ΑΚΑΔΗΜΙΑ ΕΜΠΟΡΙΚΟΥ ΝΑΥΤΙΚΟΥ ΜΑΚΕΔΟΝΙΑΣ
ΣΧΟΛΗ ΠΛΟΙΑΡΧΩΝ

ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ

<< Merchant Vessels >>

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ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ: ΠΑΝΑΓΟΠΟΥΛΟΥ ΜΑΡΙΑ

ΘΕΜΑ: MERCHANT VESSELS

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References

Abstract

Most countries of the world operate fleets of merchant ships. Due to high cost of operation, today these fleets are in many cases under the flags of nations that specialize in providing mainpower and services at favorable terms. Merchant vessels include bulk carriers which are designed to transport unpacked bulk cargo. Bulks are segregated into five major categories: handysize, handymax, panamax, capesize, and Very Large Ore Carriers (VLOC). Another category is container ship. There are tankers as well which vary from handysize to ultra large carriers (ULCC). We also have passenger ships, as yachts, ferries and cruise ships, specialized ships for general purposes , including Rollon/Rolloff ships which are designed to carry wheeled cargo such as automobile tracks, semi-trailer tracks, trailers and railroad cars. The Greek owned fleet is the largest of the world. It accounts for same 16 per cent of the world's tonnage. This makes it currently the largest single international merchant fleet in the world, albeit not the largest in history.

Key Words: fleet, bulk carriers, tankers, specialized ships, passengers ships

History of Ships

1.1 The construction

In ancient marine times, people used rafts, logs of bamboo, bundles of reeds, air filled animal skins and asphalt covered baskets to traverse small water bodies. To be precise, the first boat was a simple frame of sticks lashed together and covered expertly with sewn hides. These boats could carry large and heavy loads easily. You get to know about examples of such ancient boats among the bull boats of North American plains, the kayaks of the Inuit's and the coracks of British islanders. Yet another ancient boat was the dugout which is a log that is hollowed out and pointed at the ends. Some of these were even as long as sixty feet. Here is a brief attempt to traverse lightly over the history of ships and how they evolved to what they are now.

1.2 Types of Ships in Ancient Maritime History

As marine history and along with it, the history of ships unfolds, it draws images of intrigue and amazement at the expert and diligent craftsmanship of the ancient mariners. The medieval ships were clinker built, which refers to the clenching of nail -on technique used for securing planks. The clinker design was adapted from the earlier skin boats which had to be over lapped to make it water tight.

The Irish, in the medieval ages were in possession of more advanced vessels like the Irish curragh. These had wooden frames and a hide covered wicker hull; it is speculated that these ancient ships were fitted with removable masts rigged using primitive sails.

By 1000 AD, the famed Viking Long ship was permitted a travel into the Mediterranean. These ships were wider and had a more advanced mast stepping design.

By 800 AD an alternative form of the north European ship design, the hulk came into vogue. The Utrecht ship is an example of the hulk. Its planks are flush, butted end to end and tapered in order to draw up at the sides and at the bow and stern.

1.3 Improvements in Marine Vessels

Ships continued to develop as overseas trade became increasingly more important. By late 1100's a straight stern post was added to ships to facilitate the hanging rudder. This aspect improved greatly the handling characteristics of a ship. The rudder permitted larger ships to be designed. It also allowed for ships with increasingly higher free boards to be built.

As years passed, in order to avoid risk of water damage, cargo was transported in large gallon barrels called tuns. The crew could now sleep on big leather bags on deck; the passenger space was termed "steerage" and this term is still in use today to refer to passenger accommodation of minimal facilities.

The British relied heavily on the nef, a term used for ships. At this point of time, ship design took a different turn – the first distinctive feature was the plank on frame construction. This allowed for much larger ships to be built. With more ships at sea, trade occurred from nearly all ports and there arose a need for a ship that could sail from anywhere to anywhere.

The carrack was designed and she was truly one of the tall ships. It has its origin in Genoa and sports the design of three Mediterranean vessels set to sail north through the Atlantic trade in the Bat of Biscay. The carrack was almost exclusively built of carvel, a type of construction that had its uses in both skin and frame built ships. In this design, the planks are fitted edge to edge rather than overlapping. In fact the carrack was the first to use the full skeletal design with planking framed on ribs the entire way to the keel.

1.4 Liberty Ships

The Liberty ship was a class of cargo ship built in the United States during World War II. Though British in conception, the design was adapted by the U.S. for its simple, low-cost construction. Mass produced on an unprecedented scale, the now iconic Liberty ship came to symbolize U.S. wartime industrial output.

The class was developed to meet British orders for transports to replace those torpedoed by German U-boats. The vessels were purchased both for the U.S. fleet and lend-lease deliveries of war materiel to Britain and the Soviet Union. Eighteen American shipyards built 2,710 Liberty ships between 1941 and 1945, easily the largest number of ships produced to a single design.

Their production mirrored on a much larger scale the manufacture of the *Hog Islander* and similar standardized ship types during World War I. The immensity of the effort, the sheer number of ships built, the vaunted role of Rosie the Riveters in their construction, and the survival of some far longer than their original five-year design life, all make them the subject of much continued interest.

Only a handful remain in 2015, two as operational museum ships.

Merchant vessels

2.1 What is “merchant vessel”?

A merchant vessel or trading vessel is a ship that transports cargo or passengers. The closely related term commercial vessel is defined by the United States Coast Guardas any vessel (i.e. boat or ship) engaged in commercial trade or that carries passengers for hire. This would exclude pleasure craft that do not carry passengers for hire or warships.

Most countries of the world operate fleets of merchant ships. However, due to the high costs of operations, today these fleets are in many cases sailing under the flags of nations that specialize in providing manpower and services at favourable terms. Such flags are known as "flags of convenience". Currently, Liberia and Panama are particularly favoured. Ownership of the vessels can be by any country, however.

The Greek-owned fleet is the largest in the world. Today, the Greek fleet accounts for some 16 per cent of the world's tonnage; this makes it currently the largest single international merchant fleet in the world, albeit not the largest in history.

In English, "Merchant Navy" without further clarification is used to refer to the British Merchant Navy; the United States merchant fleet is known as the United States Merchant Marine.

During wars, merchant ships may be used as auxiliaries to the navies of their respective countries, and are called upon to deliver military personnel and material.

