like steel walls rising from the deck. The height of these coamings is regulated by statute or classification society regulations.

Each mercantile type vessel has a certain number of various types of tanks for a variety of purposes and the following are the more salient ones:

(a) The forepeak tank is situated in the bows of the vessel between the bows and the collision bulkhead.
(b) Conversely the aft peak tank is situated in the stern of the vessel. It forms the aftermost watertight bulkhead.
(c) The wing tank is located at the side of the holds designed for carrying water ballast. These are found particularly in specialized bulk carriers.
(d) The deep tanks are situated one in each of the holds at the two ends of the ship. Such tanks are used for carrying water ballast and can be used to carry dry cargo. In modern vessels they are constructed to convey oil, either as bunkers, or wood or palm oil.

A tramp, carrying shipments of coal or ore, will be a single-deck vessel with large unobstructed hatches to facilitate loading and discharge.

The handling of cargo will be mechanized as far as possible with the use of conveyor belts, pallets and containers. The holds of a modern cargo liner are designed to facilitate dealing with such modern methods of cargo handling.

The derricks are the ship's cranes, and are electrically operated. Their lifting capacity can vary from 3 to 50 tonnes. If heavy items such as locomotives or boilers are commonly carried, jumbo derricks capable of lifting up to 120 tonnes are provided (see Fig. 4.4). The decks are strengthened to accommodate such heavy lift cargoes.

A modern vessel called a Combi carrier (see Fig. 4.4) has superseded the 'tween-deck tonnage in trades unable to invest in container tonnage and its infrastructure of port facilities and distribution overland network.

The bridge of a vessel is the navigating centre of the ship where its course is determined. Most modern tonnage today has the navigating bridge and machinery situated aft thereby facilitating the naval architect's designing the vessel of the maximum cargo capacity. The engines are bridge controlled and the navigating officer on watch makes use of a bridge computer to steer the vessel, to work out its course, and give position reports etc. In an era of high-tech it is mandatory for all vessels to have Global Navigation Satellite system (GNSS) receivers, Automatic Identification System (AIS) transponders, voyage data recorders (VDRs) and optionally Electronic Chart Display Information Systems (ECDIS) in lieu of paper charts. The bridge is in direct communication with all parts of the vessel.

It is also mandatory for a continuous synopsis record to be provided on board of the history of the ship under the ISPS code (p. 214) together with a ship security alert system. In regard to radio communication, as from February 1999 the SOLAS Chapter IV 1974 was revised in 1988 to embrace amendments to introduce the GMDSS (p. 38) which became operative from February 1999. A key area was all passenger and cargo ships of 300 gross tonnage and upwards on international voyages are required to carry equipment designed to improve the chances of rescue following an accident, including satellite emergency position indicating radio beacons (EPIRBs) and search and rescue transponders (SARTs) for the location of the ship or survival craft. Chapter IV has been renamed Radio Communications, deleting the previous title Radiotelegraphy and Radiotelephony.

Many vessels today have an Integrated Bridge System (IBS)/Integrated Navigational System (INS) and a global electronic chart service to plan their voyages. The system is distinct from a manual updating, is electronic and suppliers are able to offer a real time updating service also embracing the official ENC via internet or e-mail.

Crew accommodation on modern cargo ships and tankers is situated aft in close proximity to the machinery. Standards of accommodation are high, and are controlled by various statutory regulations.

In the late 1960s the development of the container ship became evident in many cargo liner trades. Such vessels are usually free of derricks and the seventh generation have a capacity in excess of 10,000 high capacity ISO container TEUs (Twenty-foot Equivalent Units). Their speed is between 16 and 22 knots and the more sophisticated type of container vessel is called a cellular ship. Such a vessel is built in the form of a series of cells into which the containers are placed, usually by sophisticated shore-based cranes. The most recent container vessel tends to be multi-purpose in design with ramp facilities for transhipping vehicle cargo. This improves the general cargo mix flexibility of the vessel (see Fig. 3.4).

Passenger accommodation will be either one-class with different grades of cabin comfort, as on a hotel basis, or two-class, incorporating first class and tourist. This ensures that the most economical use is made of the cubic capacity of the ship. In a cruise passenger liner, it is common to find a swimming pool, cinema, shops, hospital, nursery and numerous other amenities and recreational facilities (see Fig. 4.7 on p. 70).

There are various statutory provisions concerning the quantity and type of life-saving apparatus carried on a vessel. Broadly, it is determined by the type of vessel, crew establishment and passenger certificate (authorized number of passengers permitted to be carried). Life-saving apparatus includes lifeboats, inflatable rubber liferafts, lifebuoys and individual lifejackets. Freeboard is the distance measured amidships from the waterline to the main deck of

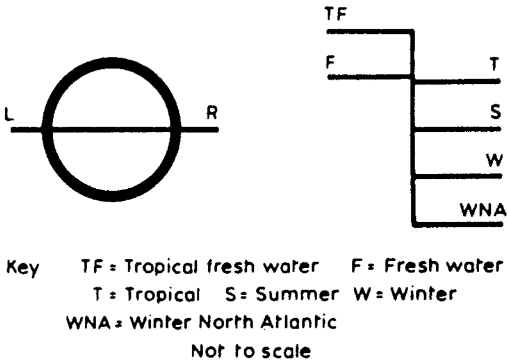

Figure 2.1 International load line of cargo vessel. Passenger and timber vessels have additional lines

vessel. This is normally the uppermost continuous deck in a ship with one or more decks. However, in a shelter dock vessel it would be the deck below.

The draught of a vessel is the vertical distance from the keel to the waterline. The maximum permitted draught varies according to the seasons and waters in which she plies. The markings are given in Fig. 2.1 and all ships must be loaded so that the loadline corresponding to the zone in which they are steaming must not be submerged. The seasons to which the markings apply are Tropical (T), Summer (S), Winter (W) and Winter North Atlantic (WNA). The world has been mapped off into sections showing where those sections apply.

2.2 International navigation limits

On 1 November 2003 the Institute Warranty Limits – the former trading limits – were amended and renamed the International Navigation Limits (INL). Details are given below of the INL.

Navigation Limits

Unless and to the extent otherwise agreed by the underwriters in accordance with, the vessel shall not enter, navigate or remain in the areas specified below at any time or, where applicable, between the dates specified below (both days inclusive).

Area 1 – Arctic

(a) North of 70° N. Lat.
(b) Barents Sea

except for calls at Kola Bay, Murmansk or any port or place in Norway, provided that the vessel does not enter, navigate or remain north of 72° 30° N. lat. or east of 35° E. long.

Area 2 – Northern Seas

(a) White Sea.
(b) Chukchi Sea.

