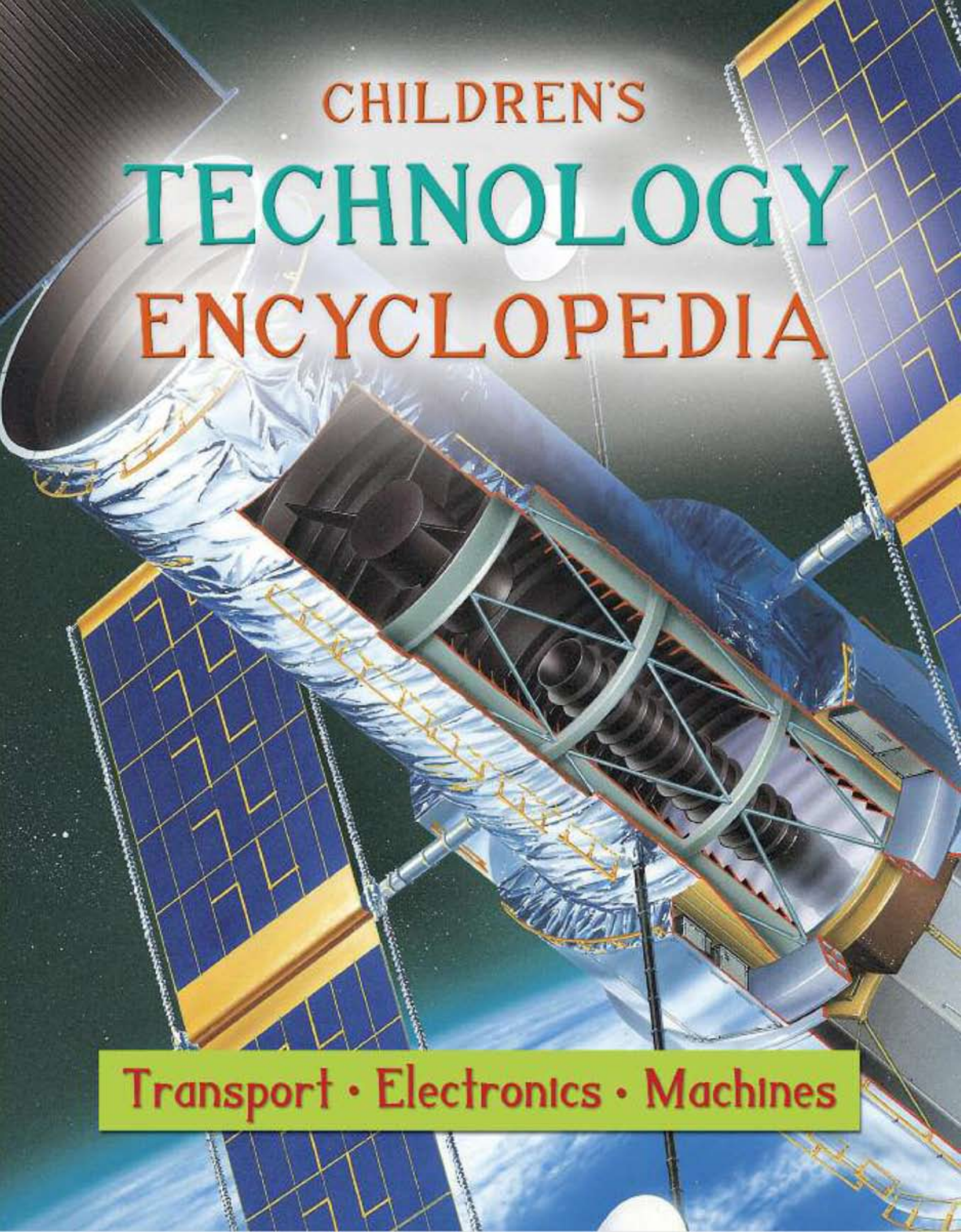
CHILDREN'S
TECHNOLOGY
ENCYCLOPEDIA
Transport • Electronics • Machines

CHILDREN'S

TECHNOLOGY ENCYCLOPEDIA

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Orpheus

Created and produced by Nicholas Harris, Sarah Hartley, Katie Sexton, Ruth Symons and Erica Williams, Orpheus Books Ltd

Illustrators Susanna Addario, Ferrucchio Cucchiarini, Giuliano Fornari, Mike Fuller, Tim Hutchinson Alessandro Rabatti, Sebastian Quigley, Claudia Saraceni, Ivan Stalio, Thomas Trojer, Martin Woodward

Consultant Steve Parker

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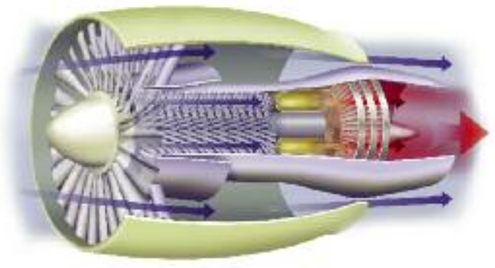
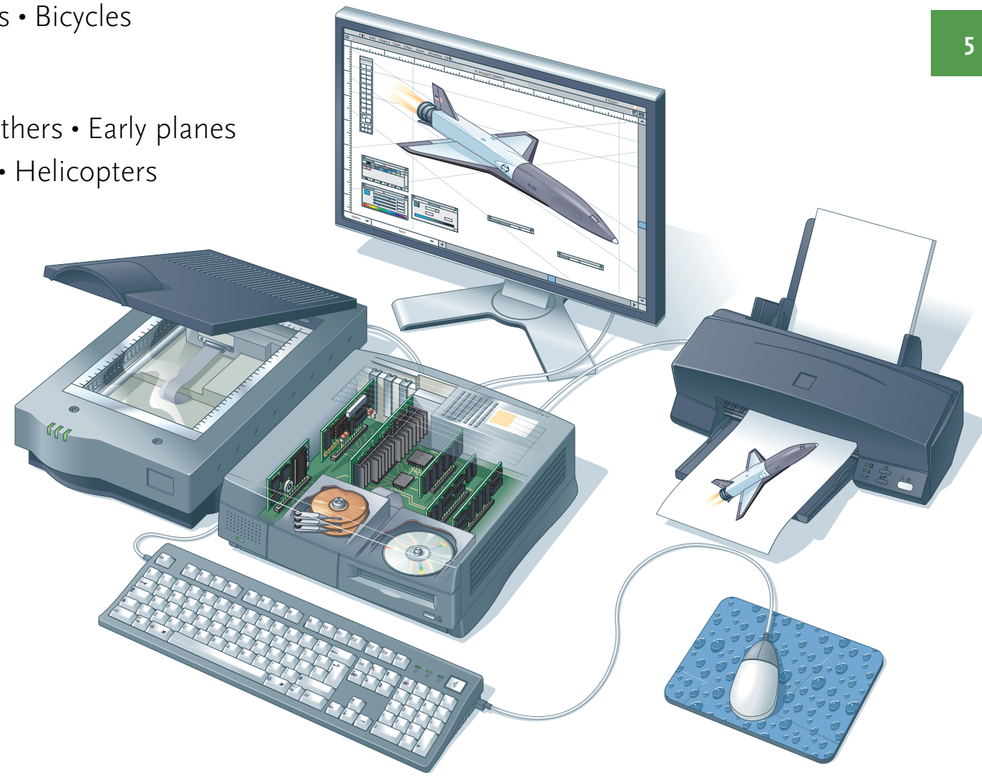
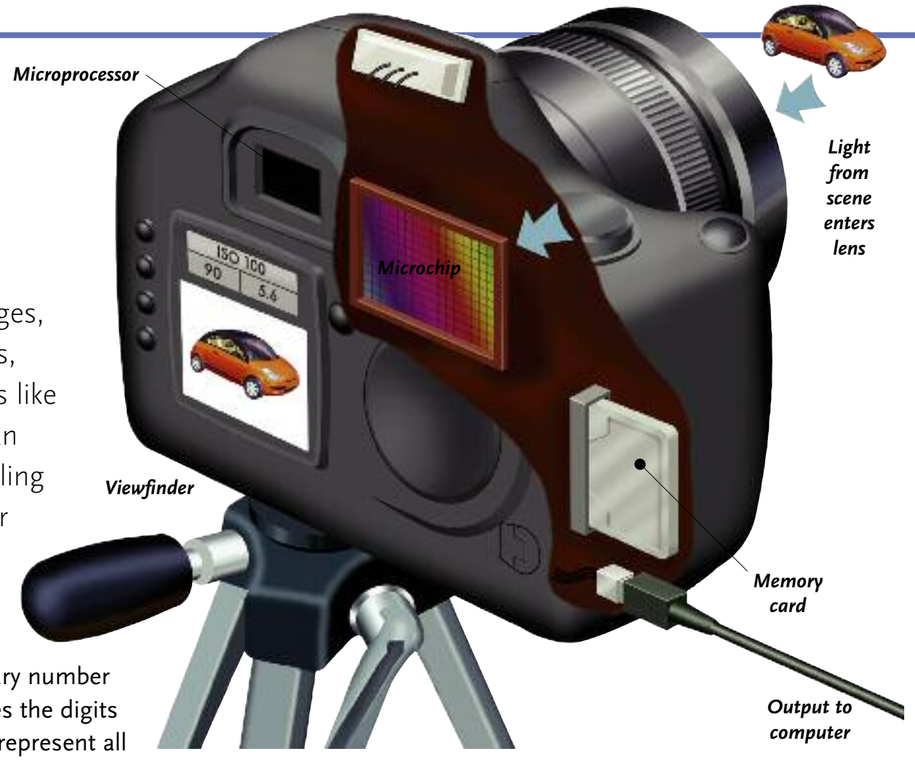




DIGITAL TECHNOLOGY

ALMOST any sort of information, from simple words to complex moving images, can be turned into a series of numbers, represented by the digits 0 and 1. The series is like a code. Coded information can be stored on an electronic circuit inside a computer by controlling the flow of electricity (0 is for "off" and 1 is for "on") through it.

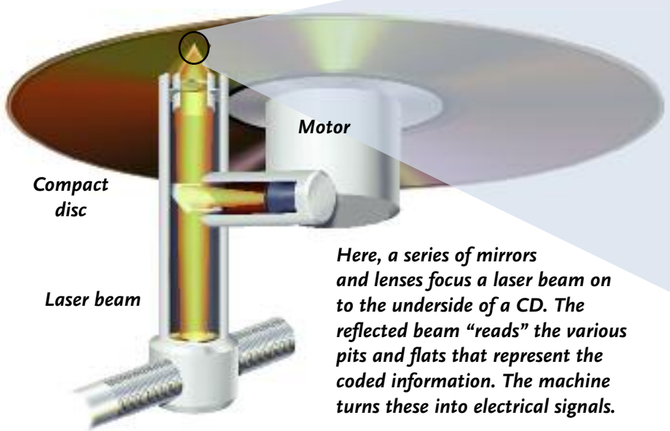


A digital camera is a camera in which photographs are stored electronically in digital form rather than on traditional film. Light from a scene is let into the camera when the shutter opens. The lens focuses the light on to a special microchip, called a charge-coupled device (CCD). This divides the image into pixels, measures the brightness and colour of each one, and digitizes the readings. The digitized image is stored in memory chips or on a disc. The photographs are transferred to a computer. Here they can be viewed on screen, edited, added to documents, used to make greetings cards, or attached to emails.

