HOW IT WORKS

THE

SHIP

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Conquering the waves

- Primitive man rides a log
- A hollowed log
- Catamaran
- Floating basket
- Sailing ship
- Sailing boat
- Steamship
- Steamboat
The dock is flooded. The gates, opened. And 'down the ways' she goes to be lifted away by the sea. Suddenly, this mighty structure, weighing 2,73,000 tons, appears as fragile and light as the tiny paper boat you launched in your bucket that morning!

Conquering the most terrifying of the elements—water—was one of man's greatest desires. He had to find a way to overcome those turbulent waves. And that he did.

Thousands of years ago, man discovered that he could ride the waters on a simple log. A tree trunk was sufficient for his needs, but only if it was not overcrowded with branches.

Later he tried to improve upon the log and make it more comfortable. So he hollowed it out and made a kind of seat for himself. This turned out to be much safer. Gradually, he learnt that if you tied several logs together, you could get more stability. And that was how the raft came to be.

Soon a variety of floating platforms or crafts came to be used in different parts of the world. In fact, certain specimens of ancient Indian vessels can be seen even today on the Tungabhadra river in the South, and on the Ganga. These vary from the 'kattumaram' (catamaran) which means 'logs tied together' to the 'harigolu' (coracles) which are floating baskets made of buffalo hide, and 'oolaks' which are big boats with chains and balconies.

A peep into Indian art and literature reveals many more representations of the ships that were used those days. The earliest example is the vessel portrayed on a seal excavated at Mohenjo-daro, now in
Pakistan. It depicts a ship with a sharply upturned prow and stern.

Marco Polo, the great Venetian traveller who visited India in the 13th century, speaks of ships so large as to need a crew of 300 men!

How a ship stays on the water

Seeing a ship cruising on the sea, with not a care in the world, one would think that it is the most natural thing for it to be there. Yet, many of you must have wondered how this ship, weighing thousands of tons, stays on the water?

When we play around with water and splash it on our faces, we feel it is so light and inconsequential that we hardly give it a thought. But water, especially as a mass, is a force to be reckoned with.

If you were to fill a bucket with water and press your palm into it, you will realize immediately that there is a certain density and upward force pushing against your hand. That is the natural force of water. So you can imagine (or perhaps you can’t!)
the kind of force and density an entire ocean would contain.

Yet some things float on water and some sink. What is the reason for this?

The secret lies in 'displacement'. According to Archimedes Principle, 'a body which is wholly or partly immersed in a fluid undergoes a loss in weight equal to the weight of the fluid which it displaces'.

To understand this better, get hold of a large stone, which is not too easy to lift. Put it into a bucket of water. Now lift the stone out of the water. You will notice at once, how much easier it is to pick up the stone while it is in the water.

This shows that whenever something is in the water, the water helps to hold it up or support it and thus makes it seem less heavy.

If you repeat this experiment slowly, you will notice that as more and more of the stone is lifted out of the water, it gets heavier. This is because the upward push of the water depends on how much of the stone is below the surface. The upward push is greatest when the stone is completely underwater.

When part of the stone is underwater, it takes the place of some water. We say that it displaces this water. The upward push of the water on the stone depends on how
much water it has displaced. If it is large enough, the upward push will support that object completely and it will float. Even if something is very heavy, it will still float if enough water is displaced.

However, the size and the weight of the object do not always tally. That is, the weight of the water displaced by an object is not always equal to its own weight. If the object is large, for instance, it can displace a volume of water the weight of which may be greater than itself. In that case, the object will float on the water. But if the opposite happens, that is, the object displaces a volume of water that weighs less than itself, then down, down, down it will go. For example, if you take a sheet of foil and place it in a bucket filled with water, it will float. On the contrary, if you crush it into a ball and then place it on the water, it will go down immediately.

So, it appears that, the only way an object can float is if the weight of the water displaced is equal to or greater than its own weight. Now you know why big, fat people can float easily. It is all a matter of displacement! They displace more water than thin people.

Similarly, a ship is designed so that the weight of the water it displaces can support it and keep it afloat. In fact, the size of a ship is often expressed in terms of its displacement (or weight) in tons.
Sailing ships

With growing powers of reasoning, by accident and experiment, man evolved better methods for voyaging across the rivers and the seas.