Area 3 – Baltic

(a) Gulf of Bothnia north of a line between Umea (63° 50° N. lat.) and Vasa (63° 06° N. lat.) between 10 December and 25 May.
(b) Where the vessel is equal to or less than 90,000 dwt, Gulf of Finland east of 28° 45° E. long. between 15 December and 15 May.
(c) Vessels greater than 90,000 dwt may not enter, navigate or remain in the Gulf of Finland east of 28° 45° E. long. at any time.
(d) Gulf of Bothnia, Gulf of Finland and adjacent waters north of 59° 24° N. lat. between 8 January and 5 May, except for calls at Stockholm, Tallinn or Helsinki.
(e) Gulf of Riga and adjacent waters east of 22° E. long. and south of 59° N. lat. between 28 December and 5 May.

Area 4 – Greenland

Greenland territorial waters.

Area 5 – North America (east)

(a) North of 52° 10° N. lat. and between 50° W. long. and 100° W. long.
(b) Gulf of St Lawrence, St Lawrence River and its tributaries (east of Les Escoumins), Strait of Belle Isle (west of Belle Isle), Cabot Strait (west of a line between Cape Ray and Cape North) and Strait of Canso (north of the Canso Causeway) between 21 December and 30 April.
(c) St Lawrence River and its tributaries (west of Les Escoumins) between 1 December and 30 April.
(d) St Lawrence Seaway.
(e) Great Lakes.

Area 6 – North America (west)

(a) North of 54° 30° N. lat. and between 100° W. long. and 170° W. long.

(b) Any port or place in the Queen Charlotte Islands or the Aleutian Islands.

Area 7 – Southern Ocean

South of 50° S. lat. except within the triangular area formed by rhumb lines drawn between the following points:

(a) 50° S. lat; 50° W. long.
(b) 57° S. lat.; 67° 30° W. long.
(c) 50° S. lat.; 160° W. long.

Area 8 – Kerguelen/Crozet

Territorial waters of Kerguelen Islands and Crozet Islands.

Area 9 – East Asia

(a) Sea of Okhotsk north of 55° N. lat. and east of 140° E. long. between 1 November and 1 June.
(b) Sea of Okhotsk north of 53° N. lat. and west of 140° E. long. between 1 November and 1 June.
(c) East Asian waters north of 46° N. lat. and west of the Kurile Islands and west of the Kamchatka Peninsula between 1 December and 1 May.

Area 10 – Bering Sea

Bering Sea except on through voyages and provided that:

(a) Vessel does not enter, navigate or remain north of 54° 30° N. lat.; and
(b) The vessel enters and exits west of Buldir Island or through the Amchitka, Amukta or Unimak passes; and
(c) The vessel is equipped and properly fitted with two independent marine radar sets, a global positioning system receiver (or Loran-C radio positioning receiver), a radio transceiver and GMDSS, a weather facsimile recorder (or alternative equipment for the receipt of weather and routing information) and a gyro-compass, in each case to be fully operational and manned by qualified personnel; and
(d) The vessel is in possession of appropriate navigational charts, corrected up-to-date sailing directions and pilot books.

2.3 International Convention on Load Lines 1966

The first International Convention on Load Lines, adopted in 1930, was based on the principle of reserve buoyancy, although it was recognized then that the freeboard should also ensure adequate stability and avoid excessive stress on the ship's hull as a result of overloading.

In the 1966 Load Lines convention, adopted by IMO, provisions are made determining the freeboard of tankers by subdivision and damage stability calculations. The Convention includes Annex I, divided into four chapters: Chapter I, General; Chapter II, Conditions of assignment of freeboard; Chapter III, Freeboards; Chapter IV, Special requirements for ships assigned timber freeboards. Annex II covers zones, areas and seasonal periods, and Annex III contains certificates, including the International Load Line Certificate. The 1966 Convention provided for amendments to be made by positive acceptance. Amendments could be considered by the Maritime Safety Committee, the IMO Assembly or by a conference of governments.

The 1988 Protocol was primarily adopted in order to harmonize the Convention's survey and certification requirement with those contained in SOLAS and MARPOL 73/78. All three instruments require the issuing of certificates to show that requirements have been met and this has to be done by means of a survey which can involve the ship being out of service for several days. The harmonized system alleviates the problems caused by survey dates and intervals between surveys which do not coincide, so that a ship should no longer have to go into port or repair yard for a survey required by one Convention shortly after doing the same thing in connection with another instrument.

The 1988 Load Lines Protocol provides for amendments to the Convention to be considered either by the Maritime Safety Committee or by a conference of Parties and to be adopted by a two-thirds majority of Parties to the Convention present and voting. Amendments enter into force six months after the deemed date of acceptance – which must be at least a year after the date of communication of adoption of amendments unless they are rejected by one-third of Parties. Usually, the date from adoption to deemed acceptance is two years.

The 1995 amendments concern the southern tropical zone off the coast of Australia and have been incorporated in the 2003 amendments. The amendments adopted in June 2003 and entered into force on 1 January 2005 (under tacit acceptance) to Annex B to the 1988 Load Lines Protocol (ie the International Convention on Load Lines, 1966, as modified by the Protocol of 1988 relating thereto) include a number of important revisions, in particular to regulations concerning: strength and intact stability of ships; definitions; superstructure and bulkheads; doors; position of hatchways, doorways and ventilators; hatchway coamings; hatch covers; machinery space opening; miscellaneous openings in freeboard and superstructure decks; cargo ports and other similar openings; spurling pipes and cable lockers; side scuttles;

windows and skylights; calculation of freeing ports; protection of the crew and means of safe passage for crew; calculation of freeboard; sheer; minimum bow height and reserve buoyancy; and others.

The amendments, which amount to comprehensive revision of the technical regulations of the original Load Lines Convention, will not affect the 1966 Load Line Convention and will only apply to approximately two-thirds of the world's fleet, i.e. to those ships flying the flags of States Party to the 1988 Load Line Protocol.

2.4 Types of propulsion and future trends

Today the world's mercantile fleet is powered primarily by diesel engines. They have a low fuel consumption which gives added deadweight and cubic capacity for cargo. Factors influencing choice of propulsion unit embrace initial cost, required speed, cost and availability of fuel on the route used, cargo carrying capacity required, length of duration of voyage, and operational expenses. With the tendency for higher capacity ships, longer hauls, rising bunker costs, need for improved ship productivity, a surge in new builds and the need to make better and more productive use of available shipboard cargo and passenger space, it has presented a new opportunity for innovative ship space and operational cost productivity.