Merchant vessel categories

3.1 Dry cargo ships

Dry cargo ships are used to carry solid dry goods that have a higher tolerance to heat and cold, such as metal ores, coal, steel products, forest products, and grains. These vessels are equipped with on-deck cranes and other mechanism for loading and unloading of goods. As dry cargo shipment doesn't require special types of precautions (as required for carrying liquid and gases), bulk carriers and container ships don't have onboard temperature control equipment. Today, bulk of international trade is carried out by thousands of dry cargo carriers transporting goods to ports across the world.
Dry cargo vessel category mainly includes bulk carriers and container ships. Bulk carriers are used for transportation of unpackaged bulk cargo, such as metal ores, coal, cement, tin, steel, and grains in its cargo holds. Container ships are primarily used for the transportation of non-bulk cargo, generally manufactured goods, in truck-size intermodal containers.

3.1.1 Bulk Carriers

A bulk carrier, bulk freighter, or bulker is a merchant ship specially designed to transport unpackaged bulk cargo, such as grains, coal, ore, and cement in itscargo holds. Since the first

specialized bulk carrier was built in 1852, economic forces have fuelled the development of these ships, causing them to grow in size and sophistication. Today's bulkers are specially designed to maximize capacity, safety, efficiency, and durability.

Today, bulkers make up 15% - 17% of the world's merchant fleets and range in size from single-hold mini-bulkers to mammoth ore ships able to carry 400,000 metric tons of deadweight (DWT). A number of specialized designs exist: some can unload their own cargo, some depend on port facilities for unloading, and some even package the cargo as it is loaded. Over half of all bulkers have Greek, Japanese, or Chinese owners and more than a quarter are registered in Panama. Korea is the largest single builder of bulkers, and 82% of these ships were built in Asia.

A bulk carrier's crew participates in the loading and unloading of cargo, navigating the ship, and keeping its machinery and equipment properly maintained. Loading and unloading the cargo is difficult, dangerous, and can take up to 120 hours on larger ships. Crews can range in size from three people on the smallest ships to over 30 on the largest.

Bulk cargo can be very dense, corrosive, or abrasive. This can present safety problems: cargo shifting, spontaneous combustion, and cargo saturation can threaten a ship. The use of ships that are old and have corrosion problems has been linked to a spate of bulker sinkings in the 1990s, as have the bulker's large hatchways, important for efficient cargo handling. New international regulations have since been introduced to improve ship design and inspection, and to streamline the process of abandoning ship.

3.1.2 Size categories

Post-deepening of the Suez Canal, a capesize bulk carrier approaches theEgyptian-Japanese Friendship Bridge

Bulkers are segregated into six major size categories:
small, handysize, handymax, panamax, capesize, and very large. Very large bulk and ore carriers fall into the capesize category but are often considered separately.

Major bulk carrier size categories					
Name	Size in DWT	Ships	Traffic	New price	Used price
Handysize	10,000 to 35,000	34%	18%	$25M	$20M
Handymax	35,000 to 59,000	37%			
Panamax	60,000 to 80,000	19%	20%	$35M	$25M
Capesize	80,000 and over	10%	62%	$58M	$54M

3.1.3 Categories as per Regions

Categories occur in regional trade, such as Kamsarmax, Seawaymax, Setouchmax, Dunkirkmax, and Newcastlemax also appear in regional trade.

- "Kamsarmax" : Maximum length overall 229 meters refers to a new type of ships, larger than panamax, that are suitable for berthing at the Port of Kamsar(Republic of Guinea), where the major loading terminal of bauxite is restricted to vessels not more than 229 meters.
- "Newcastlemax" : Maximum beam 50 meters,and maximum length overall of 300 meters Refers to the largest vessel able to enter the port of Newcastle, Australia at about 185,000 DWT

- "Setouchmax" : About 203,000 DWT, being the largest vessels able to navigate the Setouch Sea, Japan
- "Seawaymax" : LOA 226 m max / 7.92 m draft. Refers to the largest vessel that can pass through the canal locks of the St Lawrence Seaway (Great lakes, Canada)
- "Malaccamax" : LOA 330 m / 20 m draft / 300,000 DWT, Refers to the largest vessel that can pass through the Straits of Malacca.
- "Dunkirkmax" : Maximum allowable beam = 45 m / LOA 289 m. max (175,000 DWT approx) for the eastern harbour lock in the Port of Dunkirk (France)

Mini-bulkers are prevalent in the category of small vessels with a capacity of under 10,000 DWT. Mini-bulkers carry from 500 to 2,500 tons, have a single hold, and are designed for river transport. They are often built to be able to pass under bridges and have small crews of three to eight people.

Handysize and Handymax ships are general purpose in nature. These two segments represent 71% of all bulk carriers over 10,000 DWT and also have the highest rate of growth. This is partly due to new regulations coming into effect which put greater constraints on the building of larger vessels.Handymax ships are typically 150–200 m in length and 52,000 – 58,000 DWT with five cargo holds and four cranes. These ships are also general purpose in nature.

The size of a Panamax vessel is limited by the Panama canal's lock chambers, which can accommodate ships with a beam of up to 32.31 m, a length overall of up to 294.13 m, and a draft of up to 12.04 m.

Capesize ships are too large to traverse the Panama canal and must round Cape Horn to travel between the Pacific and Atlantic oceans. Earlier, capesize ships could not traverse the Suez and needed to go around the Cape of Good Hope. Recent deepening of the Suez canal to 66 ft (20 m) permits most capesize ships to pass through it.

Capesize bulkers are specialized: 93% of their cargo is iron ore and coal. Some ships on the Great Lakes Waterway exceed Panamax dimensions but they are limited to use on the Great Lakes as they cannot pass through the smaller St. Lawrence Seaway to the ocean. Very large ore carriers and very large bulk carriers are a subset of the capesize category reserved for vessels over 200,000 DWT. Carriers of this size are almost always designed to carry iron ore.

3.1.4 General types

General Bulk Carrier Types	
Illustration	Description
	Geared bulk carriers are typically in the handysize to handymax size range although there are a small number of geared panamax vessels, like all bulkers they feature a series of holds covered by prominent hatch covers. They have cranes, derricks or conveyors that allow them to load or discharge cargo in ports without shore-based equipment. This gives geared bulkers flexibility in the cargoes they can carry and the routes they can travel. (Photo: A typical geared handysize bulk carrier.)
	Combined carriers are designed to transport both liquid and dry bulk cargoes. If both are carried simultaneously, they are segregated in separate holds and tanks. Combined carriers require special design and are expensive. They were prevalent in the 1970s, but their numbers have dwindled since 1990. (Photo: The oil pipeline and dry bulk hold aboard the *Maya*.)
	Gearless carriers are bulkers without cranes or conveyors. These ships depend on shore-based equipment at their ports of call for loading and discharging. They range across all sizes, the larger bulk carriers (VLOCs) can only dock at the largest ports, some of these are designed with a single port-to-port trade in mind. The use of gearless bulkers avoids the costs of installing, operating, and maintaining cranes. (Photo:*Berge Athen*, a 225,000 ton gearless bulker.)
	Self-dischargers are bulkers with conveyor belts, or with the use of an excavator that is fitted on a traverse running over the vessel's entire hatch, and that is able to move sideways as well. This allows them to discharge their cargo quickly and efficiently. (Photo: The *John B. Aird* a self-discharging lake freighter.)
	Lakers are the bulkers prominent on the Great Lakes, often identifiable by having a forward house which helps in transiting locks. Operating in fresh water, these ships suffer much less corrosion damage and have a much longer lifespan than saltwater ships. As of 2005, there were 98 lakers of 10,000 DWT or over.[32] (Photo: *Edward L. Ryerson*, a Great Lakes bulker.)