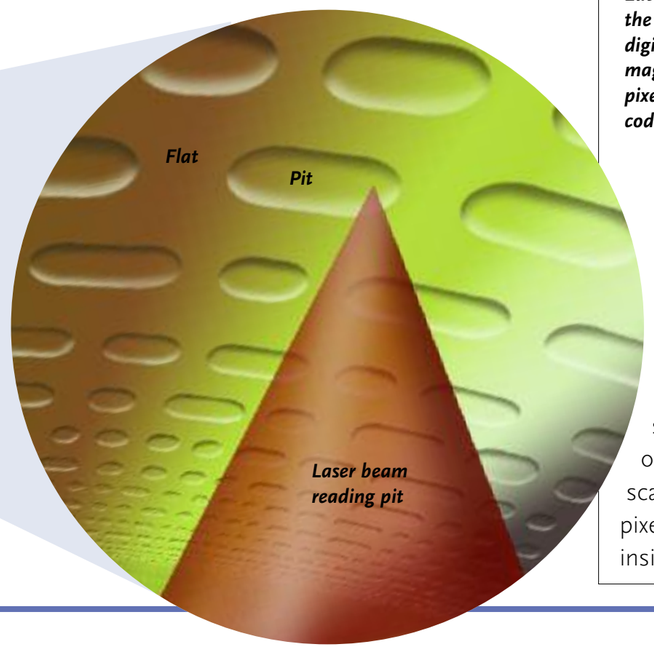
16	8	4	2	1	
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16

The binary number system uses the digits 0 and 1 to represent all numbers. In the binary system, 0 and 1 represent ones, twos, fours, eights, and so on. The binary "word" 1101, for example, represents the number 13 (one 8, one 4, no 2s and one 1). In digital circuits, each 0 or 1 is called a bit. So 13 is represented by the four-bit "word" 1101, its digital code.

Information can be recorded in digital form on a compact disc (CD). Sounds, images, video or text are turned into a series of digital codes. These are stored on the disc as a series of pits and flats. The disc is "read" by a laser beam.



Here, a series of mirrors and lenses focus a laser beam on to the underside of a CD. The reflected beam "reads" the various pits and flats that represent the coded information. The machine turns these into electrical signals.

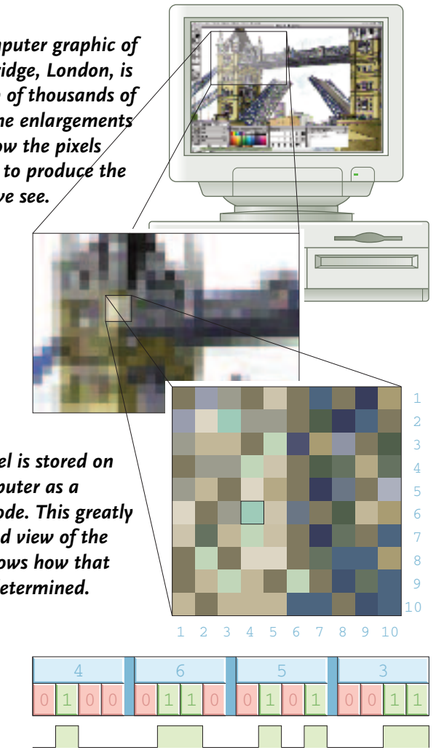


PIXELS

ANYTHING that appears on a computer's monitor is called computer graphics. They are made up of small coloured squares called pixels (short for picture elements) in a grid pattern. The concentration of pixels in a picture is called resolution. High-resolution (hi-res) graphics are viewed without the pixels being visible. Graphics can have a different range of colours, too. In eight-bit graphics, each pixel is represented by eight bits, and can be any one of 256 colours.

This computer graphic of Tower Bridge, London, is made up of thousands of pixels. The enlargements reveal how the pixels combine to produce the picture we see.

Each pixel is stored on the computer as a digital code. This greatly magnified view of the pixels shows how that code is determined.

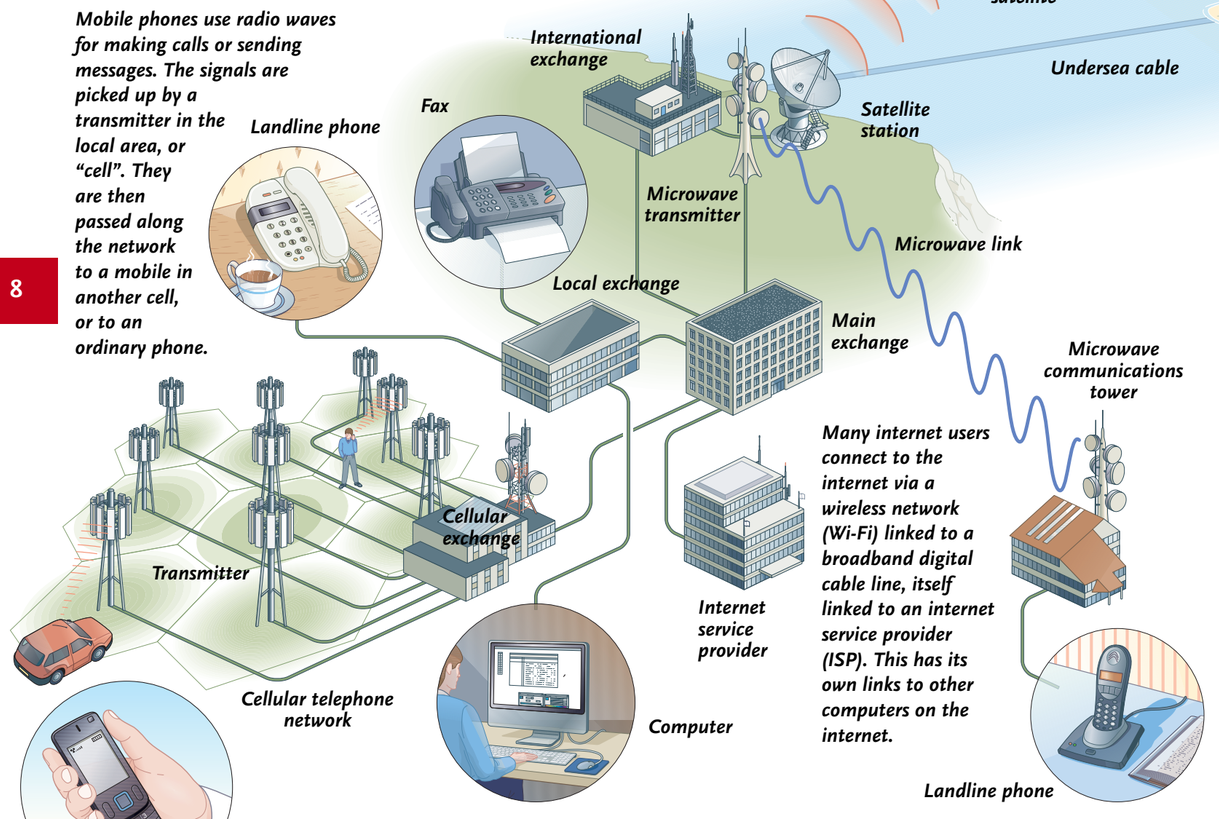


Each pixel has a position, colour and brightness, which exist as binary codes in the computer. This pixel is 4 units across, 6 down, so its position code is 4, 6. Its colour, a shade of green, is coded 5, and its brightness is 3 on a scale of 1 to 10. Its code is therefore 4653. The pixel code is stored as a binary number, which, inside the computer, exists as electrical signals.

NETWORKS

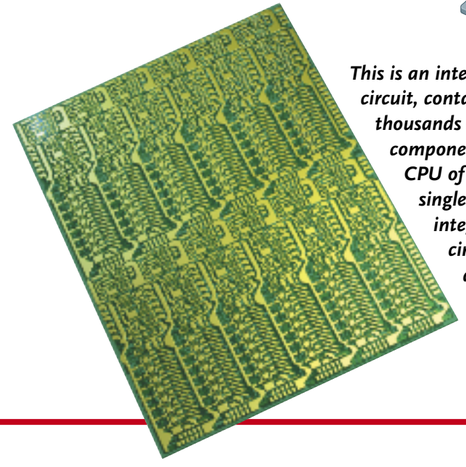
TELEPHONE calls, text messages, emails and computer data—and often radio and television signals as well—travel through a vast communications network. They are all turned into electrical signals that can travel from point to point. A network may be made up of telephone lines, cables, and radio and satellite links.

▶ There are several different ways of linking telephone exchanges on a network together. Some links are underground cables. Some links are made with microwave radio. International links across oceans are made via satellites or through cables stretched across the sea bed.



▲ All telecommunications devices, including phones and home computers, that are connected to telephone lines are linked to a local telephone exchange. Each line has its own unique telephone number which the exchange uses to find it. All the local exchanges are linked to a main exchange, which is linked to others to form a national network. Also linked to it are special exchanges for mobile telephones, and internet service providers.

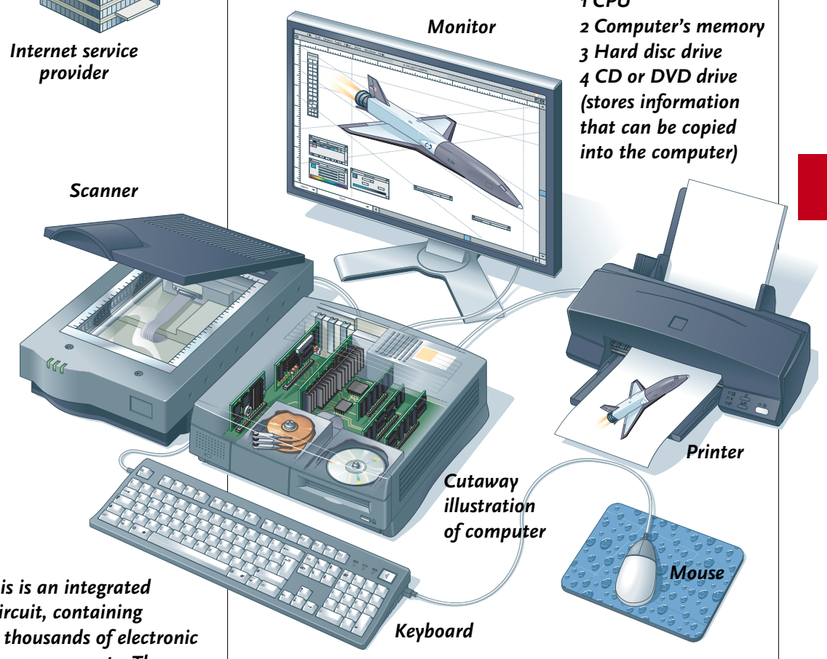
◀ The internet is a giant network that links together hundreds of millions of computers all around the world. Information (text, pictures, video clips, etc.) travels almost instantly between any computer along links in the network to any other user. People access the internet to send and receive emails and to use the World Wide Web, a massive collection of websites.



This is an integrated circuit, containing thousands of electronic components. The CPU of a PC has a single large integrated circuit, called a microprocessor.

COMPUTERS

COMPUTERS are very useful electronic machines. They can be used for accessing the internet, flying an aircraft, designing a car, storing data and playing games. The basic computer equipment is called hardware. It includes the central processing unit (the CPU), the memory, the screen or monitor, the CD or DVD drive, keyboard, mouse, printer and scanner. Software includes the operating system that enables the computer to work, as well as databases, games and graphics programs. Most personal computers (PCs) have application software for word processing, databases, a web browser for surfing the internet, and email.