The twenty-first century has therefore brought a new resurgence of interest in marine propulsion. This has been driven by demand for the environmental friendliness and cost-effectiveness of marine transport. Hence the focus on the development of ships that can offer larger carrying capacities and higher speeds, lower capital and operating costs, increased manoeuvrability, reliability and safety and reduced environmental impact. Developments in technology in ships' power, propulsion and motion control systems are essential to meet many of the requirements outlined. Details are given below of recent developments to achieve this objective, which was initially driven by the growth in cruise tonnage.

The need to make better utilization of ship capacity is the concept of the electric ship. Integrated Full Electric Propulsion (IFEP) lies at the heart of the electric ship. It offers lower running costs and sometimes reduced capital investment. The IFEP system involves the ship's propulsors being driven by electric motors alone, and the power for the electric motors is drawn from a unified electrical power system that also provides all the ship's electrical services. The power and propulsion systems are therefore integrated, because there is only one electrical power system where more conventionally there might have been two.

A major benefit of the IFEP is the layout flexibility offered by the elimination of the shaft tunnel housing the conventional propulsion unit (Fig. 2.2) as the prime mover is no longer coupled to the propulsors. It also provides more freedom for the prime mover location and thereby more effective use of available space. Further benefits of electrical propulsion – both in terms

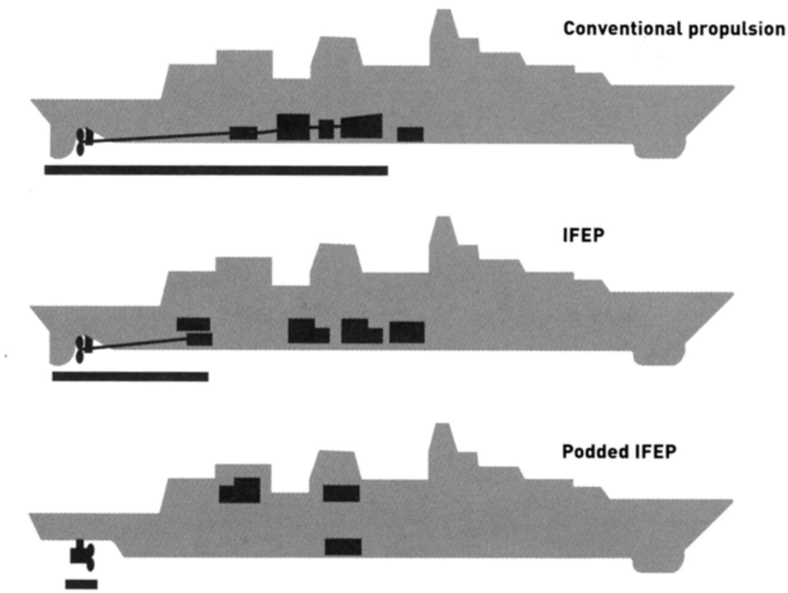

Figure 2.2 Layout of mechanical and electric propulsion systems

of internal layout and vessel manoeuvrability – can be realized through the use of podded propulsion, in which an electric motor driving a propeller is mounted in a 'pod' beneath the ship. An example of such an arrangement is the Mermaid pod.

A further benefit of the IFEP system is reduced fuel consumption, because the base load of the ship's service power demand can be used to ensure that the load on the prime movers never falls to inefficient levels. Cruise liners (p. 41) with relatively high service loads and operational profiles that frequently leave the propulsion system operating at fractional loads, offer an ideal platform for the IFEP system to generate fuel savings.

The next generation of marine prime movers is found in the advanced marine gas turbine. It incorporates both intercooler and recuperator heat exchangers, the combined effect of which is to allow 'waste' heat to be recovered from the gas turbine exhaust, providing significant fuel savings across the entire power range. These complex cycles have been adopted by Celebrity Cruises' Millennium class ships by the selection of a combined gas turbine and steam turbine electric drive system (COGES). In this situation a steam bottoming cycle rather than intercooling and recuperation has been chosen as an alternative solution to reduce fuel consumption through recovery of exhaust heat.

The LNG tonnage prime mover technology is changing, embracing duel fuel diesel engines (natural gas and MDO), heavy fuel diesel engines with a re-liquefaction plant, gas turbines – either single or combined cycle – and a combination of these ideas (p. 65 and 155–6).

Manoeuvrability is a basic safety requirement for all vessels as well as being an intrinsic element of the operational capability in some applications. The thruster system enables a more dynamic positioning of the vessel and widely used in ro-ro ships, cruise ships and types of offshore support ships. Three types of thrusters exist. The azimuth thruster provides the main or auxiliary inboard or outboard propulsion and manoeuvring with 360° turn, using controllable or fixed pitch propeller. The bow and stern thrusters are conventional turned thrusters with controllable or fixed pitch propellers.

A recent development in ship manoeuvrability realized through a combination of compact, powerful and efficient thrusters and control systems that manage them, is the podded propulsor. These provide a high level of manoeuvrability as found, for example, on the Millennium Ship (p. 18), which has a tactical diameter of less than two ships' lengths from an initial speed of 24 knots. Moreover, there are equally innovative designs for mechanical drive applications.

An example of a steerable mechanical thruster is the Azipull, which has a pulling propeller. This design has a very compact body, since it contains only gears and driveshaft rather than an electric motor. It is ideal for the smaller ferries where electric propulsion is not an economic alternative. In tunnel thrusters, designs with two contra-rotating propellers, one on each side of the gear housing, improve the thrust output per tunnel diameter, which is of great importance for high-speed ships where they have been applied in order to decrease drag.

Noise and vibration are key areas of ongoing research. The major technical areas being addressed include: reduction of propulsor noise at source, isolation of propulsion machinery noise and control of intake and exhaust noise. This is focused on developing new comfort class requirements for cruise ships and fast ferries.

2.5 Types and methods of tonnage measurement

There are five main kinds of tonnage in use in shipping business. These are deadweight, cargo, displacement, gross and net tonnages, now superseded by the International Convention on Tonnage Measurement of Ships 1969 (2.4).

Deadweight tonnage (dwt) expresses the number of tons (of 2,240 lb) a vessel can transport of cargo, stores and bunker fuel. It is the difference between the number of tons of water a vessel displaces 'light' and the number of tons of water a vessel displaces when submerged to her loadline. Deadweight tonnage is used interchangeably with deadweight carrying capacity. A vessel's capacity for weight cargo is less than its total deadweight tonnage.

Cargo tonnage is expressed in terms of a weight or measurement. The weight ton in the United States and sometimes in the UK is the American short ton of 2,000 lb, or the English long ton of 2,240 lb. A measurement ton is usually 40 ft^3, but in some instances a larger number of cubic feet is taken for a ton. Most ocean package freight is taken at weight or measurement (W/M) ship's option. With the growth in use of the metric system the metric tonne of 1,000 kg or cubic metre is becoming more widely used. The freight ton is a mixture of weight and measurement tons and can lead to confusion in the collection and analysis of statistics.