The discovery of the sail was almost as revolutionary as the idea of floating on the waters at all.

Sailing ships used the power of the wind to propel them in any direction, no matter which quarter the wind blew from. These ships had a sail that could be shifted around the boat’s mast to engage the wind at various angles. The wind inflated the sail, curving it so that the sail became an aerofoil producing a suction force that helped the ship to move forward.

Some remarkable sailing ships were built by the ancient Greeks and Romans. The Norsemen, in later years known and dreaded as the Vikings, in fact, built some magnificent ships capable of carrying people to England and other countries of western Europe. Villagers living along the coast of northern Europe at that time dreaded the sight of a large square sail on the horizon. For, it meant the arrival of Vikings, who plundered settlements and slaughtered people.

By the 15th century, when Columbus crossed the Atlantic on the SANTA MARIA...
from Spain, and Vasco da Gama fought his way round the Cape of Good Hope to India on the *São Gabriel*, ships were thoroughly seaworthy and could sail reasonably close to the wind. In fact, Vasco da Gama's flagship landed at Calicut on May 27, 1498, after a voyage of more than ten months from Portugal!

It was during the reign of Elizabeth I (1558–1603) in England, that scientific minds were brought to bear upon the making of ships. It was decided that a really seaworthy ship that was sturdy, safe and yet not difficult to control, needed to be designed. Thus, these ‘low-charged’ ships were constructed. And it was these ships that defeated the Spanish Armada and which, by their hardiness, were able to trade in every corner of the world. By that time, the single sail on each mast had developed into a set of three.

A later evolved the 18th and the early 19th century ‘East Indiamen’. These were fine sailing ships which could carry a big cargo and a number of passengers, with sufficient guns to defend themselves against enemies. Yet these were still restricted in length and size because they were built entirely of wood. Also they were at the mercy of the wind which would leave them quite motionless for days on end.
Steamships

Some ingenious people got together and tried to evolve the steam engine, which would enable the ship to move ahead even if there was no wind.

A steam engine utilized the energy contained in steam under high pressure. The energy that was released when the steam expanded was produced to make rotary motion that drove the machines.

By the later 18th century, as soon as Newcomen and Watt had made the steam engine successful on land, experimenters began trying to make it drive ships.

The first efficient steamboat, the Clermont, was built by an American inventor, Robert Fulton. Launched on the Hudson river, it was the first commercially successful

In about A.D. 1100, the Chinese found that if a piece of magnetic iron-ore was suspended freely by a string, it would always point north-south. Some enterprising Indian sailors picked up this knowledge and made the 'matsyayantra'—that is, a thin leaf of magnetic iron cut in the shape of a fish and kept afloat on oil. This fish, unlike live ones, pointed north-south constantly and was used on the high seas to determine the direction the ship was taking. This, in fact, was the beginning of the mariner's compass—probably the first navigational aid that came into being.
The experimental period was over.

For a long time after, ships continued to have sails along with engines just in case the engines were to break down. Most of them were also built of wood. But in 1843, Isambard Kingdom Brunel designed the **Great Britain** which was not only built of iron but was driven by a screw propeller.

As ships became bigger, it was necessary to fit them with two propellers (or twin screws) in order to reduce the chance of breaking the propeller shaft. Later, triple and quadruple screw ships were built.

By 1940, a steamship could make at least six trips between America and Europe.
Meanwhile, Charles Parsons (1854–1931), an inventor, demonstrated that the effect of steam on a series of blades attached to a shaft would cause it to turn round.

Parsons tried this in a small vessel which he called Turbinia, and drew attention to her by racing up and down the lines of warships at Queen Victoria’s Diamond Jubilee naval review in 1897. The vessel naturally attracted plenty of attention and the Admiralty was forced to try the turbine in the fastest destroyers. It also proved most successful in very fast cross-channel steamers. But when it came to ships of moderate speed, it was most uneconomical. That difficulty was not overcome until cogwheels (wheels with projections) of different sizes were made to reduce the speed to the necessary low level. All turbine ships now have the engine speed thus geared down.