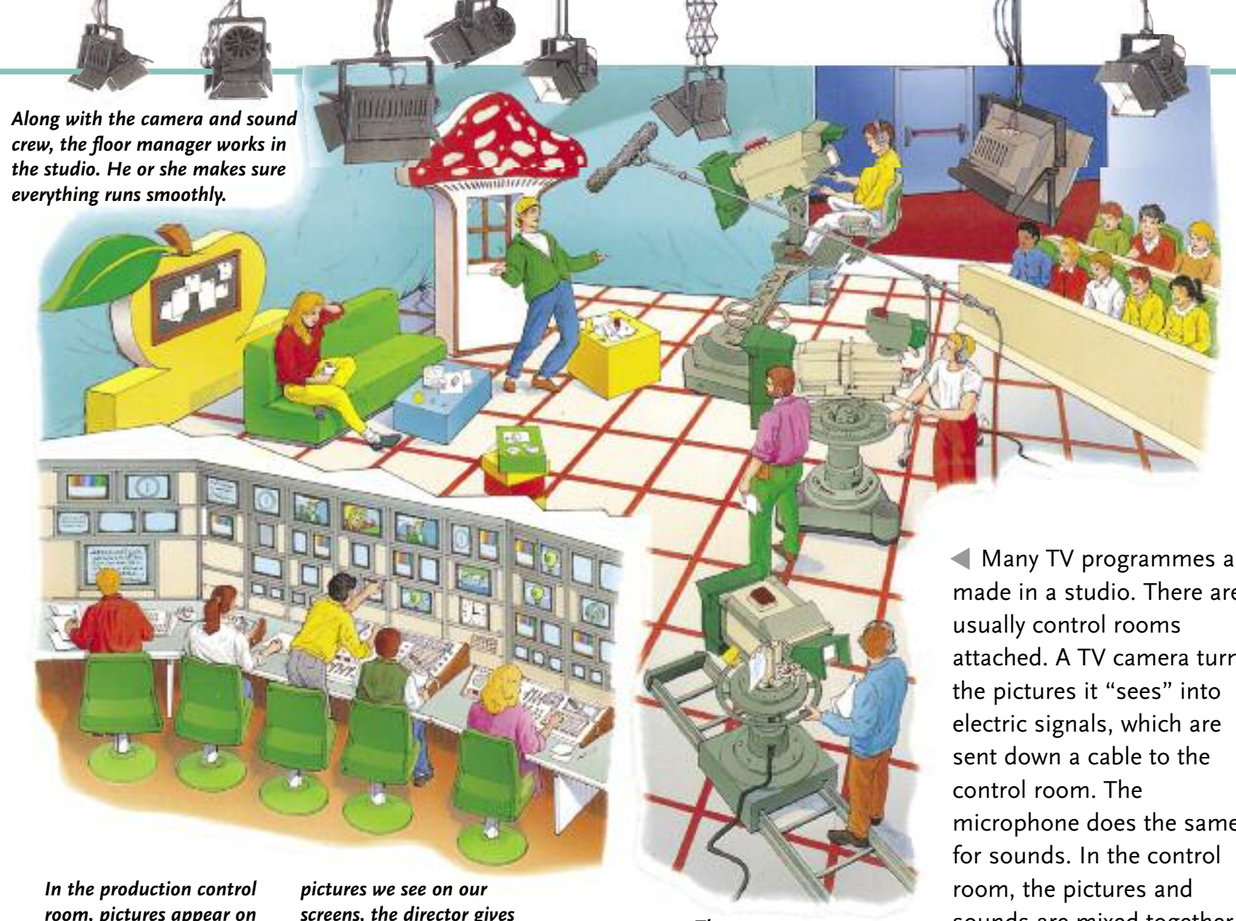


The main part of a computer is the CPU, the computer's "brain". The microprocessors inside it receive instructions from a program and carry them out. Programs and data are stored as electrical signals in a hard disc drive. The computer's memory holds information as electrical signals.

TELEVISION

TELEVISION (TV) was invented during the 1930s. It first became popular in the 1950s as people bought television sets to have in their homes. Now TV is the most important source of entertainment in the world. Many programmes are now beamed into homes from satellites thousands of kilometres up in space.

Television works using electronics, the control of the flow of electrons through an electric circuit. The broadcasting station transmits (sends out) radio waves which are turned into sounds and pictures by TV sets. Some programmes, especially news and sport, are broadcast live: they are transmitted as they happen. But many TV programmes are recorded for broadcasting at a later date. Programmes can also be broadcast live or recorded via the internet using what is called "streaming" technology.



Along with the camera and sound crew, the floor manager works in the studio. He or she makes sure everything runs smoothly.

In the production control room, pictures appear on TV screens in front of the director and her assistants. Responsible for what pictures we see on our screens, the director gives instructions to the people in the studio and the vision and sound controllers.

◀ Many TV programmes are made in a studio. There are usually control rooms attached. A TV camera turns the pictures it "sees" into electric signals, which are sent down a cable to the control room. The microphone does the same for sounds. In the control room, the pictures and sounds are mixed together and recorded or sent to a transmission station.

The operator steers the camera while checking the picture in the viewfinder.

◀ Television signals are transmitted using radio waves. Different channels are carried by waves of different frequency (the number of waves sent out each second). Aerials on people's homes pick up the signals and the TV set turns them back into pictures and sound. Dish aerials can pick up TV signals from a satellite. In some areas, underground cables also carry TV signals into homes.

◀ A satellite is an object that travels about a planet while being held in orbit by gravity. Earth has one natural satellite, the Moon, and many artificial satellites. TV programmes are transmitted to satellites by earth stations and picked up by dish aerials. Satellites are also used in weather forecasting, for providing telephone links, and to help road users pinpoint their positions (satellite navigation system, or sat nav).

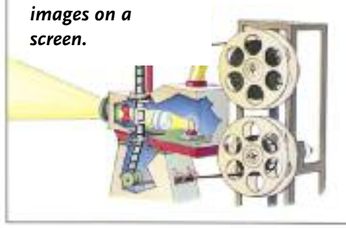
THE MOVIES

THE FIRST CINEMA showing of a motion picture, or "movie", took place in Paris on 28th December 1895. On that day, the brothers Louis and Auguste Lumière showed movies using their newly invented film projector, the *Cinématographe.* The audience saw a film in which a gardener was tricked into soaking himself with a hosepipe!

Hundreds of people work together to make a movie. They are brought together by the producer. The director guides the actors and the camera operators. When everyone is ready the clapperboard is held in front of the camera and the director calls "Action!"

Cinema very quickly became popular all over the world. In 1907 the first studios were built at Hollywood, a district of Los Angeles, California. It was an ideal location, close to many kinds of natural scenery. By the 1920s Hollywood was the centre of the world film industry. Favourite actors and actresses became famous film stars. To begin with, the movies had no sound. Titles appeared on screen from time to time to explain the story. *The Jazz Singer,* made in 1927, was the first full-length movie with a soundtrack. Technicolor and cartoon films arrived in the 1930s.

A lens focuses the images on a screen.



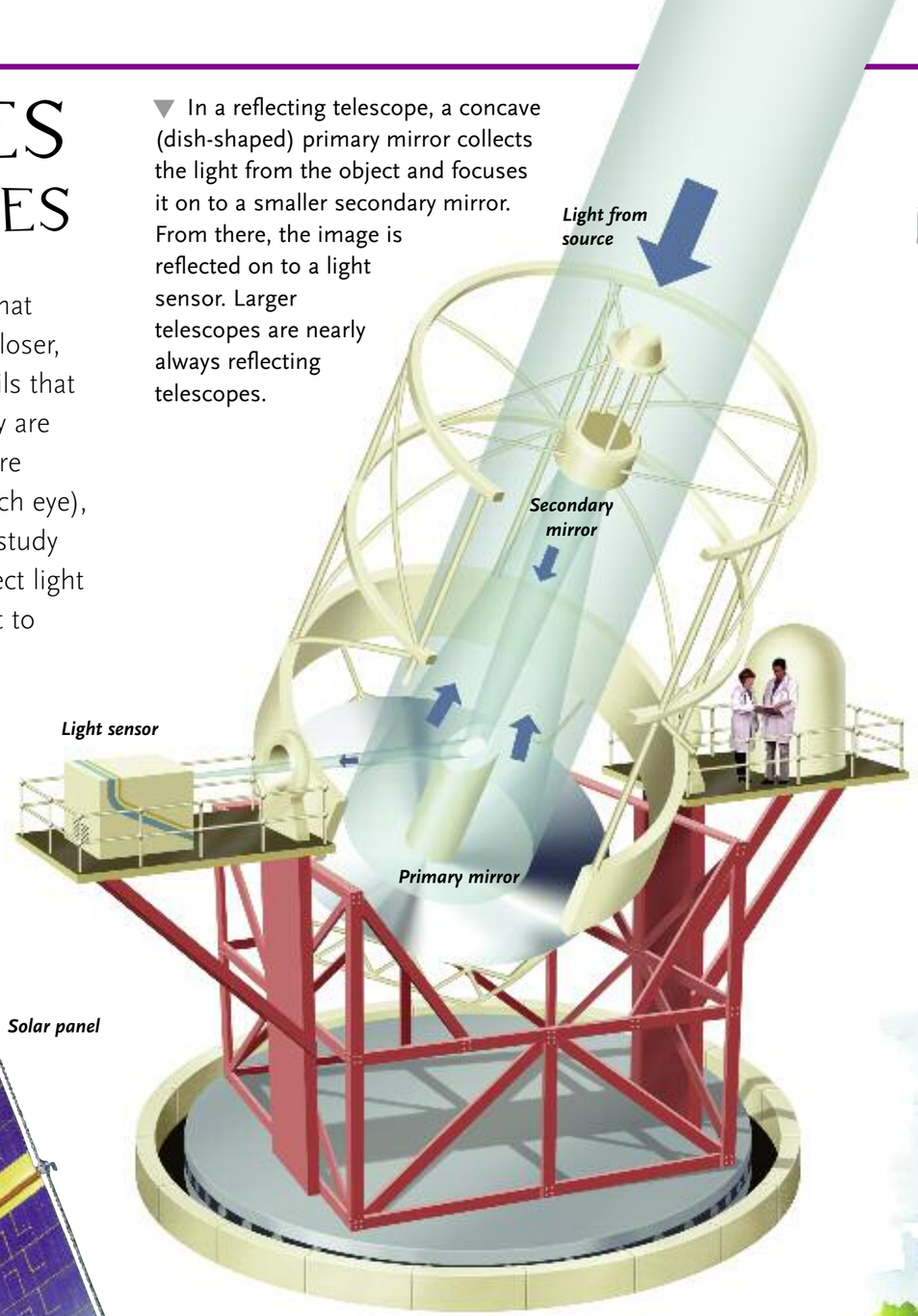
A long strip of film containing a series of images, or frames, passes through the projector in front of a light. The film moves at 24 frames per second, so our eyes see continuous moving action.

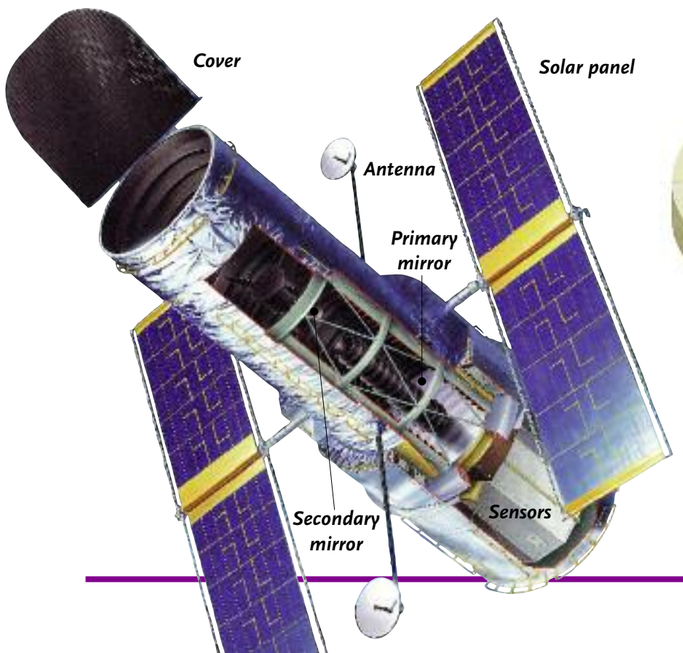
TELESCOPES AND MICROSCOPES

A TELESCOPE is an instrument that makes distant objects appear closer, allowing the viewer to see details that are not visible with the naked eye. They are used for spotting wildlife (binoculars are made up of two telescopes, one for each eye), on gunsights and in periscopes, or to study objects in space. Most telescopes collect light coming from distant objects and use it to produce images of the objects.

A microscope is an instrument that magnifies very small objects, allowing the viewer to see detail in the object that is invisible to the naked eye. Microscopes are used mostly in biology and medical research.

▼ In a reflecting telescope, a concave (dish-shaped) primary mirror collects the light from the object and focuses it on to a smaller secondary mirror. From there, the image is reflected on to a light sensor. Larger telescopes are nearly always reflecting telescopes.