Displacement of a vessel is the weight in tons of 2,240 lb of the ship and its contents. It is the weight of water the ship displaces. Displacement light is the weight of the vessel without stores, bunker fuel or cargo. Displacement loaded is the weight of the vessel plus cargo, passengers, fuel and stores.

Gross tonnage applies to vessels, not to cargo. It is determined by dividing by 100 the volume in cubic feet of the vessel's closed-in spaces, and is usually referred to as the gross registered tonnage (GRT). The spaces exempt from the measurement include light and air spaces; wheelhouse; galley; lavatories; stairways; houses enclosing deck machinery; hatchways to a maximum of 0.5% of the gross tonnage and open shelter deck. A vessel ton is 100 ft^3. It is used as a basis for pilotage and dry-dock dues, and sometimes tonnage dues. Additionally, it is employed for official statistical purposes, when comparing ships' sizes, and as a basis for Protection and Indemnity Club entries.

Net tonnage is a vessel's gross tonnage after deducting space occupied by crew accommodation, including facilities for the Master and officers; spaces used for navigation; boatswain's store room; water ballast and fresh water spaces, including forward and aft peak tanks, deep tanks provided only fitted with manholds and not employable for carriage of liquid cargo; propelling and machinery space which does not represent earning capacity of the ship. A vessel's net tonnage expresses the space available for the accommodation of passengers and stowage of cargo, and is usually referred to as net registered tonnage (NRT). A ton of cargo in most instances occupies less than 100 ft^3: hence the vessel's cargo tonnage may exceed its net tonnage, and indeed the tonnage of cargo carried is almost always greater than the gross tonnage. It is the cubic capacity of all earning space, and it is on this tonnage figure that most harbour dues and other charges are calculated. The aim of the average shipowner is to achieve a low net tonnage consistent with a maximum cubic capacity for cargo and/or passengers.

The Suez and Panama tonnage regulations make it obligatory for vessels to be measured for tonnage if they require to use the canals.

2.6 International Convention on Tonnage Measurement of Ships 1969

The Convention, adopted by IMO in 1969, was the first successful attempt to introduce a universal tonnage measurement system. Previously, various systems were used to calculate the tonnage of merchant ships. Although all went back to the method devised by George Moorsom of the British Board of Trade in 1854, there were considerable differences between them and it was recognized that there was a great need for one single international system.

The Convention provides for gross and net tonnages, both of which are calculated independently. The rules apply to all ships built on or after 18 July 1982 – the date of entry into force – while ships built before that date were allowed to retain their existing tonnage for 12 years after entry into force or until 18 July 1994.

This phase-in period was intended to ensure that ships were given reasonable economic safeguards, since port and other dues are charged according to ship tonnage. At the same time, and as far as possible, the Convention was drafted to ensure that gross and net tonnages calculated under the new system did not differ too greatly from those calculated under previous methods.

The Convention meant a transition from the traditionally used terms gross register tons (grt) and net register tons (nrt) to gross tons (GT) and net tons (NT) (p. 20). Gross tonnage forms the basis for manning regulations, safety rules and registration fees. Both gross and net tonnages are used to calculate port dues. The gross tonnage is a function of the moulded volume of all enclosed spaces of the ship. The net tonnage is produced by a formula which is a function of the moulded volume of all cargo spaces of the ship. The net tonnage shall not be taken as less than 30% of the gross tonnage.

Today the tonnage measurement criterion is under continuous review as vessel design changes in numerous trades. In 2006 the IMO sub-committee agreed to amend the provisional formulas for reduced gross tonnage (GT) for open-top container ships prescribed in TM5/circ. 4, which was issued in 1993, to give preliminary IMO formula to be used for the calculation of gross tonnage for open-top container ships of up to 30,000 gross tonnage under the International Convention on Tonnage Measurement of Ships 1969.

Recommended reading

Annual BIMCO review, www.bimco.dk
IMO quarterly magazine, www.imo.org
C-Map Norway – Electronic Charts, www.c-map.no

3 Ship design and construction

3.1 Ship design and future trends

The twenty-first century is generating a period of change and opportunity through a growth in new building and more emphasis on ship productivity. It has renewed pressure on driving down both ship operating and ship building costs. Ship specification is a highly regulated industry through IMO regulations endorsed by maritime governments. Likewise the operation and maintenance survey of ships are highly regulated, as found in the ISM code (p. 470). The concept behind such a highly regulated environment is ship safety, which extends to the environment and cargoes conveyed.

There are three main factors affecting the technical feasibility and profitability of a ship. The deadweight/displacement ratio indicates the carrying capacity in relation to the total displacement. The deadweight is low for fast ferries with extensive passenger facilities. Container vessels have much higher deadweight/displacement ratios. The tankers and bulk carriers have the highest values. For all vessel types the deadweight/displacement improves with size. The speed and power should also be judged in relation to the displacement. For speeds below 20 knots, the power demand increases very slowly with increasing displacement. But at 35 or 40 knots the power curves become very steep. The third factor to observe is the lightweight density, which is an easy way to a first weight estimate for different ship types.

The ship functions can be divided into two main categories, payload function and ship function. In a cargo vessel the payload function consists of cargo spaces, cargo handling equipment and spaces needed for cargo treatment on board such as refrigeration equipment. The ship functions are related to carrying the payload safely from port to port. The areas and volume demanded in the ship to accommodate all systems are then calculated. The result is a complete system description for the new ship, including the volumes and areas needed onboard to fulfil the mission. This gives the total volume of the vessel and the gross tonnage can be calculated. Based on these data, a first estimate of weight and building costs can be made. The next step in the design process is to select main dimensions and define the form. By variation of the main dimensions the space and weight in the selected design is matched to the system description. The best dimensions are selected based on the performance and operation economies. Given below are the salient features in ship design.