	BIBO or "Bulk In, Bags Out" bulkers are equipped to bag cargo as it is unloaded. The *CHL Innovator*, shown in the photo, is a BIBO bulker. In one hour, this ship can unload 300 tons of bulk sugar and package it into 50 kg sacks.

3.1.5 Loading and unloading

Loading and unloading a bulker is time-consuming and dangerous. The process is planned by the ship's chief mate under the direct and continued supervision of ship's captain. International regulations require that the captain and terminal master agree on a detailed plan before operations begin. Deck officers and stevedores oversee the operations. Occasionally loading errors are made that cause a ship to capsize or break in half at the pier.

The loading method used depends on both the cargo and the equipment available on the ship and on the dock. In the least advanced ports, cargo can be loaded with shovels or bags poured from the hatch cover. This system is being replaced with faster, less labor-intensive methods. Double-articulation cranes, which can load at a rate of 1,000 tons per hour, represent a widely used method, and the use of shore-basedgantry cranes, reaching 2,000 tons per hour, is growing. A crane's discharge rate is limited by the bucket's capacity (from 6 to 40 tons) and by the speed at which the crane can take a load, deposit it at the terminal, and to return to take the next. For modern gantry cranes, the total time of the grab-deposit-return cycle is about 50 seconds.[4]

Conveyor belts offer a very efficient method of loading, with standard loading rates varying between 100 and 700 tons per hour, although the most advanced ports can offer rates of 16,000 tons per hour. Start-up and shutdown procedures with conveyor belts, though, are complicated and require time to carry out. Self-discharging ships use conveyor belts with load rates of around 1,000 tons per hour.

Once the cargo is discharged, the crew begins to clean the holds. This is particularly important if the next cargo is of a different type. The immense size of cargo holds and the tendency of cargoes to be physically irritating add to the difficulty of cleaning the holds. When the holds are clean, the process of loading begins.

It is crucial to keep the cargo level during loading in order to maintain stability. As the hold is filled, machines such as excavators and bulldozers are often used to keep the cargo in check. Leveling is particularly important when the hold is only partly full, since cargo is more likely to shift. Extra precautions are taken, such as adding longitudinal divisions and securing wood atop the cargo. If a hold is full, a technique called tomming is used, which involves digging out a 6 feet (2 m) hole below the hatch cover and filling it with bagged cargo or weights.

A typical bulker offload

				
1. A bulldozer is loaded into the hold.	2. The bulldozer pushes cargo to the center of the hold.	3. The gantry crane picks up the cargo.	4. The gantry crane removes the cargo from the ship.	5. The gantry crane moves the cargo to a bin on the pier.

3.1.6 Container ships

Container ships are cargo ships that carry all of their load in truck-size intermodal containers, in a technique called containerization. They are a common means of commercial intermodal freight transport and now carry most seagoing non-bulk cargo.

Container ship capacity is measured in twenty-foot equivalent units (TEU). Typical loads are a mix of 20-foot and 40-foot (2-TEU) ISO-standard containers, with the latter predominant.

Container Ship CMA CGM Corte Real

3.1.7 Size categories

Container ships are distinguished into 7 major size categories: small feeder, feeder, feedermax, panamax, post-panamax, new panamax and ultra-large. As of December 2012, there are 161 container ships in the VLCS class (Very Large Container Ships, more than 10,000 TEU), and 51 ports in the world can accommodate them.

The size of a panamax vessel is limited by the Panama canal's lock chambers, which can accommodate ships with a beam of up to 32.31 m, a length overall of up to 294.13 m, and a draft of up to 12.04 m. The "post panamax" category has historically been used to describe ships with a moulded breadth over 32.31 m, however the Panama Canal expansion project is causing some changes in terminology. The "new panamax" category is based on the maximum vessel-size that will be able to transit a new third set of locks. The new locks are being built to accommodate a container ship with a length overall of 366 metres (1,201 ft), a maximum width of 49 metres (161 ft), and tropical fresh-water draft of 15.2 metres (50 ft). Such a vessel would be wide enough to carry 19 rows of containers, have a total capacity of approximately 12,000 TEU and be comparable in size to a capesize bulk carrier or a suezmax tanker.

Main article: Feeder ship

Container ships under 3,000 TEU are generally called feeders. Feeders are small ships that typically operate between smaller container ports. Some feeders collect their cargo from small ports, drop it off at large ports for transshipment on larger ships, and distribute containers from the large port to smaller regional ports. This size of vessel is the most likely to carry cargo cranes on board.

Container Ship Size Categories						
Name	Capacity (TEU)[17]	Length	Beam	Draft	Example	
Ultra Large Container Vessel (ULCV)	14,501 and higher	1,200 ft (366 m) and longer	160.7 ft (49 m) and wider	49.9 ft (15.2 m) and deeper	With a length of 400 m, a width of 59 m, draft of 14.5 m, and a capacity of 18,270 TEU, ships of the Maersk Triple E classclass are able to transit the Suez canal. (Photo: MV *Mærsk Mc-Kinney Møller*.)	
New panamax	10,000–14,500	1,200 ft (366 m)	160.7 ft (49 m)	49.9 ft (15.2 m)	With a beam of 43 m, ships of the *COSCO Guangzhou* class are much too big to fit through the Panama Canal's old locks, but could easily fit through the new expansion. (Photo: The 9,500 TEU MV *COSCO Guangzhou* pierside in Hamburg.)	
Post panamax	5,101–10,000					
Panamax	3,001 – 5,100	965 ft (294.13 m)	106 ft (32.31 m)	39.5 ft (12.04 m)	Ships of the Bay-class are at the upper limit of the Panamax class, with an overall length of 292.15 m, beam of 32.2m, and maximum depth of 13.3 m. (Photo: The 4,224 TEU MV *Providence Bay* passing through the Panama Canal.)	
Feedermax	2,001 – 3,000				Container ships under 3,000 TEU are	

Feeder	1,001 – 2,000				typically called feeders. In some areas of the world, they might be outfitted with cargo cranes. (Photo: The 384 TEU MV *TransAtlantic* at anchor.)	
Small feeder	Up to 1,000					

3.1.8 Cargo cranes

View from the top of a container ship crane.