Orbiting 620 km above Earth is the Hubble Space Telescope (left). *Unaffected by disturbances in Earth's atmosphere, it can see objects much more clearly than Earth-based telescopes. It has special mirrors to reflect and focus images and electronic detectors to record them. Images are sent to Earth via the space telescope's antennae.*

▲ The Gran Canaria Telescope is the world's largest telescope. Its light-collecting mirror, measuring 10.4 m across, consists of 36 hexagons fitted together in a honeycomb pattern. Protected by its steel observatory, the telescope is designed to study the most distant galaxies in the Universe.

▼ Objects in space give off other kinds of radiation besides light. These include radio waves. A radio telescope is a huge dish that collects these radio waves and focuses them on to a detector, where an image is formed.

A typical compound microscope with three inter-changeable objective lenses, provides magnifications from about 50 times to about 200 times.

KEY
1 Eyepiece lenses
2 Focus controls
3 Objective lenses
4 Other objectives
5 Slide with specimen
6 Condenser
7 Mirror
8 Light beam

MICROSCOPES

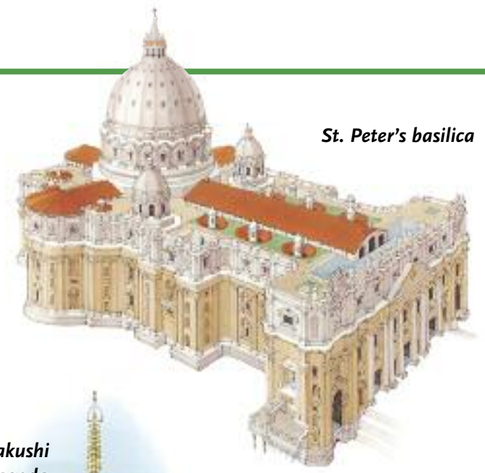
IN an optical microscope, the image of the object is created by light. The simplest microscope is a magnifying glass, which contains a single lens. The lens gathers and bends light coming from the object, making the object look larger than it really is. Compound microscopes have more than one lens. A standard compound microscope has two groups of lenses. The first group, called the objective, gathers light from the object and focuses it to create a magnified image of the object. The second group, called the eyepiece, magnifies this image.

This head louse is just 1.5 mm long. A microscope allows its features, such as body "hairs" , and the clawed feet it uses to grip on to hair, to be studied in detail.

BUILDINGS AND BRIDGES

THROUGHOUT history, people have made structures for many purposes. Simple buildings provide shelter. Grander buildings, such as castles, temples and pyramids, were built for powerful people, or for religious worship.

Many people work together to construct a building. An architect designs the form of the building while engineers work out how to make it strong and safe. Then builders follow careful plans to construct the building.



St. Peter's basilica

Yakushi pagoda

◀▲ These two buildings are for religious worship. St Peter's basilica in the Vatican City, Rome, is the largest church in the world. Somewhat smaller, this Buddhist pagoda in Japan is cleverly built to withstand frequent earthquakes.

Eiffel Tower

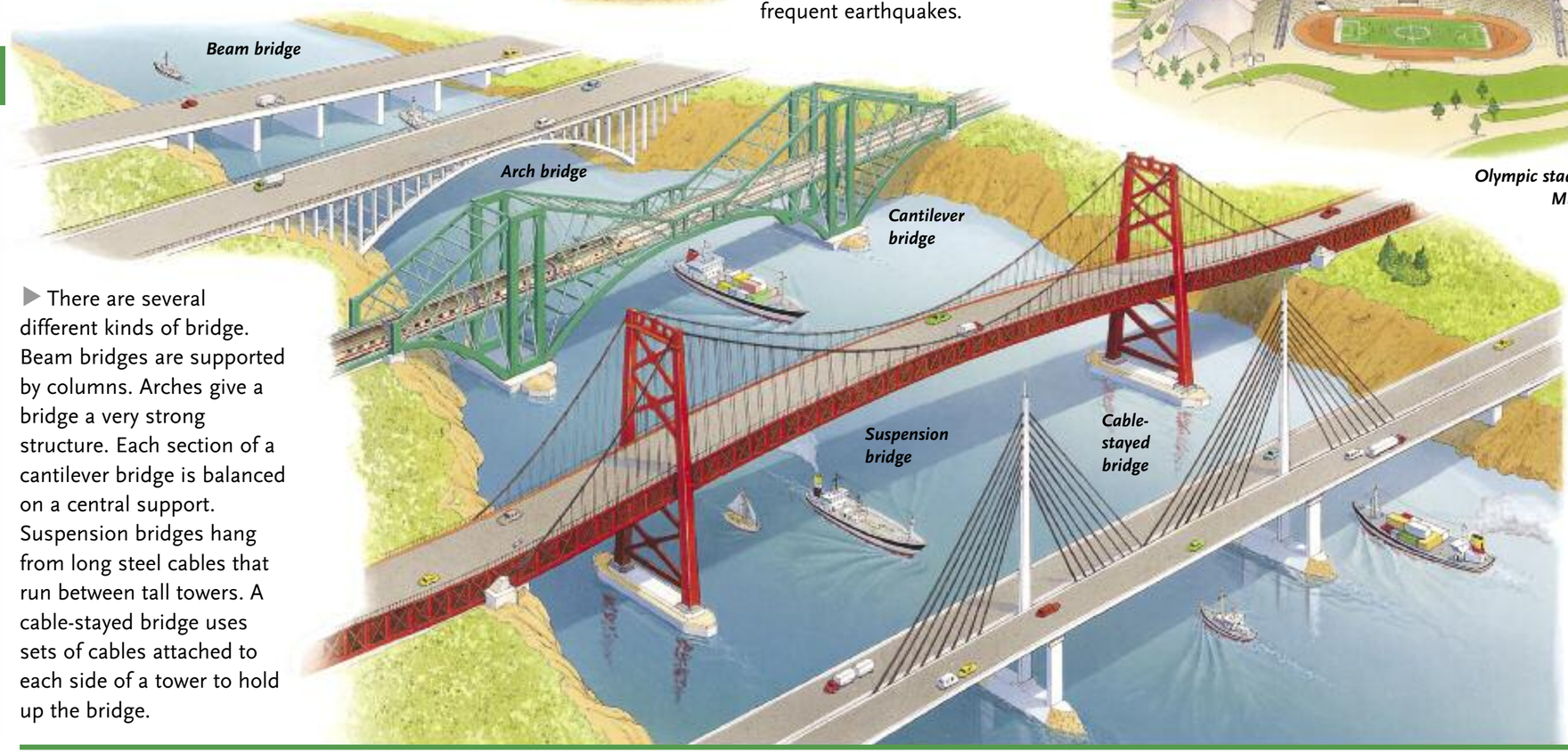
◀▼ These two structures are famous for the way they were built. The 300-metre-high Eiffel Tower in Paris was built in 1889. It is made of iron held together by 2.5 million rivets (metal pins). Built for the 1972 Olympic Games, the Olymic stadium at Munich, Germany, has a tent-shaped roof made of glass, supported by steel masts and cables. The glass cleans itself when it rains.

Olympic stadium, Munich

SKYSCRAPER

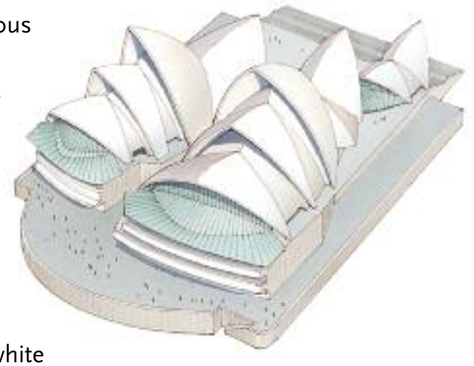
THE TALLEST buildings in the world are called skyscrapers. The John Hancock Center in Chicago, USA, is one of the tallest. Made of steel and glass, it soars to a height of 343 metres. The strong lengths of steel that crisscross the building help it to withstand any kind of weather, especially high winds. Inside the John Hancock Center are 100 floors, containing offices, shops, apartments, a car park and a swimming pool.

Long steel tubes filled with concrete form the building's foundations, the base that supports its weight on firm rock.



▶ There are several different kinds of bridge. Beam bridges are supported by columns. Arches give a bridge a very strong structure. Each section of a cantilever bridge is balanced on a central support. Suspension bridges hang from long steel cables that run between tall towers. A cable-stayed bridge uses sets of cables attached to each side of a tower to hold up the bridge.

▶ One of the most famous modern buildings in the world, the Sydney Opera House was built during the 1960s. It was designed so that it could be admired from any direction—even from above. Looking like a series of overlapping shells, the white roof is covered with over a million tiles, specially made to fit over the curves of the shells.

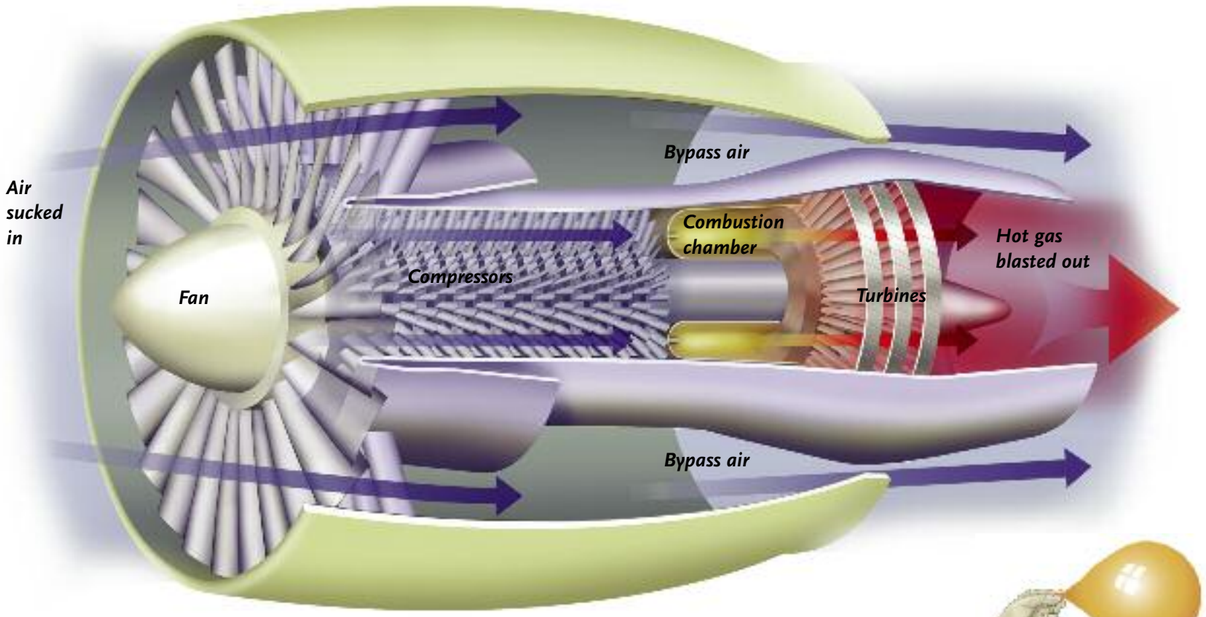


Inside the Sydney Opera House are halls for opera, music, theatre and exhibitions, plus restaurants, bars and a library.