(a) The salient factor is the broad specification outlined by the shipping company to the naval architect and shipbuilder, usually following a critical evaluation. It will feature the capital investment parameters, the return on capital, with special emphasis on revenue (cargo/passenger) production and related operating costs, the trade forecast and level of competition. Innovation is a key factor in ship design. The international entrepreneur is very conscious ship investment is a risk business and the operational life may be beyond 25 years, during which period the profile of the trade and market conditions may change. Moreover, the older the vessel becomes the more costly it is to maintain. This is due to the regulatory ship survey and maintenance code, which becomes more severe especially beyond the fifth survey.
(b) Market conditions and how best to respond to the needs of the shipper will be major factors in ship design, which will focus on raising standards for the merchant shipper in the form of overall faster transits and the continuing expansion of multi-modalism. The interface between the ship and berthing operations will be much improved thereby speeding up ship turn-round time. This involves quicker and more efficient transhipment techniques both for containerized traffic and the bulk carrier market. An example of the lengthened container ship technology demonstrating this point is found in Fig. 3.4 on p. 45.
(c) The shipowner will continue to extend shipboard efficiency with the aid of continuously improving onboard technology in all areas of operation. The continuing expansion of the INMARSAT shipboard navigation/communication technology (see pp. 434–40) is bringing in a new era of information technology and communications involving EDI (see Chapter 20) in the global maritime field.
(d) Ship safety will remain paramount, consistent with efficiency and the application of modern technology. The IMO (see pp. 140–8) is continuing to persuade member states of the need to adopt conventions to raise the safety of ships at sea. This involves especially ship design and specification.
(e) Ships are now subject to inspection by the registered state maritime agency whilst in port (p. 398), usually by accredited classification society surveyors or other designated surveyors, to ensure they are seaworthy. Member states subscribing to the IMO Convention have legal powers to detain tonnage which fails to conform to the prescribed standards as found, for example, under MARPOL 90.
(f) Shipowners, as trade increases, are tending to replace tonnage by larger vessels rather than provide additional sailings. This lowers nautical tonne per mile costs but places more stress on planning and the total

logistics operation at the berth. Accordingly container tonnage has now reached 10,000 TEUs and could attain 12,000 TEUs by the year 2010/12. Likewise ferries operating in the cross-Channel and Baltic trades have much increased their capacity from 200 to 450 cars and/or the corresponding combination of road haulage vehicles. It results in vessels having a wider beam, increased length overall, but more especially more decks, increasing the ship freeboard. Such developments require extensive research to evolve/design such tonnage to comply with the strict IMO safety standards.

(g) More automation is now emerging in transhipment and docking arrangement (p. 389).

(h) The development of the floating terminal and floating production, storage and offloading vessel is another example of innovation in ship design.

(i) Market research is used extensively to influence the interior design of cruise tonnage, both new build and refurbishment. Focus groups are employed from loyal cruise customers and potential ones.

(j) Design of the fast ferry must focus on turn-round time, speed and passenger interior décor. In order to attract passengers, a fast ferry must offer a service that the passenger perceives as ‘value added’. Passengers will determine their acceptance of the ferry based on a variety of factors relating to comfort. In particular where passengers sit, dine, congregate and recreate will influence their passenger comfort and overall sense of well-being. The levels of vibration, noise, interior environment and lighting that passengers are exposed to will have either a positive or negative effect on these judgements. A second group of passengers will be influenced by vessel design, layout and seakeeping qualities. Factors such as pitching, rolling, slamming, excessive vibration and noise are not conducive to favourable ambient environmental conditions for the discerning passenger.

3.2 Ship productivity

Ship productivity is a key factor in ship design and its impact on ship operation. We have already identified the new generation of electrical propulsion systems (p. 18) which will lower operation costs and provide more shipboard cargo and passenger capacity through the elimination of the shaft tunnel. More automation in cargo transhipment (p. 389) and docking arrangement (p. 390) all impact on ship design and quicker port turn-round times.

Operational productivity of the world fleet is an analysis of the balance between supply and demand for tonnage. Key indicators are the comparison of cargo generation and fleet ownership, tons of cargo carried and ton miles performed per deadweight ton and the analysis of tonnage over supply in the main shipping market sectors.

An analysis of Table 3.1 provides indicative data on ton miles performed by oil tankers, dry bulk carriers, combined carriers and the residual world mercantile fleet. The thousands of ton miles per dwt of oil tankers increased in 2004 by less than 1% to 32.4, while the ton miles per deadweight ton of dry bulk carriers and combined carriers increased by 2.8% and 11.6% to 25.7 and 43.1 respectively. The residual fleet increased its productivity by 3.9% to 34.9 ton miles per deadweight ton.

The financier in the building cost analysis may use the cost of the dwt related to the cargo earning potential. The iron ore carrier building cost per dwt is much lower than the high-tech LNG tonnage. The container analysis would relate the TEU capacity with the building cost and the cruise liner on a berth basis. The mega container vessel and cruise liner exploit the economies of scale as the building cost per TEU and cabin falls as larger tonnage is built (p. 41).

Ship productivity is realized through an efficient cargo flow ship to shore and vice versa. This ensures a quick port turn-round time at the port. Terminal layout is the key factor. Likewise passenger car/vehicular ferry (Fig. 4.7) must be customized in design to the trade and terminals. It illustrates the bow and stern loading arrangement.

Table 3.1 Estimated productivity of tankers, bulk carriers, combined carriers and the residual fleet, selected years (000 of ton miles performed per dwt)

Year	*Ton miles of oil carried by tankers (000 million)*	*Ton miles per dwt of tankers*	*Ton miles of dry cargo carried by dry bulk carriers (000 million)*	*Ton miles per dwt of bulk carriers*	*Ton miles of oil and dry bulk cargo by combined carriers (000 million)*	*Ton miles per dwt of combined carriers*	*Ton miles of the residual fleet (000 million)*	*Ton miles per dwt of the residual fleet*
1970	6,039	43.8	1,891	39.4	745	52.5	1,979	15.7
1980	9,007	27.6	2,009	14.5	1,569	32.4	4,192	24.8
1990	7,376	30.8	3,804	18.8	1,164	36.0	4,777	26.0
2000	9,840	34.5	6,470	23.9	593	38.5	6,837	28.3
2003	10,210	32.2	7,357	24.9	467	38.6	7,823	33.6
2004	10,898	32.4	7,984	25.7	418	43.1	8,349	34.9

Sources: Compiled by the UNCTAD secretariat on the basis of data from *Fearnleys Review*, various issues; *World Bulk Trades* and *World Bulk Fleet*, various issues; and other specialist sources.

