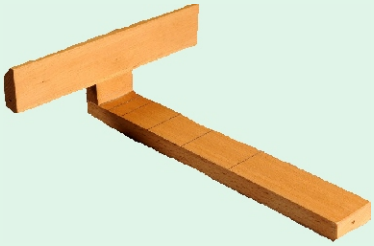
Hands On Learning
with Reading Museum Service

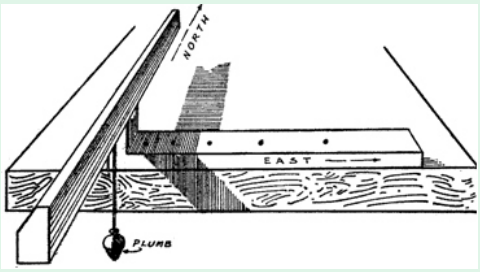
READING MUSEUM SERVICE

TIME S1/A

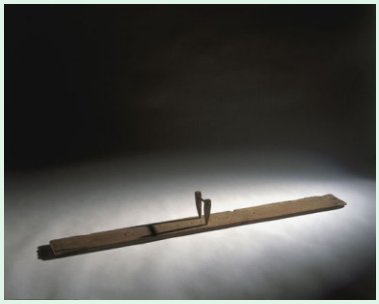
Replica Egyptian Sun Clock



It is thought that this kind of shadow clock orginated in Egypt about 3,000 years ago. The Egyptians divided the daylight period into ten parts, with an additional twilight hour in the morning and evening, making twelve parts in all. The night was also divided into twelve parts, in this case measured by the periodic rising of twelve stars or groups of stars.



T-bar shadow clocks like this one were used by pointing it towards the east. A plumb line could be used to make sure that it was level. The time of day was deduced by the position of the shadow cast by the upper edge of the cross piece on the marks cut at irregular intervals on the top surface of the bar. After noon, the T-bar was pointed towards the west.



Similar devices were used in Egypt into the twentieth century. The photograph on the right shows a shadow clock from Qus in Egypt from 1925. It was placed in an east-west direction and the hours were measured by marks on the base. At mid-day the shadow cast was directly underneath the central bar.

Such devices are practicable in Egypt, where there is strong sun (as are the shadows cast by it) most days of the year. In a country like England sundials are less reliable.



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Water Clock



Another early method of marking the passage of time is to use dripping water. One of the oldest water clocks dates from the reign of Amenhotep III, between about 1390-1352 BC. It was used in the Temple of Amen-Re at Karnak. The oldest documentation of the water clock is the tomb inscription of the sixteenth century BC in which the Egyptian court official Amenemhet, is identified as its inventor.

It is thought that these early water clocks were used by priests during hours of darkness, when sundials were unusable, in order to make sure that rites and sacrifices could be performed at the correct hour. They consisted of stone vessels with sloping sides that allowed water to drip at a nearly constant rate from a small hole near the bottom. There were twelve separate columns with consistently spaced markings on the inside to measure the passage of hours as the water level reached them. The columns were for each of the twelve months to allow for the variations of the seasonal hours. The photograph on the left shows a basalt fragment from one of these clocks with a marked column clearly visible.



This measuring container can be used in a similar way. Put your finger over the hole at the bottom and fill it with water. When you are ready to begin take your finger away. Use a stop-watch to find out how long it takes the water to run from 250 ml. to 200 ml. and so on.

Other early civilisations also used water clocks. They were used in ancient Mesopotamia between 2000 and 1600 BC, although in this case time was measured by units of water called 'mana' that flowed out of the container. To measure two hours, two mana of water were poured into the container and the time was judged to have passed when it became empty.



Water clocks of various designs were also used in ancient China and India. They are often called clepsydra, from two Greek words meaning 'Water Thief'. An elborate modern clepsydra can be seen on the right.

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Sand Timer



The sand timer (or hourglass) works in a similar way to a water clock, except that the movement of sand out of the upper container marks the passage of time. They were probably invented in the Middle Ages. An hourglass appears in the painting *Allegory of Good Government* by Ambrogio Lorenzetti in 1338. A few years later, in 1345, Thomas de Stetesham, clerk of the English ship *La George*, records the purchase of glass clocks, presumably hourglasses.

As suggested by the reference to their presence on *La George*, hourglasses proved very useful to keep time on board boats because, although they are fragile, the flow of sand is not much affected by the sometimes violent movement of a ship at sea.

In the eighteenth century, hourglasses were used to time thirty minute spans of time on naval ships. As each thirty minute period went by, a bell was struck by hand to note the time that had passed.

Another place where hourglasses were regularly found was next to a pulpit in a church. The photograph on the far left shows an hourglass in its stand on the pulpit of the parish church at Glastonbury. The preacher could keep turning the glass over each time it ran out in order to measure how long he had been speaking: quarter of an hour, half and hour, three-quarters of an hour … Some church hourglasses came in sets (left), each of which could be used to measure a different time period.





Hourglasses are also often used on tombstones to symbolise the inevitable passing of time. The example on the right, from Old Crailing, Roxburghshire, has a vigourous looking figure of Death, with an hourglass at his elbow. The symbol has found new life in recent years, being used on computers to show that a programme is in the middle of a task (left).





Sundial



Using a shadow cast by a stick set upright in the ground is probably the oldest way of measuring time known to humankind. This rather battered modern example is typical of many that are installed as a garden feature across Britain.

Horizontal sundials such as this example are often put up primarily for their appearance, but if they are to work properly they must be carefully installed. With a horizontal sundial, the gnomon (the bit that casts a shadow) should point towards true north (not magnetic north) and its angle with horizontal must equal the sundial's geographical latitude. A sundial designed for one latitude can only be accurately used in another latitude if the sundial is tilted upwards or downwards by an angle equal to the difference in latitude.