Then came the internal combustion engine usually called the diesel. At first, the
The first practical submarine was a rowboat covered with greased leather. It was the idea of Cornelius Van Drebbel, a Dutch doctor living in England in 1620. This was powered by 12 rowers pulling by oars that protruded through sealed ports in the hull. Snorkels or air tubes were held above the surface by floats, thus permitting diesel to be used only for the slower ships, but now it is sometimes installed in ships of over 20 knots speed (about 32 km per hour).

Nuclear power for ship propulsion is developing fast. Its greatest advantage is the infrequent need to refuel, which is why it is being used more by warships than by merchant vessels.

At the beginning of the 20th century, the most important type of warship was the armoured battleship. After that the aircraft carrier took its place. Now the submarine has become the equivalent of the battleship. This is a ship that can run both on and below the surface of the sea and can remain stationary underwater for a long period of time. A submarine is the best vessel to launch torpedo attacks.

A nuclear-powered submarine can operate not only underwater but under ice as well for days on end, at speeds never possible on the surface.
the boat to submerge.

Unlike a ship, the buoyancy of a submarine can be controlled, thus allowing it to sink and surface at will. To control the submarine, a ballast tank is used that can be alternately filled with water or air. When the submarine is on the surface, the ballast tanks are filled with air. The density of the submarine is then less than that of the surrounding water. As the submarine dives, the ballast tanks are filled with water and air is let out, thereby increasing its overall density. Thus the submarine begins to sink.

When the submarine intends to surface, the compressed air flows from the air flasks into the ballast tank and throws out the water till the density of the submarine is less than the surrounding water. Thus the submarine rises. In an emergency, ballast tanks can be quickly filled with high pressure air so as to make the submarine rise to the surface quickly.

Nowadays, we have submarines which are powered by nuclear reactors which produce heat to generate steam for the turbine. The turbine directly drives the propellers as well as the electric generators.
The Hovercrafts are another modern and successful invention of the twentieth century. It was invented by Christopher Cockerell in 1956.

A Hovercraft is usually described as an air cushion vehicle or ground effect vehicle. It can travel on land as well as water. A hovercraft consists of a body or a hull in which a rotor is fixed in a way that it creates an air cushion on which the craft is supported. Thus there is no contact between the craft and the ground and no friction to overcome.

FastShip

Even in fair weather, ships battle waves of their own making. As a ship moves through, it displaces water and creates waves. The faster it moves, the larger these disturbances become and merge into a single wave called the captive wave. A captive wave can present serious problem as it creates additional drag, thus making the stern of the ship sink. Hence, a few marine engineers got together and created a fast moving ship, 'FastShip', with advanced hull design and propulsion technology, and an innovative loading
Ancient Indians built some of the largest ships of the time and sailed to distant lands including Thailand and China. We hear of brisk sea-borne trade between Rome and India during the first century A.D. Ancient books and records mention a large number of these ports, some of which continue to be in use even today. Muziris (now Cranganore) in Kerala is one such port. It had ships coming in with cargo from Arabia, Greece and Rome. According to some ancient Tamil books, Yavanas (a name for Greeks and Romans) paid in gold at this port in exchange for pepper and other products. Their great skill in navigation took Indians to many lands carrying trade and culture.

The FastShip can transport cargo across the North Atlantic in five to seven days, whereas conventional freighters take anywhere between 14 to 35 days to do the same job.

Produced by FastShips Atlantic, the ship's top speed will be around 43 knots (about 50 miles per hour). Each vessel will be powered by five Rolls-Royce marine Trent engines—the most powerful gas turbine propulsion unit available to the ship operators as against the earlier diesel engine.
sea routes for trade and communication with the rest of the world. Vital sea links, therefore, emerged over a period of time for the exchange of trade, commerce and culture. Historians and scholars have traced our associations with the sea way back to the Harappan culture, around 3000 B.C.

The first Indian steamboat was built in 1819 by an Englishman for Ghazi-ud-Din Haider, the Nawab of Oudh. In 1919, two very enterprising Indians, Narottam Morarjee and Walchand Hirachand, started the Scindia Steam Navigation Company. On April 5, 1919, the company's first ship, S.S. Loyalty, left from Bombay to the United Kingdom carrying passengers and cargo.