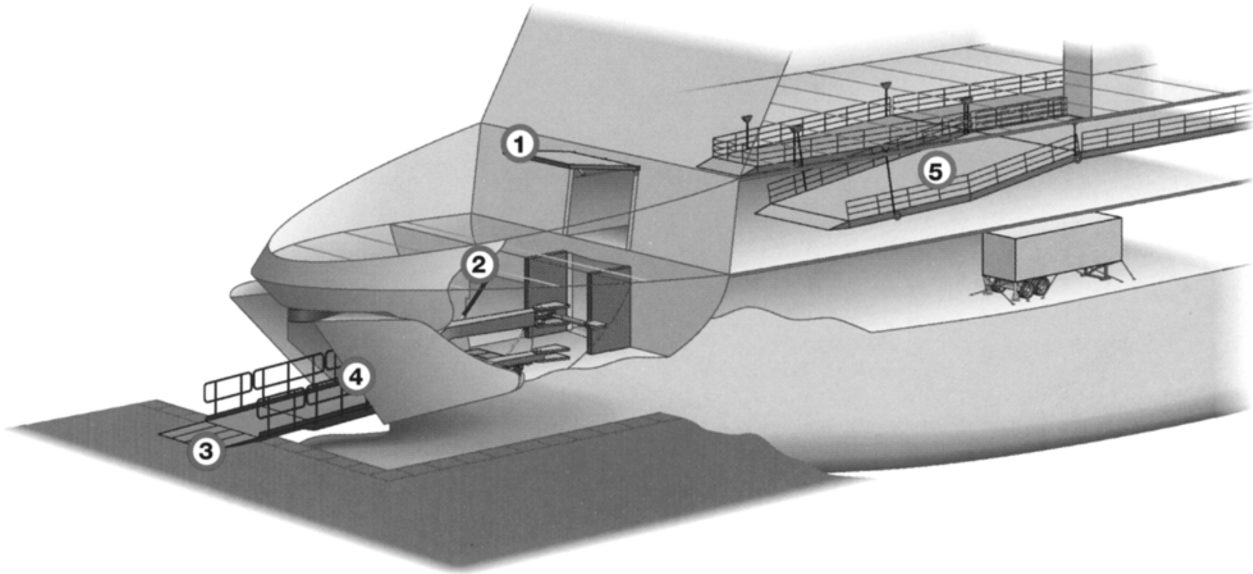

Figure 3.1a Efficient cargo flow on a passenger/vehicle ferry (*a*) bow section: *1* front door, *2* inner bow door, *3* bow ramp/door, *4* bow doors, *5* hoistable car deck. (Reproduced by courtesy of MacGregor Group AB, Stockholm)

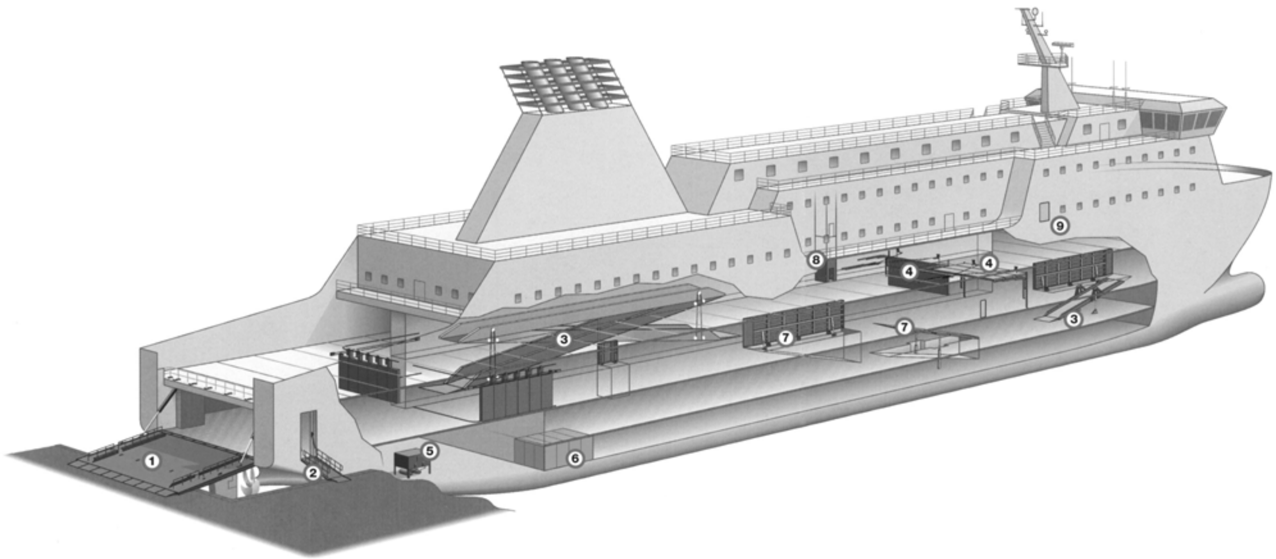

Figure 3.1b Efficient cargo flow on a passenger/vehicle ferry (*b*) stern view: *1* straight stem ramp/door, *2* side ramp/door, *3* hoistable ramps, *4* flood control doors, *5* hydraulic power pack, *6* provision stores, *7* ramp cover, *8* elevators, *9* side doors. (Reproduced by courtesy of MacGregor Group AB, Stockholm)

3.3 General principles and factors influencing design, type and size of ship

In his choice of the type of ship to be built, the shipowner must consider primarily the trade in which she is to operate. His decision as to size and propelling machinery will be governed by the factors involved in his particular trade, such as the nature of the cargo mix to be moved, the cost and availability of fuel, the minimum carrying capacity required, the length and duration of the voyages and the required speed. Economic, technical, statutory and safety considerations will all influence his choice.

So far as the building and operating costs are concerned, within certain limits, the larger ship is a cheaper proposition. For example, the cost of the propelling machinery for a 100,000 tonner is less than the cost for two 50,000 tonners developing the same power. The larger ship costs less to crew than two smaller ships and its operating costs per ton are lower. In the bulk trades, where the nature of the cargo calls for large roomy holds, the economics of size alone favour the employment of large ships. However, increased size implies deeper draught, and if a general trader is to be operated economically, she must be able to proceed anywhere where cargo is offered. On one voyage she may be going to Mumbai which permits vessels with a maximum draught of 16 m, while its next employment may be in the River Plate where the draught is limited to about 9 m. She may have to load from an ore jetty off the coast of Chile where safety considerations prohibit the large ship. All these considerations have to be balanced, and today the modern tramp has developed into a handy-size vessel for dry bulk cargo: Handysize 20,000–35,000 dwt, Handymax 35,000–50,000 dwt, Panamax 50,000–80,000 dwt and Capesize 80,000–150,000 dwt. The speed is 14–16 knots and all are capable of passing through the Panama Canal except the Capesize. The Handymax operates in the Far East and Pacific regions carrying timber and many are family-owned. The Panamax conveys coal/grain between North America to the Far East/Middle East. The Capesize, the most economical per dwt, conveys iron ore and coal between Australia to Japan, China and Brazil to Europe/Far East.