A major characteristic of a container ship is whether it has cranes installed for handling its cargo. Those that have cargo cranes are called *geared* and those that don't are called *ungeared* or *gearless*. The earliest purpose-built container ships in the 1970s were all gearless. Since then, the percentage of geared newbuilds has fluctuated widely, but has been decreasing overall, with only 7.5% of the container ship capacity in 2009 being equipped with cranes.

While geared container ships are more flexible in that they can visit ports that are not equipped with pierside container cranes, they suffer from several drawbacks. To begin with, geared ships will cost more to purchase than a gearless ship. Geared ships also incur greater recurring expenses, such as maintenance and fuel costs. The United Nations Council on Trade and Development characterizes geared ships as a "niche market only appropriate for those ports where low cargo volumes do not justify investment in port cranes or where the public sector does not have the financial resources for such investment."

Instead of the rotary cranes, some geared ships have gantry cranes installed. These cranes, specialized for container work, are able to roll forward and aft on rails. In addition to the additional capital expense and maintenance costs, these cranes generally load and discharge containers much more slowly than their shoreside counterparts.

The introduction and improvement of shoreside cranes have been a key to the success of the container ship. The first crane that was specifically designed for container work was built in California's Port of Alameda in 1959. By the 1980s, shoreside gantry cranes were capable of moving containers on a 3-minute-cycle, or up to 400 tons per hour. In March 2010, at Port

Klang in Malaysia, a new world record was set when 734 container moves were made in a single hour. The record was achieved using 9 cranes to simultaneously load and unload the MV *CSCL Pusan*, a ship with a capacity of 9,600 TEU.

Vessels in the 1,500–2,499 TEU range are the most likely size class to have cranes, with more than 60% of this category being geared ships. Slightly less than a third of the very smallest ships (from 100–499 TEU) are geared, and almost no ships with a capacity of over 4,000 TEU are geared.

3.1.9 Cargo holds

A view into the holds of a container ship. Of note are the vertical cell guides that organize containers athwartships.

Efficiency has always been key in the design of container ships. While containers may be carried on conventional break-bulk ships, cargo holds for dedicated container ships are specially constructed to speed loading and unloading, and to efficiently keep containers secure while at sea. A key aspect of container ship specialization is the design of the hatches, the openings from the main deck to the cargo holds. The hatch openings stretch the entire breadth of the cargo holds, and are surrounded by a raised steel structure known as the *hatch coaming*. On top of the hatch coamings are the hatch covers. Until the 1950s, hatches were typically secured with wooden boards and tarpaulins held down with battens. Today, some hatch covers can be solid metal plates that are lifted on and off the ship by cranes, while others are articulated mechanisms that are opened and closed using powerful hydraulic rams.

Another key component of dedicated container-ship design is the use of *cell guides*. Cell guides are strong vertical structures constructed of metal installed into a ship's cargo holds. These structures guide containers into well-defined rows during the loading process and provide some support for containers against the ship's rolling at sea. So fundamental to container ship design

are cell guides that organizations such as the United Nations Conference on Trade and Development use their presence to distinguish dedicated container ships from general break-bulk cargo ships.

A system of three dimensions is used in cargo plans to describe the position of a container aboard the ship. The first coordinate is the *row*, which starts at the front of the ship and increases aft. The second coordinate is tier, with the first tier at the bottom of the cargo holds, the second tier on top of that, and so forth. The third coordinate is the *slot*. Slots on the starboard side are given odd numbers and those on the port side are given even numbers. The slots nearest the centerline are given low numbers, and the numbers increase for slots further from the centerline.

3.2 Tankers

Tankers are used for bulk transporting of crude oil, finished petroleum products, liquefied natural gas (LNG), chemicals, edible oils, wine, juice, molasses, fresh water, and other liquids. They play an important role in international trade with a share of over 33% of the world tonnage. Tankers come in varied sizes ranging from handysize tankers to ultra large crude carriers (ULCC) with a deadweight tonnage ranging between 320,000 to 550,000.

3.2.1 History of Tankers

The first use of tankers in transporting bulk liquids dates back to the later years of the 19th century. Before the advent of tankers, the idea of carrying bulk liquids in ships was considered a costly and even an infeasible affair. In that period, the market was also not ready for transporting or selling cargo in bulk. As a result, ships were used for transportation of a wide range of products in their holds. Liquids including wines and fresh water were usually loaded in casks. With the discovery and exploration of oil, tankers have emerged as the main mode of transportation to carry crude and refined oil to ports across the world. Today, tankers carry over 33% of the world tonnage.

3.2.2 Backround

Tankers can range in size of capacity from several hundred tons, which includes vessels for servicing small harbours and coastal settlements, to several hundred thousand tons, for long-range haulage. Besides ocean- or seagoing tankers there are also specialized inland-waterway tankers which operate on rivers and canals with an average cargo capacity up to some thousand tons. A wide range of products are carried by tankers, including:

- hydrocarbon products such as oil, liquefied petroleum gas (LPG), and liquefied natural gas (LNG)
- chemicals, such as ammonia, chlorine, and styrene monomer
- fresh water
- wine
- molasses

The *Thomas W. Lawson* (1902), converted in 1906 into the world's first sailing tanker.

Tankers are a relatively new concept, dating from the later years of the 19th century. Before this, technology had simply not supported the idea of carrying bulk liquids. The market was also not geared towards transporting or selling cargo in bulk, therefore most ships carried a wide range of different products in different holds and traded outside fixed routes. Liquids were usually loaded

in casks—hence the term "tonnage", which refers to the volume of the holds in terms of how many tuns or casks of wine could be carried. Even potable water, vital for the survival of the crew, was stowed in casks. Carrying bulk liquids in earlier ships posed several problems:

- The holds: on timber ships the holds had not sufficiently water, oil or air-tight to prevent a liquid cargo from spoiling or leaking. The development of iron and steel hulls solved this problem.
- Loading and discharging: Bulk liquids must be pumped - the development of efficient pumps and piping systems was vital to the development of the tanker. Steam engines were developed as prime-movers for early pumping systems. Dedicated cargo handling facilities were now required ashore too - as was a market for receiving a product in that quantity. Casks could be unloaded using ordinary cranes, and the awkward nature of the casks meant that the volume of liquid was always relatively small - therefore keeping the market more stable.
- Free Surface Effect: a large body of liquid carried aboard a ship will impact on the ship's stability, particularly when the liquid is flowing around the hold or tank in response to the ship's movements. The effect was negligible in casks, but could cause capsizing if the tank extended the width of the ship; a problem solved by extensive subdivision of the tanks.