ENGINES

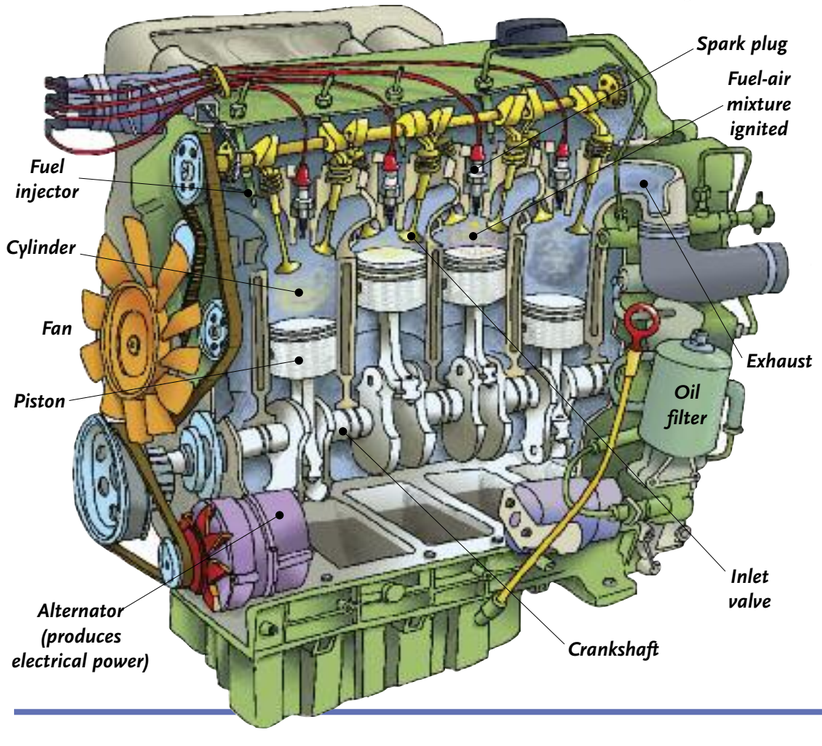
MOST CARS, together with light aircraft, are powered by internal combustion engines. The job of this type of engine is to turn the energy stored in its fuel into movement. Inside the engine are a set of pistons fitted inside cylinders. When the engine is running, the pistons move up and down, turning a crankshaft, which turns the wheels via connecting rods.

Airliners and military planes are powered by jet engines, in which hot, compressed air is expelled at speed from the back of the engine, driving it forwards. Spacecraft use rocket engines, which do not rely on air, since there is none in space. The thrust is supplied by hot gases rushing out through a nozzle.



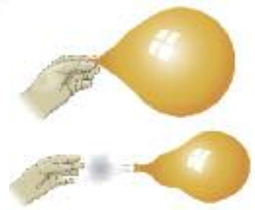
On a large airliner, there may be four giant turbofan engines, two on each wing.

They are fitted inside pods called nacelles, attached to the underside of the wings.



◀ A car is powered by an internal combustion engine, so-called because fuel, usually petrol or diesel, is burned (combusted) inside it. Fuel is pumped from the tank to an electronic fuel-injection system. There it is turned into a fine spray and mixed with air. Inlet valves let the fuel/air mixture into the engine's cylinders where it is ignited by electric spark plugs. The resulting explosions drive the pistons inside the cylinders down. The crankshaft turns this up-and-down motion into a turning motion.

▲ In a turbofan jet engine, air is sucked in by a whirling fan at the front. Some of the air is compressed by spinning blades, then mixed with kerosene fuel and burned in a combustion chamber. The hot exhaust gas escapes at speed through the rear of the engine, turning a turbine, which drives the compressor as it spurts past. The backward-flowing air provides a forward thrust. The rest of the inflowing air is diverted around the combustion chamber to join the exhaust gas, making this type of engine both more powerful, as well as cooler, quieter, and more economical in its use of fuel than other types.

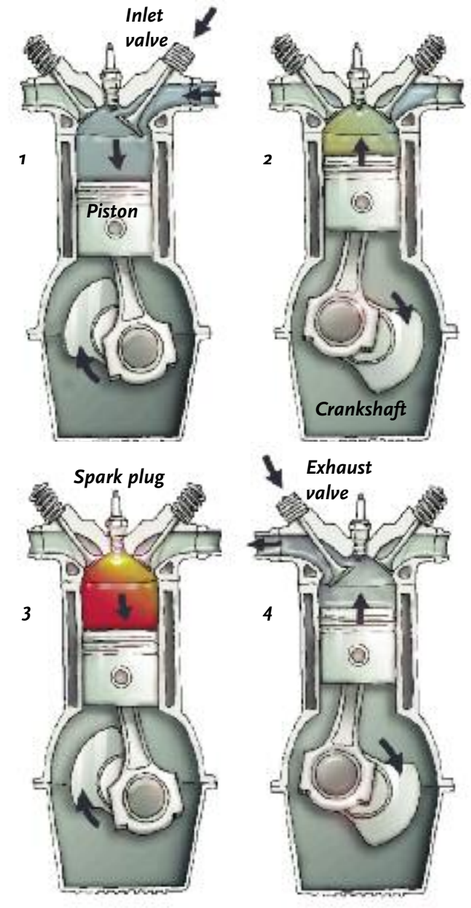


The force of air escaping from a balloon sends it in the opposite direction. This is exactly how jet and rocket engines work.

In a rocket engine, two different fuels mix and react together inside a combustion chamber. The hot gases created rush out of a nozzle (below) *at high speed. These push the engine in the opposite direction.*

FOUR-STROKE CYCLE

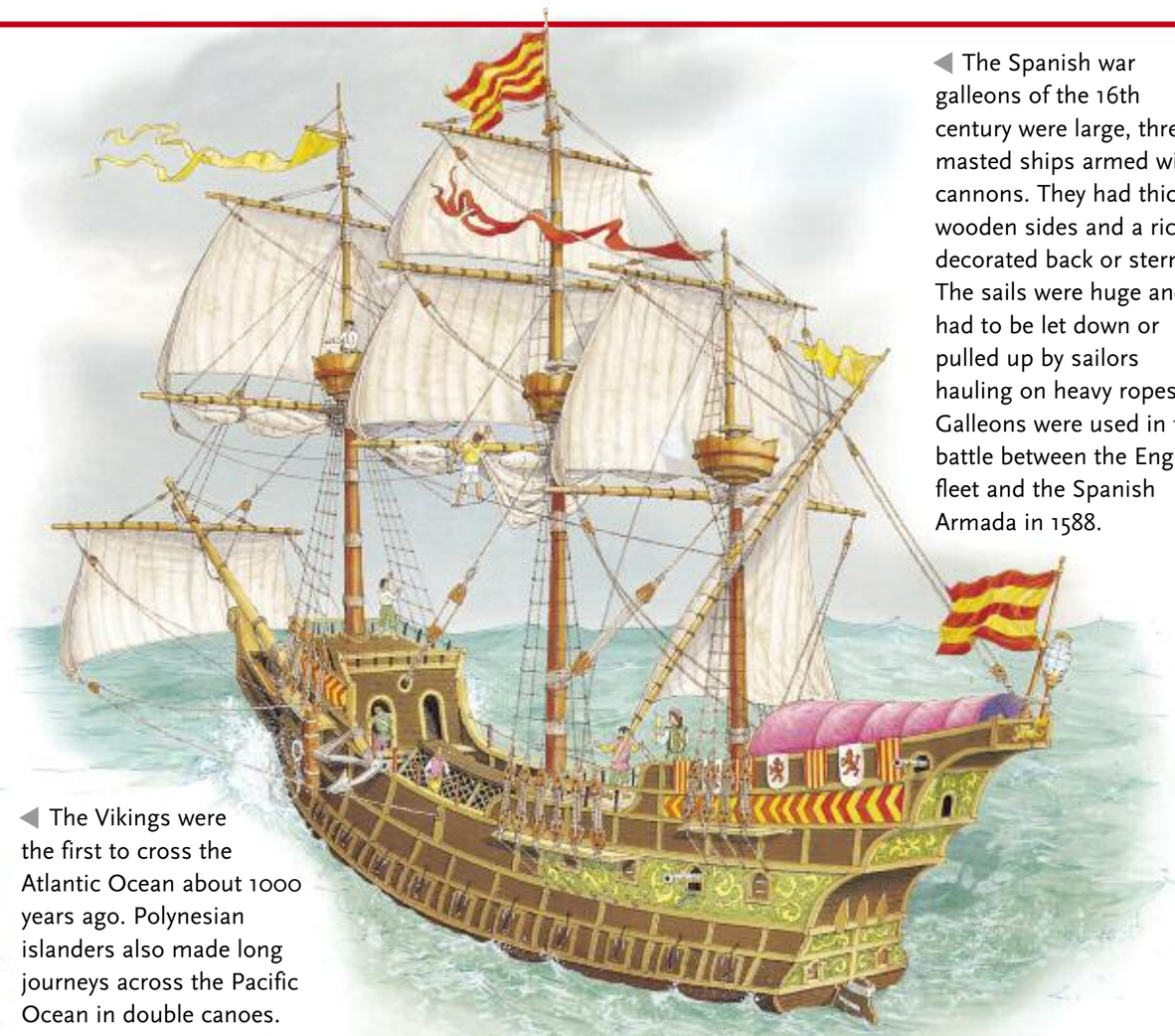
MOST internal combustion engines work on a four-stroke cycle which is repeated again and again as the pistons move up and down. On the first stroke, as the piston moves down, the inlet valve opens to allow a mixture of fuel and air to be sucked into the cylinder (1).



On the second stroke, as the piston moves up, the air and fuel is squeezed into the top of the cylinder (2). Now a spark is created electrically by the spark plug, igniting the fuel, which forces the cylinder down (3). This is the third stroke. On the fourth stroke, the exhaust valve opens to let waste gases escape as the piston moves up again (4).

SHIPS

THE FIRST BOATS were probably just rafts of logs or reeds tied together. As time went on, people learnt to make boats by hollowing out logs and, later, by fixing planks together. Adding sails made it possible to use the power of the wind. Now big boats, or ships, could make long journeys by sea.Sailing ships took explorers, such as Christopher Columbus, to all corners of the Earth. Later, metal ships with engines were built. The spinning, curved blades of their propellers drove the ships through the water.



◀ The Spanish war galleons of the 16th century were large, three-masted ships armed with cannons. They had thick wooden sides and a richly decorated back or stern. The sails were huge and had to be let down or pulled up by sailors hauling on heavy ropes. Galleons were used in the battle between the English fleet and the Spanish Armada in 1588.

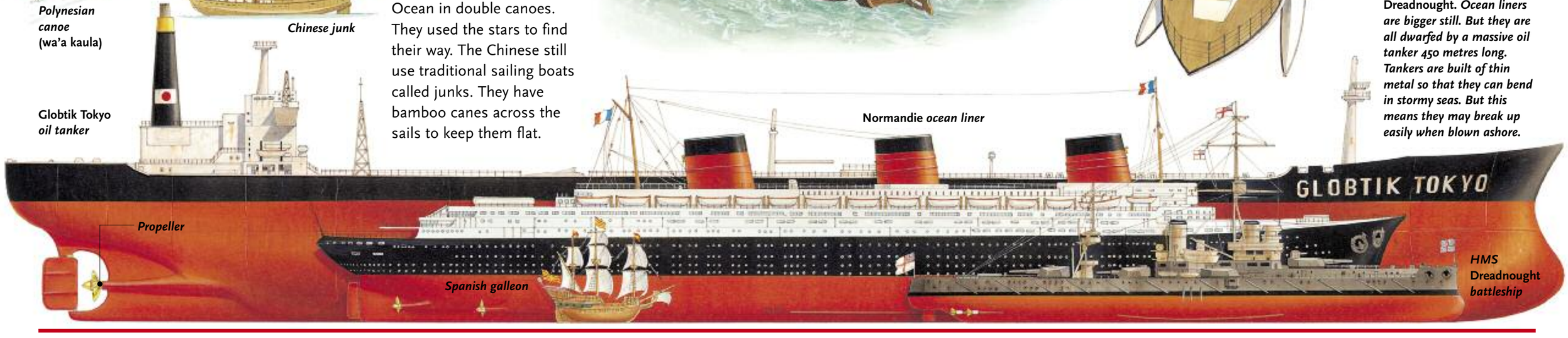
Viking knorr

***Polynesian canoe* (wa'a kaula)**

Chinese junk

◀ The Vikings were the first to cross the Atlantic Ocean about 1000 years ago. Polynesian islanders also made long journeys across the Pacific Ocean in double canoes. They used the stars to find their way. The Chinese still use traditional sailing boats called junks. They have bamboo canes across the sails to keep them flat.

Globtik Tokyo *oil tanker*



Propeller

Spanish galleon

Normandie *ocean liner*

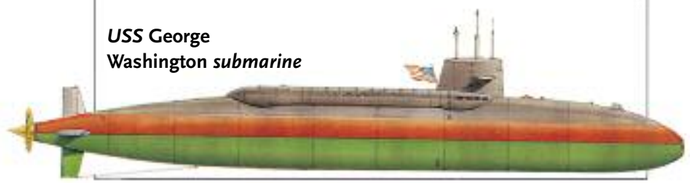
HMS* Dreadnought *battleship

BENEATH THE WAVES

SUBMARINES are vessels that can dive and move along under water. In war, they attack ships on the surface by firing torpedoes at them. Nowadays, submarines are powered by nuclear power. They can stay under water for years at a time.