Recently the cellular container ship has featured more prominently in cargo liner trades. Additionally, more purpose-built tonnage is becoming available for carrying such products as liquefied methane, trade cars, etc. Such ships – often owned or on charter to industrial users – are designed for a particular cargo and are frequently involved in a ballast run for part of the round voyage (see pp. 310–16). Purpose-built tonnage requires special terminals – often situated away from the general port area – frequently involving expensive equipment to ensure quick transhipment. As we progress through the early years of the twenty-first century we are experiencing a growth in container tonnage which is driving a logistic environment causing many shippers to review their break bulk shipments and bulk cargo shipments, especially fruit and cement carriers. This has been facilitated by ‘on going’ modernization of container terminals (p. 386). Moreover, the demise of the mammoth oil tanker of 500,000 dwt – the ultra-large crude carrier of 29 m draught – is due to the very limited number of ports of call it may operate, owing to its size. The draught is too deep for some shipping lanes. A further factor is the diminishing number of trades which can support a vessel of such size other than on a multi-port operation, which is uneconomical. The ore/bulk/oil OBO continues to fall, representing less than 1% of the world fleet. This is due to the high maintenance cost and absence of trades to support such tonnage. No new builds are predicted, which is especially due to high capital costs. The student must study closely the world merchant fleet composition profile and factors driving change (p. 3). The changing pattern of trade and emerging trends plays a significant role in new investment and employment of tonnage. The era of multi-purpose tonnage still remains where trade situations demand.

Where the vessel to be constructed is intended for long-term charter to industrial users, as in the case of many oil tankers, ore carriers and other specialized cargo ships, the limits of size are dictated by terminal facilities or by obstacles of the voyage – such as arise, for example, in the Panama Canal or St Lawrence Seaway (see p. 126).

Much of the foregoing analysis applies equally to cargo liners, except that flexibility of operation is not so important. A factor tending more to limit their size is the importance of providing frequent sailings which the market can support. The overseas buyer pays for his goods when the seller can produce bills of lading showing that the consignment has been shipped. Under such conditions the merchant demands frequent sailings, and if the shipowner does not provide them his competitors will! Today the container line operator is continuously remodelling their services through larger vessels (p. 64) on core routes to serve hub ports and feeder vessels operating the hub and spoke system. This is driven by logistics and ongoing container terminal modernization (p. 352). Container tonnage is growing at 8% per year.

3.4 Safety and other regulations

Associated with the provision of new tonnage, there is the obligation to comply with statutory regulations, classification society rules and international agreements affecting ship design, and these vary according to the requirements of the different flags, particularly in matters relating to accommodation.

Vessels registered in the UK have to be built to the statutory requirements imposed by the Department of Transport, Local Government and the Regions. The regulations concern all life-saving apparatus, navigational aids, the hull and machinery, crew and passenger accommodation, water-tight and fireproof bulkheads, gangways, emergency escapes, anchor cable and hawsers, shell plating, ship inspection at the seaport, etc. The basis of these requirements is included in the Merchant Shipping Act of 1894. Various amendments and additions to these regulations have reached the statute book to meet new conditions and developments. These are found in the IMO Conventions on Maritime Safety, which include the International Convention on the Safety of Life at Sea (SOLAS) 1960 and 1974 and entered into force in 1980. It specifies minimum standards for the construction, equipment and operation of ships compatible with safety. It has been amended several times, including twice in 1978 and 1988 by means of Protocol (p. 33). A significant one which entered into force in July 2004 was measures to enhance maritime security embracing the International Ship and Port Facility Security Code (p. 214). Also mandatory provision is made from December 2004 for installation of automatic information, systems and continuous synopsis records to provide 'on board' records of the history of the ship. Other IMO conventions are the International Convention on Load Lines 1966, the Special Trade Passenger Ship Agreement 1973, the Convention on the International Maritime Satellite Organization (INMARSAT) 1976, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978 and the International Convention on Maritime Search and Research (SAR) 1979.

All the foregoing have been subject to amendment and protocol as recorded on pp. 140–8.

3.5 Statutory regulations

International conventions, codes and protocols concerning ship safety and marine pollution are agreed by the member states of the United Nations Agency, the International Maritime Organization (IMO; see pp. 140–8). In the past 50 years IMO has promoted the adoption of some 35 conventions and protocols and adopted numerous codes and recommendations. The conventions and codes usually stipulate inspection and the issuance of certificates as part of enforcement. Most member countries and/or their registered shipowners authorize classification societies to undertake the inspection and certification on their behalf. For example more than 100 member states have authorized Lloyd's Register to undertake such inspection and certification.

IMO conventions define minimum standards but member states can instigate national regulations which incorporate IMO standards and apply equally well to their own fleets and visiting foreign ships. Classification societies participate in the work of the IMO as technical advisers to various delegations. Their key function is to provide inspection and certification for compliance and advice on these complex regulations. Various aspects of the IMO conventions are dealt with elsewhere in the book.

Given below are a selection of statutory marine surveys:

(a) *Load Line Certificate*. An international load line certificate is required by any vessel engaged in international voyages except warships, ships of less than 24 m in length, pleasure yachts not engaged in trade and fishing vessels. It is valid five years, with an annual survey.

(b) *Cargo Ship Safety Construction Certificate.* This is required by any ship engaged in international voyages except for passenger ships, warships and troop ships, cargo ships of less than 500 gross tonnage, ships not propelled by mechanical means, wooden ships of primitive build, pleasure yachts not engaged in trade and fishing vessels. Survey classification ensures the SOLAS 1974 convention is complied with in the areas of hull, machinery and other relevant equipment. For vessels of 100 m length and over, compliance with damage stability requirements is also required. It is valid for five years, with an annual survey.

(c) *Cargo Ship Safety Equipment Certificate.* This is required by any ship engaged on international voyages except for the ship types detailed in item (b). Survey classification ensures the SOLAS 1974 convention Chapters II–1, II–2, III and IV are complied with along with other relevant requirements. It is valid for two to five years, with an annual survey.

(d) *Cargo Ship Safety Radio Certificate.* This is required by all cargo ships of 300 gross tonnage and upwards on international voyages, which are required to carry equipment designed to improve the chances of rescue following an accident including satellite emergency position indicating radio beacons (EPIRBS) and search and rescue transponders (SARTS) for the location of the ship or survival craft. It features under the current SOLAS Convention Chapter IV, Radio Communications, which was completely revised in 1988 and amendments introduced from February 1999 and embraced the GMDSS (p. 38). By that date the Morse Code was phased out. Chapter IV is closely linked with the Radio Regulations of the International Telecommunications Union.

(e) *Passenger Ship Safety Certificate.* This is required by any passenger ship under SOLAS Regulation 12(a)(vii) engaged on international voyages except troop ships. A passenger ship is a vessel which carries more than 12 passengers. Pleasure yachts not engaged in trade do not require a Passenger Ship Safety Certificate following compliance with the requirements of the 1974 SOLAS Convention. This includes the survey arrangements for subdivision, damage stability, fire safety, life-saving appliances, radio equipment and navigational aids. It is reviewed annually following:

(f) *International Oil Pollution Prevention Certificate* (IPPC). It is valid for five years with an annual survey.