Tankers were first used by the oil industry to transfer refined fuel in bulk from refineries to customers. This would then be stored in large tanks ashore, and subdivided for delivery to individual locations. The use of tankers caught on because other liquids were also cheaper to transport in bulk, store in dedicated terminals, then subdivide. Even the Guinness brewery used tankers to transport the stout across the Irish Sea.

A US Navy T2 tanker in 1943.

Different products require different handling and transport, with specialised variants such as "chemical tankers", "oil tankers", and "LNG carriers" developed to handle dangerous chemicals, oil and oil-derived products, and liquefied natural gas respectively. These broad variants may be further differentiated with respect to ability to carry only a single product or simultaneously transport mixed cargoes such as several different chemicals or refined petroleum products.[1] Among oil tankers, supertankers are designed for transporting oil around the Horn of Africa from the Middle East. The supertanker Seawise Giant, scrapped in 2010, was 458 meters (1,503 ft) in length and 69 meters (226 ft) wide. Supertankers are one of the three preferred methods for transporting large quantities of oil, along with pipeline transport and rail.

Despite being highly regulated, tankers have been involved in environmental disasters resulting from oil spills. See *Amoco Cadiz*, *Braer*, *Erika*, *Exxon Valdez*, *Prestige oil spill*and *Torrey Canyon* for examples of coastal accidents.

3.2.3 Tanker Capacity

Tankers used for liquid fuels are classified according to their capacity.

The small coastal tanker *Pegasus*on the River Weser

The Very Large Crude Carrier (VLCC) MV *Sirius Star* in 2008 after her capture by Somali pirates.

In 1954, Shell Oil developed the average freight rate assessment (AFRA) system which classifies tankers of different sizes. To make it an independent instrument, Shell consulted the *London Tanker Brokers' Panel (LTBP)*. At first, they divided the groups as *General Purpose* for tankers under 25,000 tons deadweight (DWT); *Medium Range*for ships between 25,000 and 45,000 DWT and *Large Range* for the then-enormous ships that were larger than 45,000 DWT. The ships became larger during the 1970s, and the list was extended, where the tons are long tons:

- 10,000–24,999 DWT: General Purpose tanker
- 25,000–54,999 DWT: Medium Range tanker
- 55,000–79,999 DWT: Long Range 1 (LR1)
- 80,000–159,999 DWT: Long Range 2 (LR2)
- 160,000–319,999 DWT: Very Large Crude Carrier (VLCC)
- 320,000–549,999 DWT: Ultra Large Crude Carrier (ULCC)

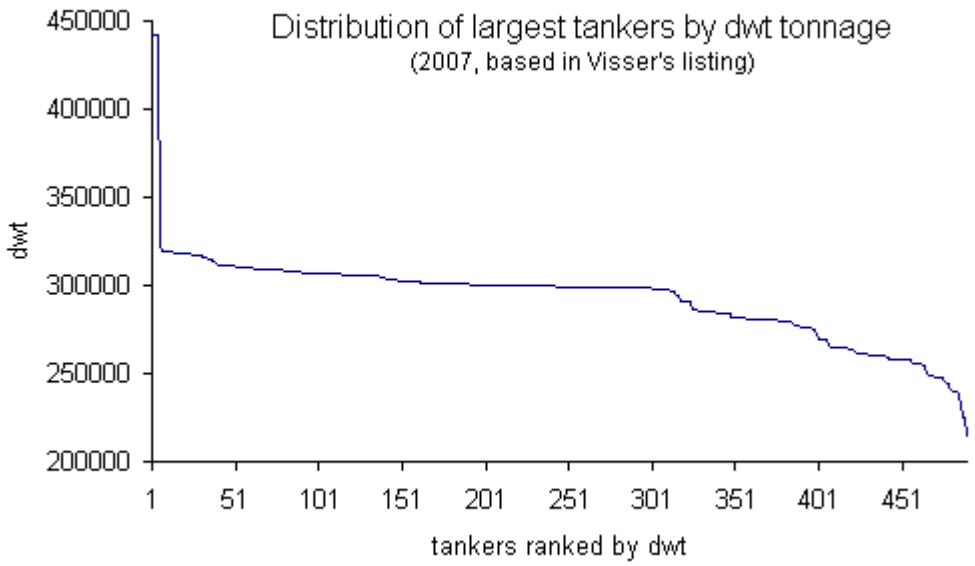
Petroleum Tankers

Class	Length	Beam	Draft	Typical Min DWT	Typical Max DWT
Seawaymax	226 m (741 ft)	24 m (79 ft)	7.92 m (26.0 ft)	10,000 t DWT	60,000 t DWT
Panamax	228.6 m (750 ft)	32.3 m (106 ft)	12.6 m (41 ft)	60,000 t DWT	80,000 t DWT
Aframax	253.0 m (830.1 ft)	44.2 m (145 ft)	11.6 m (38 ft)	80,000 t DWT	120,000 t DWT
Suezmax			16 m (52 ft)	120,000 t DWT	200,000 t DWT

VLCC (Malaccamax)	330 m (1,080 ft)	60 m (200 ft)	20 m (66 ft)	200,000 t DWT	315,000 t DWT
ULCC				320,000 t DWT	550,000 t DWT

Very Large Crude Carrier Size Range There are more ships smaller in size.

At nearly 380 vessels in the size range 279,000 t DWT to 320,000 t DWT, these are by far the most popular size range among the larger VLCCs. Only seven vessels are larger than this, and approximately 90 between 220,000 t DWT and 279,000 t DWT.



3.2.4 LNG CARRIERS

An LNG carrier is a tank ship designed for transporting liquefied natural gas (LNG). As the LNG market grows rapidly, the fleet of LNG carriers continues to experience tremendous growth.

3.2.5 History

The first LNG carrier *Methane Pioneer* (dwt 5034 tons) left the Calcasieu River on the Louisiana Gulf coast on 25 January 1959. Carrying the world's first ocean cargo of LNG, it sailed to the UK where the cargo was delivered. Subsequent expansion of that trade has brought on a large expansion of the fleet to today where giant LNG ships carrying up to 266,000 m^3 are sailing worldwide. At the end of 2005, a total of 203 vessels have been built, of which 193 are still in service.

The success of the specially modified C1-M-AV1-type standard ship *Normarti*, renamed *The Methane Pioneer*, caused the Gas Council and Conch International Methane Ltd. to order two purpose built LNG carriers to be constructed: the *Methane Princess* and the *Methane Progress*. The ships were fitted with Conch independent aluminum cargo tanks and entered the Algerian LNG trade in 1964. These ships had a capacity of 27,000 cubic meters.