The first ocean-going modern ship built in India was launched in 1948 by Pandit Jawaharlal Nehru. The launching site was the Scindia Shipbuilding Yard in Vishakhapatnam, now known as the Hindustan Shipyard. She was a general cargo steamship of 8000 dw tons and was employed in coastal trade.

The Indian Marine was formed in 1613 in England for the protection of the East India Company's ships and trade. The company established its first trading centre at Surat and expanded further. The Indian Marine, therefore, continued to grow with an increasing number of ships. By 1735, a full-fledged shipbuilding dockyard was established and named Bombay Dockyard. The Indian Marine thereafter acquired the name Bombay Marine. Early in the twentieth century, Bombay Marine was renamed 'The Royal Indian Marine'.
In 1950, when India became a Republic, the term 'Royal' was dropped and the name was changed to just Indian Navy. Now the Indian fleet numbers over 100 combat naval vessels, of which 15 are submarines, two are aircraft carriers, and another 23 are destroyers and fast frigates. A total of ten diesel-powered 'Project 877' submarines, known as the Sindhu class, are equipped with the antiship cruise missiles with a range of 220 km.

India has a number of foreign-produced cruise missile systems in its arsenal, such as Exocet, Styx, Starbright, Sea Eagle and so on. It also has some indigenous cruise missile systems under development, such as the Sagarika and the Lakshya variant.

Around 130 A.D. the first map of the lands and seas then known was produced. It included latitudes and longitudes and its creator was the astronomer, mathematician and geographer Ptolemy.

India has been working since 1985 to develop an indigenously constructed nuclear-powered submarine, one that is based on the Soviet Charlie II-class design. The Indian nuclear-powered attack submarine design is said to have a 4,000 ton displacement and a single-shaft nuclear power plant of Indian origin. Once the vessel is completed, it may be equipped with Danush or Sagarika cruise missiles and an advanced sonar system.
The ship is divided into two main parts—fore or front part and aft or hind part. Between these is the engine.

In the old-fashioned steamships, the boiler and engines were exactly in the middle, with one or more funnels jutting out and spewing heavy, dark smoke from the boiler. The engine in a motor ship, however, is not in the middle but more towards aft.

A motor ship gives off only a little smoke. But it too has a big funnel, mainly to give it a balanced appearance. There are several compartments inside the funnel.

A ship's engine looks extremely impressive. It covers almost a third of its height and its entire width. In the earlier days, many hands were required in the engine room for cleaning, repairing and fitting parts. Today's diesel engines, however, are highly automated and controlled. They are operated by push buttons and some are so sophisticated that no one needs to remain permanently in the engine room.

Above the engine is the superstructure. This consists of a number of rooms including the wheelhouse, navigation room, wireless room and so on. In the large passenger liners, the superstructure may also include sports decks and sun decks. The captain and his officers have their
open-mouthed, hollow, hockeystick-like projections. These are air vents, which allow the hot and foul air in the hatches and under-decks to escape.

Every ship carries a port and a starboard anchor in its bows. An anchor is a heavy metal piece, weighing several tons, with two hook-like arms at one end. When the captain orders ‘drop anchor’, the anchor is dropped into the sea at the end of a long anchor cable. The flukes (hooks) dig into the seabed and prevent the ship from drifting away. When he orders ‘weigh anchor’, a powerful steam winch (hoisting machine) pulls in the heavy cables and the ship moves again. Anchors can be of different weights and sizes. Some warships carry as many as eight anchors.

cabins here. It is also the place where the most sensitive equipment is housed. In the centre of the superstructure stands the ship’s navigating bridge, the top of which might carry the radar antenna.

On the deck are square or rectangular holes called hatches. These are closed watertight by hatch-covers. When the hatch-covers are opened, one can see right into the holds, where the cargo is stowed. The ship’s front end has a raised platform called the forecastle. At the tip of this is the jackstaff to fly the ship’s flag.