(g) *Document of compliance* (DOC). Mandatory under the ISM code (p. 470) and valid for five years with intermediate surveys.

(h) *Carriage of dangerous goods*. SOLAS 1974 as amended featured 12 chapters in an annex embracing Chapter VII, termed Carriage of Dangerous Goods. It features three parts: Part A, Carriage of dangerous goods in packaged form or in solid form or in bulk. It embraces the International Maritime Dangerous Goods (IMDG) code. A new code was adopted in May 2002 (p. 268) and mandatory from 1 January 2004. Part B, Construction and Equipment of Ships carrying Dangerous Liquid

Chemicals in Bulk, requires chemical tankers built after July 1986 to comply with the International Bulk Chemical Code (IBC Code). Part C embraces the construction and equipment of ships carrying liquefied gases in bulk and gas carriers constructed after July 1986 to comply with the requirements of the International Gas Carrier Code (IGC Code).

Two examples are found in the IBC and IGC codes. The IMO international code for the construction and equipment of ships carrying dangerous chemicals in bulk (IBC code) provides safety standards for the design, construction, equipment and operation of ships carrying dangerous chemicals. An additional code – the BCH – is applicable to existing ships built before 1 July 1986. A document/certificate termed a Certificate of Fitness is issued by the classification society in accordance with the provisions of the IBC or BCM code and is mandatory under the terms of either the 1983 amendments to SOLAS 1974 or MARPOL 73/78. For national flag administrations not signatory to SOLAS 1974, a statement of compliance would be issued by the classification society in accordance with a shipowner's request.

The other example is found in the IMO international code for the construction and equipment of ships carrying liquefied gases in bulk (IGC code). This requires that the design, constructional features and equipment of new ships minimize the risk to the ship, its crew and the environment. There are additional gas carrier codes applicable to existing ships built before 1 July 1986. A Certificate of Fitness is mandatory under the terms of the 1983 amendments to SOLAS. For national flag administrations not signatory to SOLAS 1974 a statement of compliance would be issued by the classification society in accordance with a shipowner's request.

(a) International Safety Management Code

In 1993 the International Safety Management (ISM) Code was completed by the IMO. The objectives of the code are to ensure safety at sea, the prevention of human injury or loss of life, and the avoidance of damage to the environment (in particular the marine environment) and property. The functional requirements for a safety management system to achieve these objectives are as follows:

(a) a safety and environmental protection policy;
(b) instructions and procedures to ensure safe operation of ships and protection of the environment;
(c) defined levels of authority and lines of communication between and amongst shore and shipboard personnel;
(d) procedures for reporting accidents and non-conformities within the provisions of the code;
(e) emergency response procedures;
(f) procedures for internal audits and management reviews.

The code effectively supersedes the guidelines in Management for the Safe Operation of Ships and for Pollution Prevention adopted by the IMO Assembly in 1991. The new Chapter IX makes the ISM code mandatory and adopted by the IMO assembly in November 1993 (Assembly resolution A.741(18)).

Until 2002 the ISM was mandatory under SOLAS for passenger ships (including high speed craft), oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high speed craft of 500 gross tonnage and upwards. From July 2002 it was mandatory for other cargo ships and mobile offshore drilling units of 500 gross tonnage and upwards. To coincide with the extension of the range of ships to which the application of the ISM Code is mandatory, it was necessary to amend Chapter IX of SOLAS 1974 and to the ISM code. It has resulted into Revised Guidelines on the implementation of the code. The code establishes the following safety management objectives: (a) to provide for safe practices in ships operation and a safe working environment; (b) to establish safeguards against all identified risks; and (c) to continuously improve safety management skills of personnel, including preparing for emergencies.

The code requires a safety management system (SMS) to be established by 'the Company' which is defined as the shipowner or any person, such as the manager or bareboat charterer who has assumed responsibility for operating the ship. The Company is then required to establish and implement a policy for achieving these objectives. This includes providing the necessary resources and shore based support (p. 470). Every Company is expected to 'designate a person or persons ashore having direct access to the highest level of management'. The procedures required by the code must be documented and compiled in a Safety Management Manual, a copy of which should be kept on board.

The scheme for certification to the International Safety Management Code (ISM Code) is a means to demonstrate a shipping company's commitment to the safety of its vessels, cargo, passengers and crew, and to the protection of the environment, in compliance with the ISM Code. Overall it provides for the assessment of a company's safety management systems on board vessels, and as required in shore-based offices. It requires each ship in a company fleet as well as the company's shore-based management systems to be separately certificated. The scheme lays down the assessment procedures which will be followed when either the shipboard systems or the shore-based systems or both are to be assessed for certification, which is usually undertaken by an accredited classification society such as Lloyd's Register. The assessment confirms company policy and central measures in accordance with the ISM Code.

Certification in accordance with the requirements of this scheme should not be taken as an indication that the company or its vessels comply with international or national statutory requirements other than the ISM Code and it does not endorse the technical adequacy of individual operating procedures or of the vessels managed by the company. Overall the certificate will confirm the following:

(a) An appropriate management system has been defined by the company for dealing with safety and pollution prevention on board.
(b) The system is understood and implemented by those responsible for the various functions.
(c) As far as periodic assessments can determine, the key actions indicated in the system are being carried out.
(d) The records are available to demonstrate the effective implementation of the system.

The scheme does not in any way replace or substitute class surveys of any kind whatsoever.

(b) Application for certificate

The company's application for certification to the IACS Society (p. 132) and the relevant information must include the size and total number of each ship type covered by the SMS and any other documentation considered necessary.

Initial verification

The initial verification for issuing a DOC to a company consists of the following steps:

(i) *Document review*. In order to verify that the SMS and any relevant documentation comply with the requirements of ISM Code, the auditor is to review the safety management manual. If this review reveals that the system is not adequate, the audit may have to be delayed until the company undertakes corrective action. Amendments made to the system documentation to correct deficiencies identified during this review may be verified remotely or during the subsequent implementation audit described in (ii) below.
(ii) *Company audit*. In order to verify the effective functioning of the SMS, including objective evidence that the Company's SMS has been in operation for at least three months, and at least three months on board at least one ship of each type operated by the Company. The objective evidence is to *inter alia*, include records from the internal audits performed by the Company, ashore and onboard, examining and verifying the correctness of the statutory and classification records for at least one ship of each type operation by the Company.

The initial verification for issuing a SMC to a ship consists of the following steps:

(i) Verification that the Company DOC is valid and relevant to that type of ship, and that the other provisions are complied with. Only after