In the late 1960s opportunity arose to export LNG from Alaska to Japan, and in 1969 that trade was initiated. Two ships, each with a capacity of 71,500 cubic meters, were built in Sweden. In the early 1970s, the US Government encouraged US shipyards to build LNG carriers, and a total of 16 LNG ships were built. The late 1970s and early 1980s brought the prospect of Arctic LNG ships with a number of projects being studied.

With the increase in cargo capacity to approximately 143,000 cubic meters, new tank designs were developed, from Moss Rosenberg to Technigaz Mark III and Gaztransport No.96.

In recent years, the size and capacity of LNG carriers has increased greatly. Since 2005, Qatargas has pioneered the development of two new classes of LNG carriers, referred to as Q-Flex and Q-Max. Each ship has a cargo capacity of between 210,000 and 266,000 cubic meters and is equipped with a re-liquefaction plant.

3.2.6 New building

According to a presentation by Golar LNG Partners, in June 2012 there were 72 new builds on order. Today the majority of the new ships under construction are in the size of 120,000–140,000 m^3 But there are orders for ships with capacity up to 260,000 m^3. As of end of 2011, there are 359 LNG ships engaged in the deepsea movement of LNG.[2]

In the case of small scale LNG carriers (LNG carriers below 40,000 cbms), the optimal size for the new buildings will be determined by the project to which they are built against. This optimal size will be calculated considering volumes, destinations and vessels characteristics

3.2.7 Cargo Handling

A typical LNG carrier has four to six tanks located along the center-line of the vessel. Surrounding the tanks is a combination of ballast tanks, cofferdams and voids; in effect, this gives the vessel a double-hull type design.

Inside each tank there are typically three submerged pumps. There are two main cargo pumps which are used in cargo discharge operations and a much smaller pump which is referred to as the spray pump. The spray pump is used for either pumping out liquid LNG to be used as fuel (via a vaporizer), or for cooling down cargo tanks. It can also be used for "stripping" out the last of the cargo in discharge operations. All of these pumps are contained within what is known as the pump tower which hangs from the top of the tank and runs the entire depth of the tank. The pump tower also contains the tank gauging system and the tank filling line, all of which are located near the bottom of the tank.

In membrane-type vessels there is also an empty pipe with a spring-loaded foot valve that can be opened by weight or pressure. This is the emergency pump tower. In the event both main cargo pumps fail the top can be removed from this pipe and an emergency cargo pump lowered down to the bottom of the pipe. The top is replaced on the column and then the pump is allowed to push down on the foot valve and open it. The cargo can then be pumped out.

All cargo pumps discharge into a common pipe which runs along the deck of the vessel; it branches off to either side of the vessel to the cargo manifolds, which are used for loading or discharging.

All cargo tank vapour spaces are linked via a vapour header which runs parallel to the cargo header. This also has connections to the sides of the ship next to the loading and discharging manifolds.

3.2.8 LPG carrier

A gas carrier (or gas tanker) is a ship designed to transport LPG, LNG or liquefied chemical gases in bulk.

Fully pressurized gas carrier

The seaborne transport of liquefied gases began in 1934 when a major international company put two combined oil/LPG tankers into operation. The ships, basically oil tankers, had been converted by fitting small, riveted, pressure vessels for the carriage of LPG into cargo tank spaces. This enabled transport over long distances of substantial volumes of an oil refinery by-product that had distinct advantages as a domestic and commercial fuel. LPG is not only

odourless and non-toxic, it also has a high calorific value and a low sulphur content, making it very clean and efficient when being burnt.

Today, most fully pressurised oceangoing LPG carriers are fitted with two or three horizontal, cylindrical or spherical cargo tanks and have typical capacities between 3,500 and 7,500 m^3. However, in recent years a number of larger-capacity fully pressurised ships have been built, most notably a series of 10,800 m^3 ships, built in Japan between 2003 and 2013. Fully pressurised ships are still being built in numbers and represent a cost-effective, simple way of moving LPG to and from smaller gas terminals.

Semi-pressurised ships

These ships carried gases in a semi-pressurized/semi-refrigerated state however due to further development semi-pressurised/fully refrigerated gas carriers had become the shipowners' choice by providing high flexibility in cargo handling. These carriers, incorporating tanks either cylindrical, spherical or bi-lobe in shape, are able to load or discharge gas cargoes at both refrigerated and pressurised storage facilities.

Ethylene and gas/chemical carriers

Ethylene carriers are the most sophisticated of the gas tankers and have the ability to carry not only most other liquefied gas cargoes but also ethylene at its atmospheric boiling point of −104 °C. These ships feature cylindrical, insulated, stainless steel cargo tanks able to accommodate cargoes up to a maximum specific gravity of 1.8 at temperatures ranging from a minimum of −104 °C to a maximum of +80 °C and at a maximum tank pressure of 4 bar.

Fully refrigerated ships

They are built to carry liquefied gases at low temperature and atmospheric pressure between terminals equipped with fully refrigerated storage tanks. However, discharge through a booster pump and cargo heater makes it possible to discharge to pressurized tanks too. The first purpose-built, fully refrigerated LPG carrier was constructed by a Japanese shipyard, to a United States design, in 1962. Prismatic tanks enabled the ship's cargo carrying capacity to be maximised, thus making fully refrigerated ships highly suitable for carrying large volumes of cargo such as LPG, ammonia and vinyl chloride over long distances. Today, fully refrigerated ships range in capacity from 20,000 to 100,000 m^3. LPG carriers in the 50,000 - 80,000 m^3 size range are often referred to as VLGCs (Very Large Gas Carriers). Although LNG carriers are often larger in terms of cubic capacity, this term is normally only applied to fully refrigerated LPG carriers.

The main type of cargo containment system utilised on board modern fully refrigerated ships are independent tanks with rigid foam insulation. The insulation used is quite commonly

polyurethane foam. Older ships can have independent tanks with loosely filled perlite insulation. In the past, there have been a few fully refrigerated ships built with semi-membrane or integral tanks and internal insulation tanks, but these systems have only maintained minimal interest. The large majority of such ships currently in service have been constructed by shipbuilders in Japan and Korea.

3.3 Passenger Ships

A **passenger ship** is a merchant ship whose primary function is to carry passengers. The category does not include cargo vessels which have accommodations for limited numbers of passengers, such as the ubiquitous twelve-passenger freighters once common on the seas in which the transport of passengers is secondary to the carriage of freight. The type does however include many classes of ships designed to transport substantial numbers of passengers as well as freight. Indeed, until recently virtually allocean liners were able to transport mail, package freight and express, and other cargo in addition to passenger luggage, and were equipped with cargo holds and derricks, kingposts, or other cargo-handling gear for that purpose. Only in more recent ocean liners and in virtually all cruise ships has this cargo capacity been eliminated.