Underwater craft called submersibles are like miniature submarines. They are used to explore ocean depths and the animals that live there. In 1960 two scientists travelled in the submersible *Trieste* to the deepest point in the sea, Challenger Deep, in the Pacific Ocean.

USS George Washington *submarine*



SeaCat *catamaran*

◀ The *SeaCat* has a double hull (the main body of a ship). It slices through the waves, so that it can travel very quickly in rough seas.

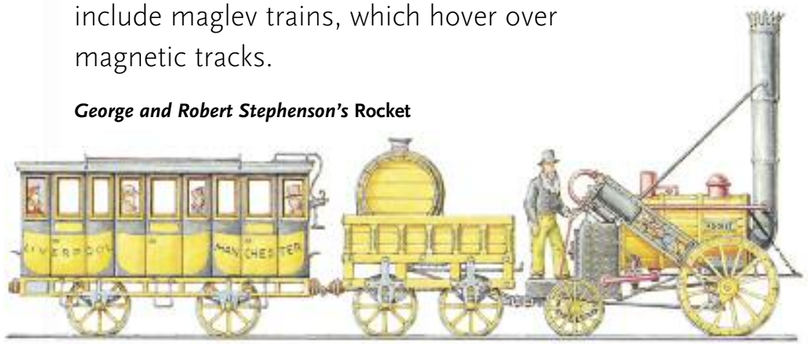
A 16th-century galleon looks tiny compared with a battleship built in 1906, the* Dreadnought. *Ocean liners are bigger still. But they are all dwarfed by a massive oil tanker 450 metres long. Tankers are built of thin metal so that they can bend in stormy seas. But this means they may break up easily when blown ashore.

TRAINS

BEFORE the invention of trains, long-distance journeys on land could only be made riding on domesticated animals, in a carriage drawn by horses or oxen, or on foot. Trains, carriages drawn by locomotives, allowed people to reach their destinations quickly and easily. Heavy goods could also be transported by rail.

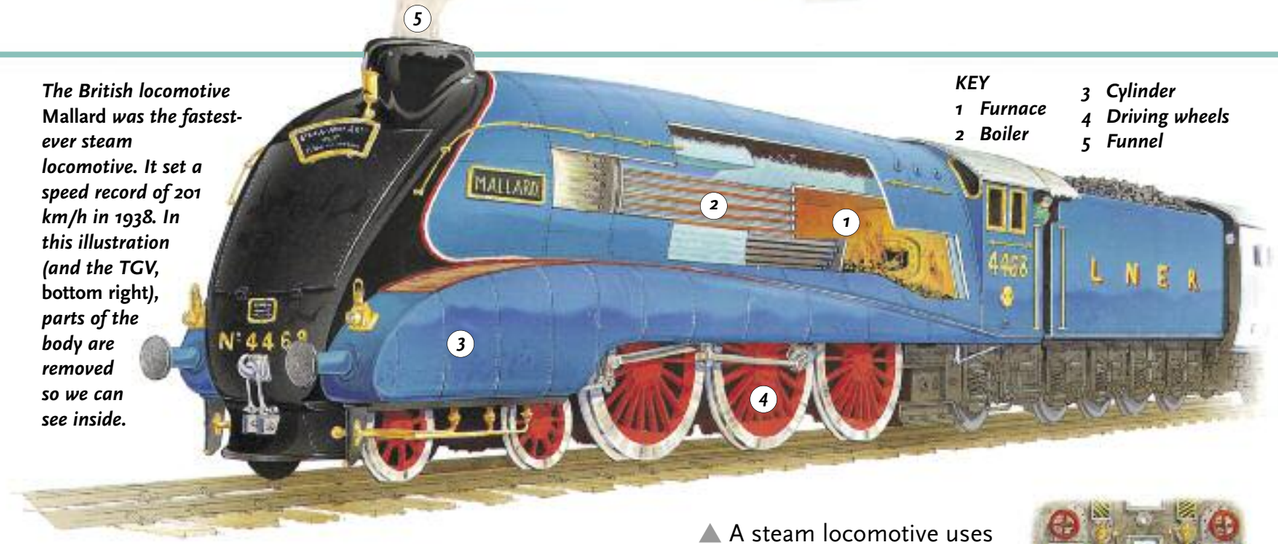
The first trains were invented almost 200 years ago and were driven by steam-powered engines, called steam locomotives. Some later steam locomotives were huge machines that billowed out clouds of smoke. Now, in most parts of the world, the age of the steam train is over. Modern trains are pulled by diesel- or electric-powered locomotives. The trains of the future may include maglev trains, which hover over magnetic tracks.

***George and Robert Stephenson's* Rocket**

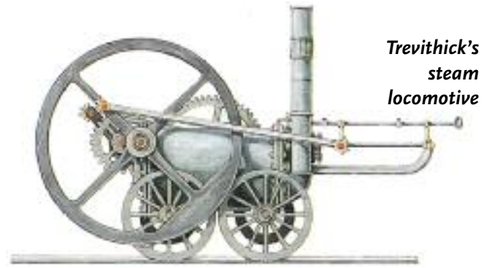


A typical train used in the USA in the late 19th century.

The British locomotive* Mallard *was the fastest-ever steam locomotive. It set a speed record of 201 km/h in 1938. In this illustration (and the TGV, bottom right), parts of the body are removed so we can see inside.



KEY
1 Furnace
2 Boiler
3 Cylinder
4 Driving wheels
5 Funnel



Trevithick's steam locomotive

◀▲ The first steam engine or locomotive to run on rails was built in 1804 by a British engineer, Richard Trevithick. Early locomotives were used to carry coal between coalmines in England. In 1829 a competition was held for the best steam locomotive. *Rocket,* built by George Stephenson and his son Robert, won the £500 prize. It moved at 56 km/h and its design was used to make all later steam locomotives. In 1830 the first passenger railway was opened. Soon there were railways and locomotives all over the world.

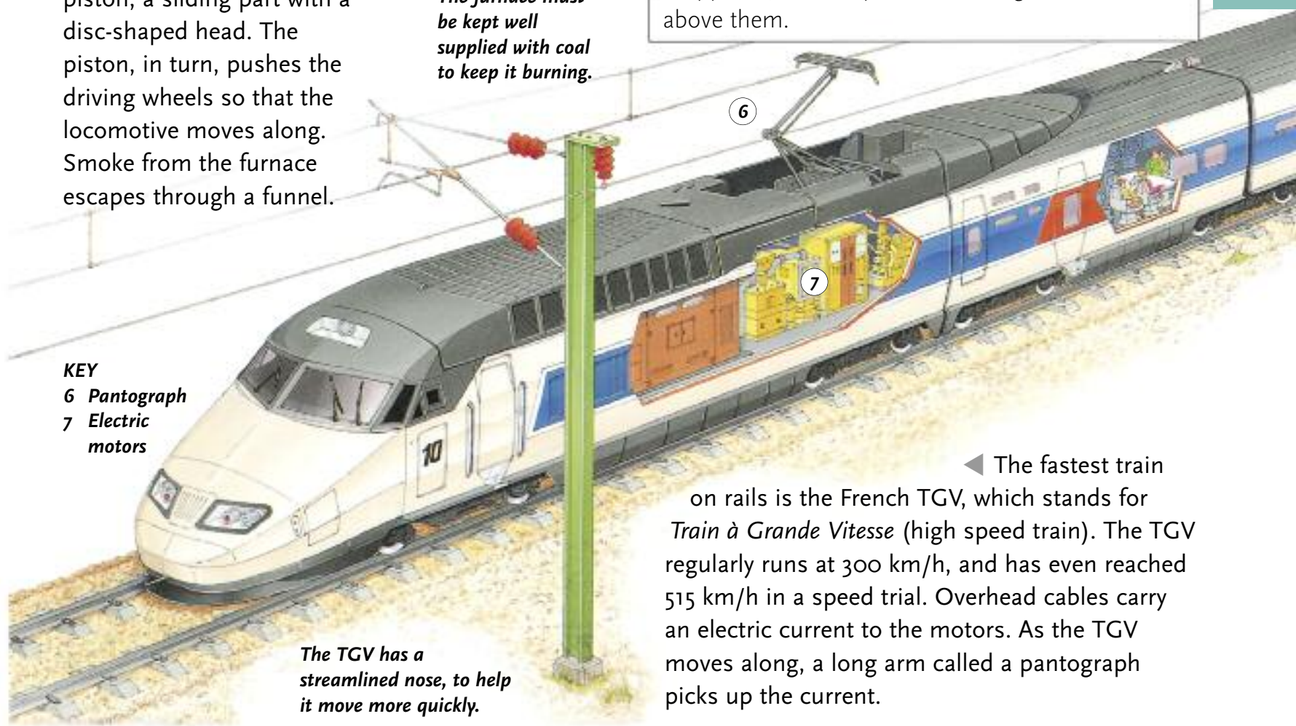
▲ A steam locomotive uses the energy produced when water heats up and becomes steam. Coal is burnt in the furnace, heating water in the tubes inside the boiler. The water turns into steam, which is forced into a cylinder. Here, it pushes a piston, a sliding part with a disc-shaped head. The piston, in turn, pushes the driving wheels so that the locomotive moves along. Smoke from the furnace escapes through a funnel.

The furnace must be kept well supplied with coal to keep it burning.

ABOVE AND BELOW

ELECTRIC TRAINS are very useful in places where smoke or diesel fumes cannot easily escape into the air. Many large cities now have networks of electric trains, called metropolitan railways. Many of these run underground, linking up all areas of the city. The first underground trains ran in London in 1863. Originally steam-powered, they are now electric *(above left).*

Trains usually run on double rails on the ground, but one kind of train, called a monorail, runs on a single rail. The illustration *(above right)* shows the suspension monorail trains of Wuppertal, Germany that run along with the rail above them.



KEY
6 Pantograph
7 Electric motors

The TGV has a streamlined nose, to help it move more quickly.

◀ The fastest train on rails is the French TGV, which stands for *Train à Grande Vitesse* (high speed train). The TGV regularly runs at 300 km/h, and has even reached 515 km/h in a speed trial. Overhead cables carry an electric current to the motors. As the TGV moves along, a long arm called a pantograph picks up the current.

ROAD TRANSPORT

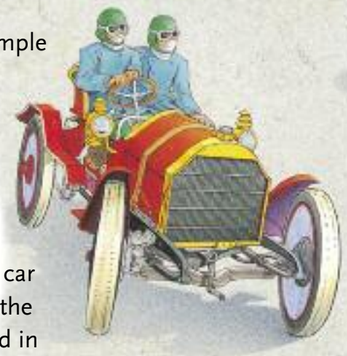
EARLY ROADS were used mainly by armies or traders who travelled on foot or on horseback. Roman roads, made from layers of earth, pebbles and stone slabs, were built to last. Later, horsedrawn carriages and bicycles also went by road. The first road vehicle which ran on its own power was built in 1769 by a Frenchman, Nicolas Cugnot. It was driven by steam, but moved so slowly it would have been quicker to walk! Cars did not become a practical way to travel until petrol engines were invented in the 1880s.

Nowadays, there are concerns about the level of greenhouse gases that petrol engines give off, contributing to climate change. In future cars may be powered by electricity or hybrid engines, a combination of electric and petrol engines.