Also, at several points on the deck, are
At sea

When we say someone is 'at sea', we imply that someone is totally lost or perplexed. But when a ship is at sea, well, that can be dangerous! That is why sailors need navigating instruments to help them steer and position their ship in the required direction.

The most essential instrument for navigation is the compass. In the past, ships used a special kind of magnetic compass called a mariner's compass. It was designed so that the ship's motion would affect it as little as possible. Modern ships have a very accurate

Other ships

Most ships are powered by some kind of steam engine, but motor ships are powered by diesel. This is the kind of engine that is widely used for heavy lorries and buses on land, called the internal combustion engine, because it burns its fuel inside the cylinders of the engine itself.

In diesel-electric ships, a diesel engine turns an electric generator and the electricity produced is used to power electric motors which turn the propellers. The latest submarines and a few surface ships use the heat from a nuclear reactor. The 'fuel' used in the reactor is a rare metal called uranium.
gyrocompass, which contains a rapidly spinning gyroscope wheel. It is completely unaffected by the movement of the ship.

The navigator can find the ship's estimated position at any time by plotting on a chart the distance and the direction the ship has travelled. He knows the direction from the ship's compass. He calculates the distance by means of the ship's log which is a device for measuring the speed and the distance travelled.

Navigators frequently check their correct position by observing the position of the heavenly bodies in the sky—the sun during the day and the stars and planets at night. This is called celestial navigation. The navigator observes the direction of several stars and the angle they make with the horizon. For this, he uses an instrument known as the sextant, which gives the altitude of the heavenly body above the horizon. By consulting a book of tables called the nautical almanac, and a very accurate clock, or chronometer, he can calculate how far he is from the so-called earthly position of each star at any time. He draws lines of position based on each star ‘fix’, and the point where they intersect gives the ship’s exact position.

Today, electronic methods of navigation are being increasingly used. Ships have radio direction-finders, which ‘fix’ on
lighthouses. By obtaining ‘fixes’ from two such beacons, the navigator can find his exact position.

Radar is another valuable navigational aid. It shows the ship’s position in relation to other ships in the area. It is especially used in foggy, stormy weather or at night. This electronic device sends out radio waves. When they hit an object, they are reflected back as an echo. The echo shows up on a radar screen, which is very much like a TV screen, as a visible dash or ‘blip’. The distance and the direction of the object can be calculated from the position of the blip on the screen.

### Depth of the ocean

The echo-sounder, which indicates what depth of water lies beneath the vessel, is essential for coastal and shallow water navigation. This is a device in the keel (bottom) of the vessel which transmits sound waves down into the water and receives back the echo as these waves are reflected from the seabed. The time the echo takes to return is an indication of the depth of water at that point. The depth is recorded on a chart or on a dial in the wheelhouse on the bridge.
When a ship berths

Surprisingly, it is only when a ship enters the shallow waters of estuaries, rivers and other port approaches that she is most vulnerable and not when she is far out in the deep ocean. Unless of course, a hurricane strikes!

To take these ships through their last difficult journey, a pilot comes aboard. He, from long experience and intense training, knows the waters and approaches of the port where he is based. He is familiar with the currents and tides, with hazards such as rocks, reefs and the hidden shape of the sea. He also knows best the shape and design of the ship.

If the ship is sailing light (unladen), the pilot has to allow for the way in which the wind and the tide will swing her about. Fifty feet this way or that may put the ship aground and might even break her back. It is an exacting profession, calling for the utmost concentration and nerve.
The call of the sea

Many of us tend to think mainly in terms of aircraft as the essence of scientific progress. But there are immensely exciting possibilities in the realm of naval architecture and marine engineering too.

Partly because of this challenge and also because of the beauty and wildness of the sea itself, life on a ship has a unique attraction.

There is a shade of adventure in the timeless and rhythmical movement of the water; sparkling in the sun, mysterious at night; its mood forever changing.

That is why perhaps it is said of the sea—'only those that brave its dangers comprehend its mystery!'
This book, one of a series of information books, introduces the child to the ship—how it works and how it has developed.

Others in this series include:

- The Television
- The Telephone
- The Motor Car
- The Aeroplane
- The Clock
- The Railway Train
- The Computer

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