While typically passenger ships are part of the merchant marine, passenger ships have also been used as troopships and often are commissioned as naval ships when used as for that purpose.

3.3.1 Types

Passenger ships include ferries, which are vessels for day or overnight short-sea trips moving passengers and vehicles (whether road or rail); ocean liners, which typically are passenger or passenger-cargo vessels transporting passengers and often cargo on longer line voyages; and cruise ships, which often transport passengers on round-trips, in which the trip itself and the attractions of the ship and ports visited are the principal draw.

3.3.2 Ocean Liners

Ocean liners are traditional passenger ships. An ocean liner typically has 1,500 to 2,000 seats for passengers and has facilities of saloons, swimming pools, and sports halls. Prior to advent of airliners, they were the primary mode of intercontinental travel. Nowadays, just a few ocean liners are in operation, their place has been taken by ferries. Some of the famous and most luxurious

ocean liners of the past are the Titanic, Olympic, and Queen Elizabeth. The largest ocean liner today is RMS Queen Mary 2.

3.3.3 Cruise Ships

The slow demise of ocean liners by the mid 20th century opened the way for cruise ships. Cruise ships are large passenger ships offering pleasure trips adventure seeking people. They have onboard facilities of restaurants, bars, casinos, theaters, ball rooms, discos, swimming pools, fitness centers, and shops that make them a complete floating resort. They are designed in a way to negotiate almost all major ports in the world.

In comparison to liners, they serve shorter routes with more stops along coastlines or islands. Among popular cruise destinations in the world include the Caribbean Sea, Alaska, Mexico, Hawaii Island, and the Mediterranean Sea. Some of the luxurious ocean liners have now been converted to cruise ships, example being the conversion of ocean liner "SS France" to cruise ship "SS Norway". At present, the two largest cruise ships are the Allure of the Seas and the Oasis of the Seas.

3.3.4 Ferries

Ferries are boats or small-sized ships that are used for day or overnight short sea trips sailing close to the coast between two or more ports. With a seating capacity ranging from 40 to 600, ferries are part of public transport systems in many waterside cities and islands. They are categorised into the ship types such as Hydrofoil, Hovercraft, Catamaran, Cruise ferry, Ro-ro, Pontoon ferry, Foot ferry, Cable ferry and Air ferries.

3.3.5 Yachts

They are small boats or ships primarily used for recreational purposes. They are either propelled by sail or power with later being very popular nowadays. Power yachts offer plenty of amenities sometimes comparable to luxurious passenger ships. They are often referred to as cabin cruisers. There are different categories of yachts such as day sailing yachts, weekender yachts, cruising yachts, racing yachts, and cruising yachts

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3.3.6 Measure of Size

By convention and long usage, the size of civilian passenger ships is measured by gross tonnage, which is a dimensionless figure calculated from the total enclosed volume of the vessel. Gross tonnage is not a measure of weight, although the two concepts are often confused. Weight is measured by displacement, which is the conventional means of measuring naval vessels. Often a passenger ship is stated to "weigh" or "displace" a certain "tonnage", but the figure given nearly always refers to gross tonnage, which in this context has nothing to do with weight.

While a high displacement can indicate better sea keeping abilities, gross tonnage is promoted as the most important measure of size for passengers, as the ratio of gross tonnage per passenger – the Passenger/Space Ratio – gives a sense of the spaciousness of a ship, an important consideration in cruise liners where the onboard amenities are of high importance.

Gross tonnage normally is a much higher value than displacement. This was not always the case; as the functions, engineering and architecture of ships have changed, the gross tonnage figures of the largest passenger ships have risen substantially, while the displacements of such ships have not. RMS Titanic, with a gross register tonnage of 46,329 GRT, but a displacement reported at over 52,000 tons, was heavier than contemporary 100,000 – 110,000 GT cruise ships which displace only around 50,000 tons. Similarly, the Cunard Line's RMS Queen Mary and RMS Queen Elizabeth, of approximately 81,000 – 83,000 GT, but displacements of over 80,000 tons, do not differ significantly in displacement from their new 148,528 GT successor, RMS Queen Mary 2, which has been estimated to displace approximately 76,000 tons. With the completion in 2009 of Oasis of the Seas, the first of the Oasis Class ships, the Cunard Queens of the 1930s have clearly been passed in displacement, as the Oasis vessels were projected to displace about 100,000 tons.

However, by the conventional and historical measure of gross tonnage, there has been a recent dramatic increase in the size of the largest new ships. The Oasis of the Seasmeasures over 225,000 GT, over twice as large as the largest cruise ships of the late 1990s.

3.4 Specialised Vessels

Specialised vessels are those vessels that have onboard machinery and equipments to perform various tasks related to marine industry. Specialised marine vessels include Anchor Handling Tug Supply Vessels, Drilling Vessels, Well Intervention Vessels, Ice Breaking Vessels, Cable Laying

Vessels, Well Testing Services Vessels, Field Support Vessels, Seismic Vessels, and Fire Fighting Vessels to name a few.

3.4.1 Anchor Handling Tug Supply Vessels

Anchor Handling Tug Supply (AHTS) vessels are designed and equipped for anchor handling and towing operations. They are also used for rescue purposes in emergency cases.

Anchor Handling Tug Supply Vessel

3.4.2 Cable Laying Vessels

Cable laying vessels are used to lay cables on the bed of ocean floors for telecommunications, power transmissions and other purposes. These vessels are deep-sea marine vessels..

Cablelayer

3.4.3 Drilling Vessels

Drilling vessels or drillships are marine vessels used for offshore drilling purposes. They are fitted with drilling apparatus and are primarily used for exploratory offshore drilling. It can also be used as a platform to perform tasks related to oil well maintenance or completion work such as casing and tubing installation, or subsea tree installation.

Drillship

3.4.4 Fire Fighting Vessels

As the name suggests, firefighting vessels are used for extinguishing fire on ships. They are also used in shore-based firefighting operations.

3.4.5 Ice Breaking Vessels

As the name suggests, Ice Breaking Vessels are specially designed to move and navigate through ice-covered water and are used to make way for other marine vessels. They have a spoon-shaped bow portion to break the ice on its way.

Icebreaker

3.4.6 Pipelaying vessel

A pipelaying vessel or pipelayer is a ship used in the construction of subsea infrastructure. It is used to lay pipes on the sea bed to connect oil(or gas) production platforms with refineries on shore.

Pipelayer

3.4.7 Seismic Vessels

Seismic vessels are vessels used for the purpose of seismic studies deep inside oceans. The ship is used as a survey vessel to explore and locate best potential areas for oil drilling in the oceans.