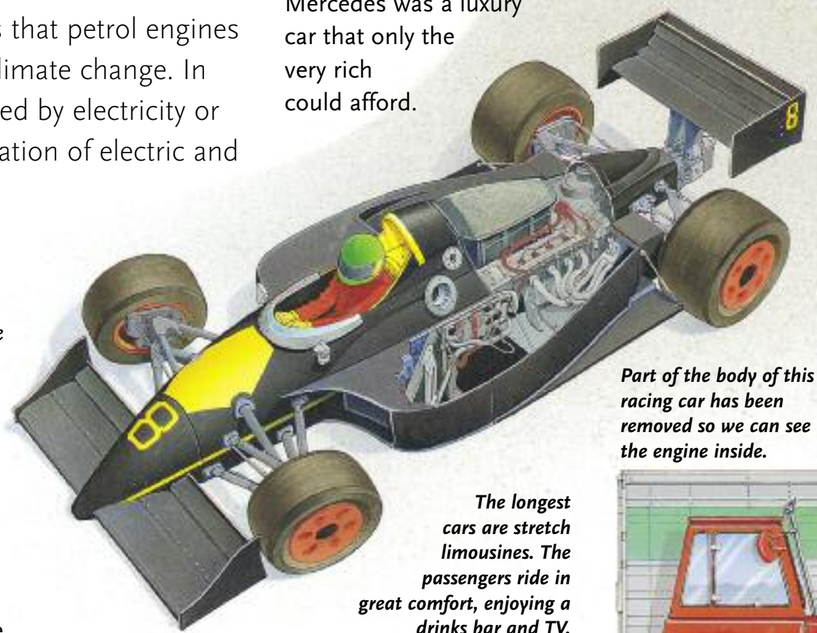
▶ Most modern cars are powered by internal combustion engines *(see page 16)* using either petrol or diesel oil for fuel. Computers are used ensure the engine runs as smoothly and efficiently as possible. Racing cars are specially designed to go very fast. They have powerful engines and a low, streamlined shape so that the car can push through the air more easily. Their broad tyres grip the surface of the track as the cars roar around tight corners.

The first petrol-driven car was invented by the German engineer, Karl Benz, in 1885. It had three wheels and its top speed was only 15 km/h.

▶ The first cars were simple vehicles known as "horseless carriages". By the beginning of the 1900s, modern kinds of engine, tyre, gears and steering had been invented. The first car to include them all was the Mercedes, first produced in 1901 by the German company Daimler. The Mercedes was a luxury car that only the very rich could afford.

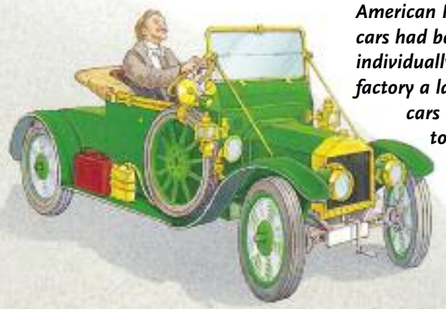


1901 Mercedes



Part of the body of this racing car has been removed so we can see the engine inside.

The longest cars are stretch limousines. The passengers ride in great comfort, enjoying a drinks bar and TV.



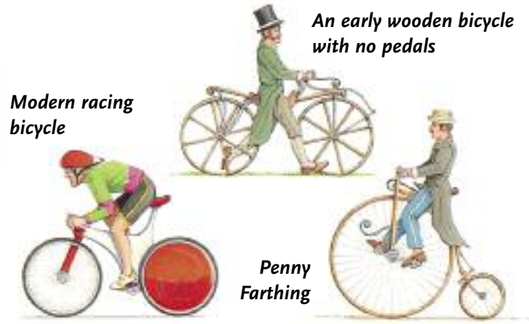
The Ford Model T, nicknamed the "Tin Lizzie", was designed by the American Henry Ford. Early cars had been made individually, but in Ford's factory a large number of cars were put together at the same time by a team of workers. This way, cars could be produced faster and more cheaply.

The Volkswagen "Beetle" (so called because of its beetle-like shape) was first built in Germany in the 1930s.

◀ The first motorcycles, built about 100 years ago, were just like bicycles with an engine attached. Modern racing machines are extremely powerful, capable of speeds of more than 250 km/h.

BICYCLES

THE FIRST bicycles were invented about 200 years ago. They had no pedals. Instead, the riders pushed along the ground with their feet. The first pedal-powered bicycle was built in 1839 by a Scotsman, Kirkpatrick Macmillan. Early bicycles, known as "bone-shakers", had wooden or iron wheels, which gave people a very bumpy ride. They came in some strange shapes, too: the Penny Farthing had a huge front wheel but only a tiny back wheel. Modern bicycles have a light frame, rubber tyres and a chain to drive the wheels.



▼ Some road vehicles dwarf even the largest cars. Huge lorries *(below right)* travel across continents carrying goods. There are giant vehicles specially designed for use on building sites. Dumper trucks *(centre)* can lift up their backs and empty out their load. Heavy rollers *(left)* flatten the surface of a new road.

AIRCRAFT

THE FIRST PEOPLE to invent a flying machine were the French brothers, Joseph and Étienne Montgolfier. Their hot-air balloon made the first manned flight over Paris in 1783.

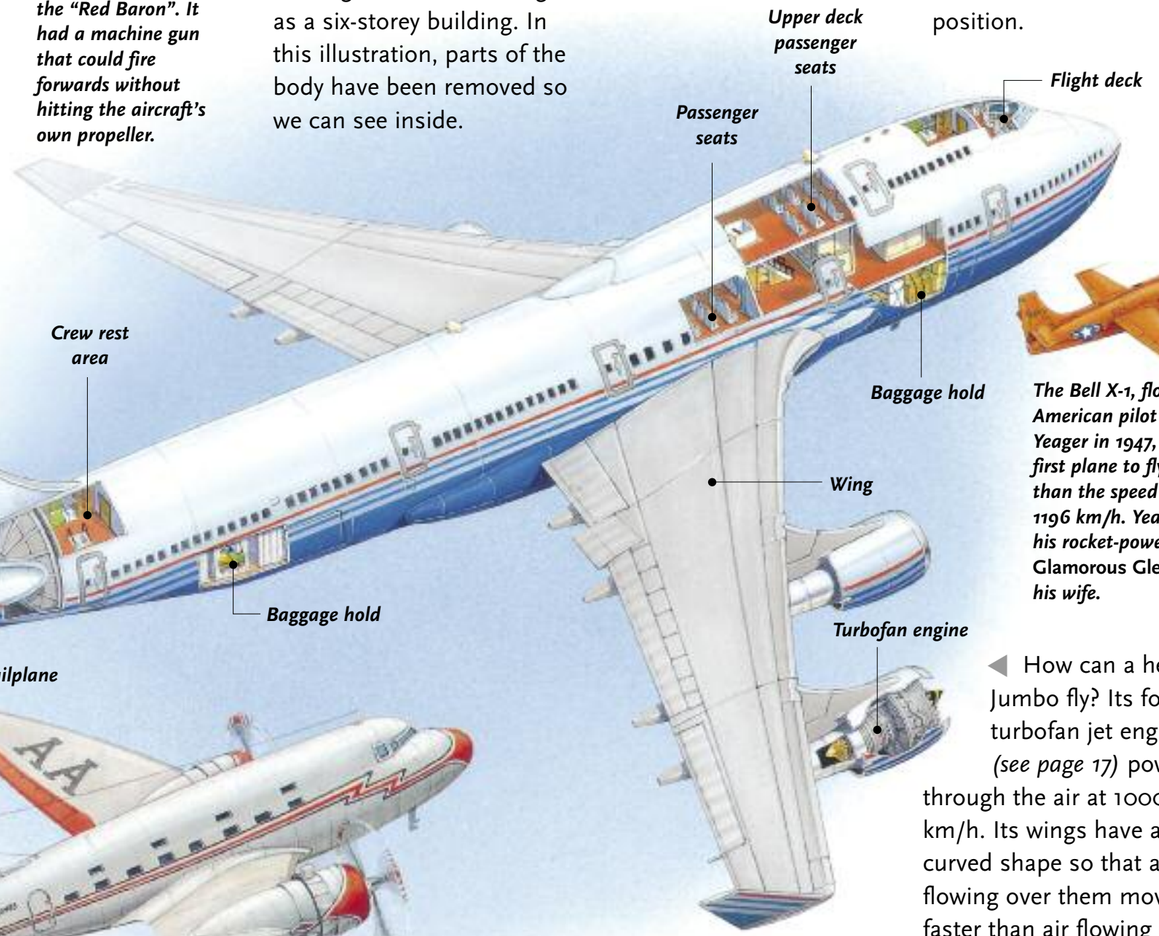
About a hundred years ago, many people were trying to build aeroplanes but their machines usually crashed! Then, in 1903, two young American brothers, Wilbur and Orville Wright, tried out their plane on sand dunes at Kitty Hawk, North Carolina. It flew for only 12 seconds before landing just 36 metres away. It was the first ever controlled, powered flight by an aeroplane.

The Fokker Dr. 1 triplane was the favourite plane of German First World War ace Baron Manfred von Richthofen, known as the "Red Baron". It had a machine gun that could fire forwards without hitting the aircraft's own propeller.

▼ The Boeing 747, the world's largest airliner, normally carries up to 420 people. It is the only airliner which has an upper deck. The wingspan of the Jumbo Jet, as it is often called, is wider than the entire distance flown by the Wright brothers' aeroplane on its first flight! Its tail is as high as a six-storey building. In this illustration, parts of the body have been removed so we can see inside.

The British Spitfire warplanes fought German fighters and bombers in the Battle of Britain during World War II

▼ The pilot and co-pilot sit in the flight deck of a Jumbo Jet with hundreds of lights, levers, dials and screens in front of them. For much of a normal flight, the aeroplane flies itself. It has an autopilot that uses computers to control the aircraft's speed and direction and check its position.



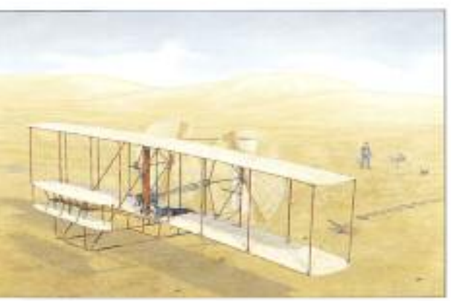
The Bell X-1, flown by American pilot Chuck Yeager in 1947, was the first plane to fly faster than the speed of sound: 1196 km/h. Yeager called his rocket-powered plane Glamorous Glennis *after his wife.*

HELICOPTERS

HELICOPTERS can fly backwards or sideways as well as forwards, hover in mid-air and take off or land vertically. They do not need the runway that aeroplanes must have for take-off or landing. Because of this, helicopters are very useful for rescuing people in mountains or out at sea. They can also transport people to and from oil rigs or the tops of skyscrapers in cities.

All helicopters have rotor blades shaped like long, thin wings. They rotate very quickly and drive the aircraft through the air. The tail rotor stops it from spinning round.

The Wright brothers' plane, Flyer 1, *was powered by a small petrol engine. The pilot lay on his front on the lower wing to steer the aircraft. His controls allowed him to twist the wings so that* Flyer *could "roll" slightly to the left or right.*

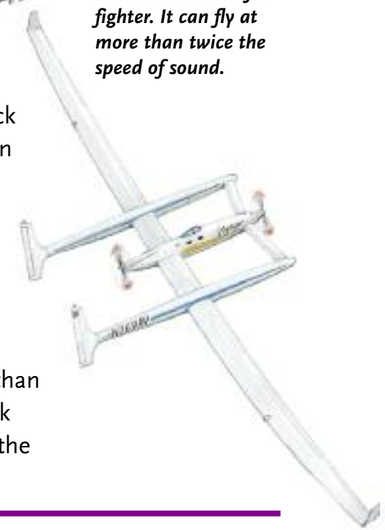


The Douglas DC-3 Dakota, which first flew in 1935, was one of the earliest airliners. It could carry 21 passengers.

◀ How can a heavy Jumbo fly? Its four turbofan jet engines *(see page 17)* power it through the air at 1000 km/h. Its wings have a curved shape so that air flowing over them moves faster than air flowing under them. This produces a force called lift (see this for yourself by blowing over the top of a small piece of paper held in one hand).

The French Mirage 2000 is a modern jet fighter. It can fly at more than twice the speed of sound.

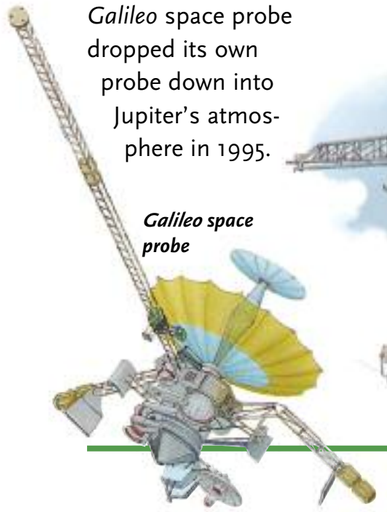
▶ In 1986 Americans Dick Rutan and Jeana Yeager in *Voyager* made the first flight around the world without refuelling. Their aircraft had very long wings. The two pilots were squeezed inside a space only a little larger than a telephone booth. It took them nine days to make the flight.



SPACE TRAVEL

A SPACE vehicle uses powerful rocket engines because it must travel very fast to escape the pull of the Earth's gravity. The first spacecraft, a satellite called Sputnik 1, was launched in the Soviet Union* in 1957. It had no people on board. The first living thing to travel in space was a dog called Laika, sent up in a spacecraft later that year. Then, in 1961, a Russian called Yuri Gagarin became the first human in space.

Space travellers, known as astronauts (or cosmonauts in Russia), have since been to the Moon and made many trips into space in the Space Shuttle. A number of space probes, unmanned spacecraft, have travelled to distant parts of the Solar System.

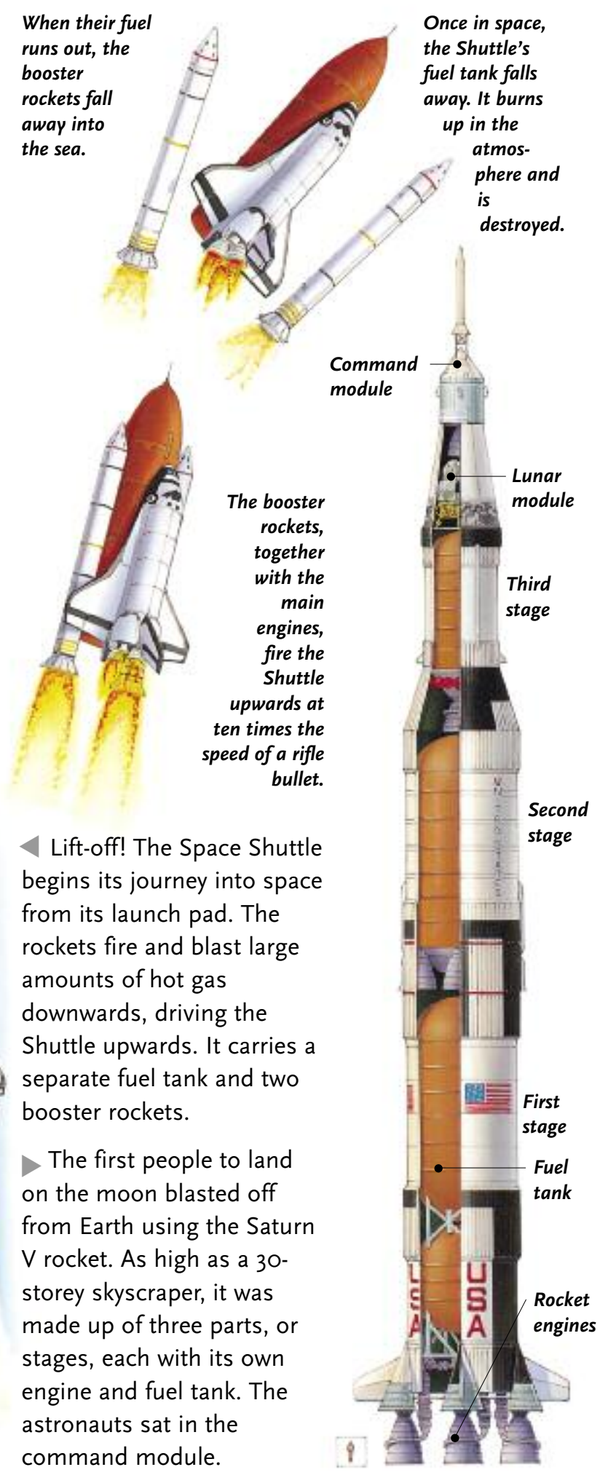


▼ Space probes are spacecraft that explore planets and moons which are too far away for people to visit. As they pass by their targets, the probes send back pictures to Earth. The *Galileo* space probe dropped its own probe down into Jupiter's atmosphere in 1995.

Galileo space probe

◀ Lift-off! The Space Shuttle begins its journey into space from its launch pad. The rockets fire and blast large amounts of hot gas downwards, driving the Shuttle upwards. It carries a separate fuel tank and two booster rockets.

▶ The first people to land on the moon blasted off from Earth using the Saturn V rocket. As high as a 30-storey skyscraper, it was made up of three parts, or stages, each with its own engine and fuel tank. The astronauts sat in the command module.

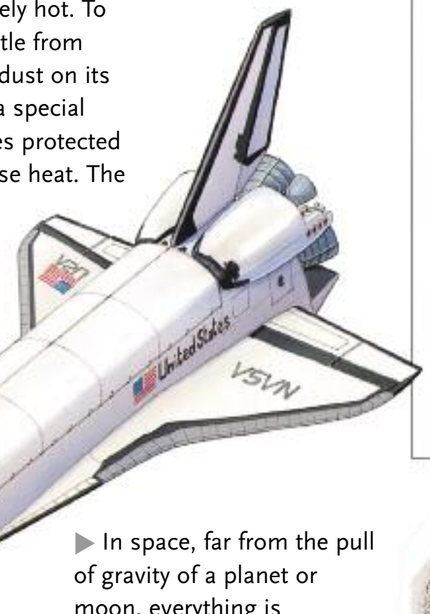


▼ The Space Shuttle was a spacecraft designed to be used over and over again. It could carry satellites up into orbit. It also took people up to retrieve or repair these satellites or to carry out experiments.

When an object enters the Earth's atmosphere, it becomes extremely hot. To prevent the Shuttle from burning up into dust on its return to Earth, a special outer layer of tiles protected it from the intense heat. The last Space Shuttle flew into space in 2011.

The Shuttle crew perform their "mission". In this case it is to launch a satellite.

Small rockets are fired and the orbiter glides back to Earth.



The orbiter puts down its wheels and lands on a runway like an airliner.

MOON LANDING

IN JULY 1969 US astronaut Neil Armstrong became the first person to set foot on the Moon. He travelled to the Moon with two other astronauts on a mission called Apollo 11. Between 1969 and 1972 eleven other astronauts landed on the Moon. They explored the surface, taking photographs and carrying out experiments. They also brought back rock samples for scientists to study. Later missions used a Lunar Rover to move about on the surface of the Moon. Here, the astronauts are seen in their space suits. These contained breathing and temperature devices, and a radio link with the spacecraft.

▶ In space, far from the pull of gravity of a planet or moon, everything is completely weightless. In a space station, the astronauts can float about. They sleep in a vertical position, firmly strapped into their sleeping bags. They must exercise to stop their muscles becoming too weak!

* *Now 15 new countries, one of which is Russia.*

GLOSSARY

Amplifier An electronic circuit that increases the strength of an electrical signal.

Binary A number system that uses only the digits zero and one.

Bit The digit, either 0 or 1, that makes up a binary code.

Charge-coupled device (CCD) A microchip that captures an image and converts into a digital form.

Compact disc (CD) A metal disc on which binary codes, containing information, can be stored. The binary digits 0 and 1 are represented by flat areas or shallow pits on the disc's surface. A **DVD** (Digital Versatile Disc) has a great storage capacity than a compact disc, and so can be used to record movies, for example.

Diesel engine A type of internal combustion engine that ignites its fuel (diesel oil) by compressing it with air.

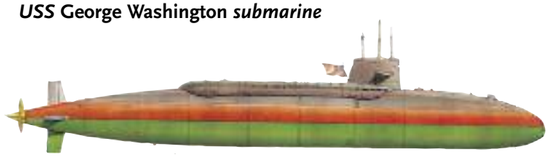
Digital electronics Electronic circuits in which information is represented in binary using currents that are either on or off.

Electrical signal An electric current that represents information, such as sound, by continuously changing in strength and direction.

Electron A extremely tiny particle that is part of an atom. An electric current is a stream of electrons.

Electronic circuit An electric circuit in which the flow of current is controlled by the circuit's components.

USS* George Washington *submarine



Frequency The number of wave crests that pass a point every second.

Generator A device that turns rotary movement into an electric current.

Gravity The force that attracts all objects to each other. Gravity is the force that keeps the planets orbiting the Sun and moons orbiting a planet.

Greenhouse gas A gas, such as carbon dioxide or methane, that is contained in the Earth's atmosphere and stops the Sun's heat from escaping. An increase in greenhouse gases may lead to global warming and climate change.

Hardware The physical parts of a computer, such as the electronic circuits, the disc drives, keyboard and monitor.

Image A picture of an object or scene formed by focusing the rays of light coming from the object or scene.

Rocket engine

Integrated circuit A complete electronic circuit consisting of microscopic electronic components built into a small piece of semiconducting material. Also known as a **microchip** or a **silicon chip**.

Internal combustion engine A type of engine in which the fuel such as petrol is burned inside the engine rather than outside.

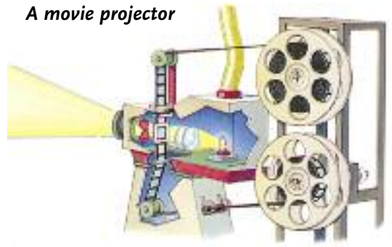
Internet A huge computer network that links millions of computers around the world.

Jet engine An engine in which the burning fuel spins a turbine that creates a stream of hot gases from the rear of the engine.

Laser A device that creates an intense, parallel beam of light known as a laser beam.

Lens A shaped piece of glass or plastic that is used to focus light.

A movie projector



Lift The upwards force created by an aeroplane's wings that counteracts gravity.

Microphone An electronic device that turns the pattern of a sound wave into an electrical signal.

Microprocessor An integrated circuit that contains the central processing unit (CPU) of a computer.

Microwaves High-frequency radio waves used in communications and for cooking.

Modem Short for modulator-demodulator, a device that enables a computer to transmit and receive data via telephone lines or radio waves.

Monitor The screen of a computer, where text and graphics appear.

Petrol engine A type of internal combustion engine that ignites its fuel by compressing a mixture of fuel and air.

Piston A part fitted closely inside a cylinder and which moves up and down.

Pixel Short for picture element, which is one of the tiny coloured dots that make up an image on a computer monitor.

Propeller A fan-like object that pushes against water (on a boat) or air (on an aircraft) as it spins at high speed.

Radar (RAdio Detection And Ranging) A system that detects objects by transmitting radio waves and receiving the "echoes".

Radiation The emission and transfer through space of electromagnetic waves, including light, radio, X-rays, etc.

Radio The use of radio waves for communication. Also the general broadcasting of sound and music.

Radio waves Invisible waves that travel at the speed of light.

Receiver A device that detects signals, such as radio waves.

Rocket engine An engine that creates a stream of hot gases by burning fuel in a chamber.

Satellite A spacecraft that orbits the Earth. Communications satellites relay radio signals between ground stations on the Earth's surface.

Trevithick's steam locomotive

Software The programs and data that a computer uses and stores.

Space probe An unmanned spacecraft guided from Earth to pass close by, or land on the surface of, other planets and moons.

Steam engine An engine that uses pressurized steam from a boiler to make its pistons move.

Telecommunications Communications systems that use electricity, radio waves or light to work.

Telephone exchange A place where telephone lines meet and can be linked to each other.

Transmitter A device that gives out signals, such as radio waves.

Turbine A machine that is caused to rotate by a fluid (including liquids and gases such as steam) in order to drive a generator. A gas turbine is another name for a jet engine.

Wavelength The distance between two crests or two troughs on a train of waves, such as radio waves.

Fokker Dr. 1 triplane

INDEX

Page numbers in **bold** type refer to main entries.