Seismic ship

3.4.8 Tugboat

A tugboat (tug) is a boat that moves ships by towing or pushing them. Tugs move vessels that either should not move themselves, such as ships in ports or in narrow canals, or those that cannot move by themselves, such as disabled ships, barges or oil platforms. Tugs are small strongly built ships with very powerful engines, and some are ocean-going.

3.4.9 Well Intervention Vessels

These vessels are used for subsea well intervention purposes. These interventions are commonly executed from light/medium intervention vessels.

Well Intervention Vessel

Offshore Vessels are specially designed ships for transporting goods and personnel to offshore oil platform that operate deep in oceans. The size of these vessels ranges between 20 meters and 100 meters. They are good at accomplishing a variety of tasks in the supply chain. The category may include Platform Supply Vessels (PSV), offshore barges, and all types of specialty vessels including Anchor Handling Vessels, Drilling Vessels, Well Intervention Vessels, Ice Breaking Vessels, Cable Laying Vessels, Seismic Vessels, and Fire Fighting Vessels.

3.4.10 Construction Support Vessels(CSV)

Construction support vessels or CSVs are used to support complex offshore construction, installation, maintenance and other sophisticated operations. CSV's are significantly larger and more specialised than other offshore vessels.

Construction Support Vessels

3.4.11 Crane vessel

A crane vessel, floating crane or crane ship is a ship equipped with large crane specialised in lifting heavy loads. The largest crane vessels are used for offshore construction. Because of their increased stability catamaran or semi-submersible types are often used, but also, conventional mono hulls are used too.

Crane vessel

3.4.12 Diving support vessel(DSV)

A diving support vessel is a ship used as a floating base for professional diving projects which are often performed around oil platforms and related installations in open water.

Diving support vessel

3.4.13 Offshore Barges

Offshore barges are used for a wide range of marine tasks. They can be equipped with heavy lifting cranes, firefighting system, or can be used for pipe laying (Derrick Barge), or even can serve as an offshore accommodation to personnel.

Offshore barge

3.4.14 Platform Supply Vessels

As the name suggests, **Platform Supply Vessels (PSV)** are used to carry crew and supplies to the oil platform deep inside oceans, and bring cargo and personnel back to shore. Their size varies from small 20 meter long ship to 100 meters large ship. These vessels are designed to transport a wide range of cargo such as drilling fluids, cement, mud, and fuel in tanks beneath the deck. The open deck on PSVs is normally used to carry other materials like casing, drill pipe, tubing and miscellaneous deck cargo to and from offshore platforms. Platform Supply Vessels are often equipped with firefighting equipments to deal with emergency situations.

Platform Supply Vessel

3.4.15 Safety Standby Vessels (SSBV)

Safety Standby Vessels are used to "protect" offshore installations from wandering vessels, also they are used as a safety vessel in case of emergency for quick evacuation.

Safety Standby Vessels

3.4.16 Roll on/Roll off ships

Roll-on/roll-off (RORO or ro-ro) ships are vessels designed to carry wheeled cargo, such as automobiles, trucks, semi-trailer trucks, trailers, and railroad cars, that are driven on and off the ship on their own wheels or using a platform vehicle, such as a self-propelled modular transporter. This is in contrast to lift-on/lift-off (LoLo) vessels, which use acrane to load and unload cargo.

RORO vessels have built-in ramps that allow the cargo to be efficiently rolled on and off the vessel when in port. While smaller ferries that operate across rivers and other short distances often have built-in ramps, the term RORO is generally reserved for large oceangoing vessels. The ramps and doors may be stern-only, or bow and stern for quick loading.

3.4.17 Types of Rollon/Rolloff Vessels

Types of RORO vessels include ferries, cruiseferries, cargo ships, barges, and RoRo service for air deliveries. New automobiles that are transported by ship are often moved on a large type of RORO called a pure car carrier (PCC) or pure car/truck carrier (PCTC).

Elsewhere in the shipping industry, cargo is normally measured by the metric tonne, but RORO cargo is typically measured in *lanes in metres* (LIMs). This is calculated by multiplying the cargo length in metres by the number of decks and by its width in lanes (lane width differs from vessel to vessel, and there are several industry standards). On PCCs, cargo capacity is often measured in RT or RT43 units (based on a 1966 Toyota Corona) or in car-equivalent units (CEU).

The largest RORO passenger ferry is MS *Color Magic*, a 75,100 GT cruise ferry that entered service in September 2007 for Color Line. Built in Finland by Aker Finnyards, it is 223.70 m (733 ft 11 in) long and 35 m (114 ft 10 in) wide, and can carry 550 cars, or 1270 lane meters of cargo.[19]

The RORO passenger ferry with the greatest car-carrying capacity is the *Ulysses* (named after a novel by James Joyce), owned by Irish Ferries. The *Ulysses* entered service on 25 March 2001

and operates between Dublin and Holyhead. The 50,938 GT ship is 209.02 m (685 ft 9 in) long and 31.84 m (104 ft 6 in) wide, and can carry 1342 cars/4101 lane meters of cargo.[20]

3.4.18 Car Carriers

The first cargo ships specially fitted for the transport of large quantities of cars came into service in the early sixties. These ships still had their own loading gear and so-called hanging decks inside. They were, for example, chartered by the German Volkswagen AG to transport vehicles in the U.S. and Canada. Since 1970, the market for exporting and importing cars has increased dramatically and the number and type of ROROs has increased also. In 1973, Japan's K Line built the *European Highway*, the first pure car carrier (PCC), which carried 4,200 automobiles. Today's pure car carriers and their close cousins, the pure car/truck carrier (PCTC), are distinctive ships with a box-like superstructure running the entire length and breadth of the hull, fully enclosing the cargo. They typically have a stern ramp and a side ramp for dual loading of thousands of vehicles (such as cars, trucks, heavy machineries, tracked units, Mafi trailers, and loose statics), and extensive automatic fire control systems.

The PCTC has liftable decks to increase vertical clearance, as well as heavier decks for "high-and-heavy" cargo. A 6,500-unit car ship, with 12 decks, can have three decks which can take cargo up to 150 short tons (136 t; 134 long tons) with liftable panels to increase clearance from 1.7 to 6.7 m (5 ft 7 in to 22 ft 0 in) on some decks. Lifting decks to accommodate higher cargo reduces the total capacity.

These kinds of vessels perform a usual speed of 16 knots at eco-speed, while at full speed can achieve more than 19 knots.

With the building of Wallenius Wilhelmsen Logistics's 8,000-CEU car carrier *Faust* out of Stockholm in June 2007 car carriers entered a new era of the large car and truck carrier (LCTC).[21] Currently, the largest are Wilh. Wilhelmsen's "Mark V" ships, led by MV *Tønsberg*.

The car carrier *Auriga Leader*, built in 2008 with a capacity of 6,200 cars, is the world's first partially solar powered ship.

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