There are many other kinds of sundial. Another common variety is installed vertically, on a church or house wall. Such dials can be a little trickier to install. The gnomon has to be aligned with the Earth's axis of rotation. If the face of a vertical dial does *not* face due south, the hours of sunlight that the dial receives may be limited. To get round this, some vertical dials are placed on all four sides of a rectangular tower, providing the time throughout the day. Also, if the building does not face in a cardinal direction such as due south, the hour lines must be corrected. The example on the left, for example, is divided into unequal sections for this reason.

The photograph on the right shows the kind of sundial that is often installed in a school playground. Technically, this is known as an analemmatic sundial - the gnomon (in this case a person) stands vertically to the earth's surface and the dial has to be elliptical rather than circular. The person has to stand on a different position each month of the year in order to get an accurate reading. The position on which to stand is marked on a rectangular platform at the centre.



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TIME S1/A

Pocket Watch



Fully mechanical clocks probably have their origin in medieval Europe. In the early Middle Ages cathedrals and monasteries, where it was important to perform services at regular times, probably used water clocks. In 1198, during a fire at the abbey at Bury St Edmunds, the monks 'ran to the clock' to fetch water!



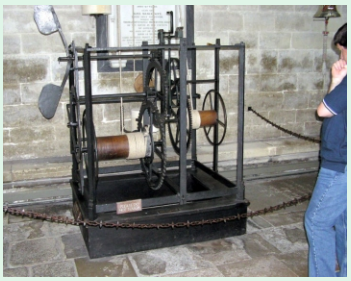
One of the first people to design a mechanical time device was born near Reading - Richard de Wallingford (1292-1336). Richard, the son of a blacksmith, was born at Wallingford, Berkshire. In 1326, he became Abbot of St Albans, one of the most important abbey's in the country.



Richard (left & right) spent so many years designing and building his machine that he was criticised for not looking after the abbey buildings! When completed (after Richard's death), his clock had a large face which showed the sun, the phase of the moon, a star map and possibly the planets. In addition, it had a wheel of fortune and an indicator of the state of the tide at London Bridge! Bells rang every hour, the number of strokes indicating the time.



Richard's clock used weights to drive its wheels. Clocks which use springs to store energy, such as this pocket watch, were developed in the fifteenth century. Pendulum clocks were invented in the mid-seventeenth, by Christiaan Huygens in the Dutch Republic.



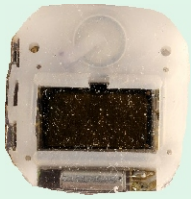
Left: The astronomical clock in Prague. The oldest bits of this clock date back to 1410. Like Richard de Wallingford's clock this device is primarily designed to show the movement of the stars and planets. Right: the mechanism of the clack in Salisbury Cathedral, believed to be the oldest working clock in the world (1386). It has no face and simply sounds a bell.

Another difference between Richard's clock and this pocket watch is their size. Richard's clock probably used (and looked like) some of the gearing found in a large windmill. The first reference to a portable clock is in a letter in November 1462 from the Italian clockmaker Bartholomew Manfredi to the Marchese di Manta, where he offers him a 'pocket clock'. In the sixteenth century portable clocks became more common, but they were quite big and boxy and were worn around the neck. It was not for another century that it became usual to wear a watch in a pocket.



This pocket watch was made by Jules Girod and may date from the late nineteenth century. The case is missing, but it would have looked something like the photograph on the right when complete. Pocket watches declined in popularity after the First World War, after wearing a waistcoat went out of fashion as they were usually kept in a waistcoat pocket. They were replaced by wrist watches.

Digital Watch



This is the works of a digital watch. If you look at the back, you can see the small battery which supplies electrical power, the circuitry which controls the digital display and a small shiny cylinder which is a crystal oscillator. The crystal oscillator ensures that the watch keeps regular time.

In the nineteenth century it was discovered that if you pass electricity through a quartz crystal then it vibrates at a very regular rate. This discovery was used in the twentieth century to make accurate watches and clocks. The first popular quartz wrist watch was made by Seiko in 1969.



Quartz has the advantage that it does not change size much as temperature changes. This means that a quartz watch will keep relatively accurate time whatever the temperature - most quartz watches only lose or gain a few seconds each year. Some quartz watches use either sunlight or the movement of their wearer to provide power, getting rid of the need for any kind of battery.

Above left: A crystal oscillator.

Continued on next page.

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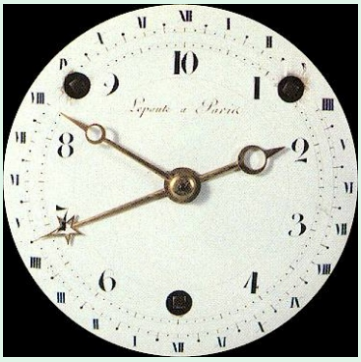
TIME S1/A

For centuries clocks and watches have used turning arms on a dial to indicate the time. This kind of device is called an analogue clock. A clock or watch like this one which simply displays numbers is called a digital clock.



Analogue clocks usually have twelve hours marked on the dial. As there are twenty-four hours in a day, the hands must move around the dial twice to measure out a full day. A few analogue clocks have been made which display the full twenty four hours, but they look rather crammed and are rare. The photograph on the right shows a twenty-four hour clock at Greenwich Observatory in London.



During the French Revolution, when metrication was imposed on territory ruled by France, there was a brief period in which the day was divided into periods of 10 hours. The photograph on the left shows a 10-hour clock face from this period.

The system of dividing the day into two sections of twelve hours dates back to ancient Egypt and Mesopotamia. A digital clock makes displaying the time using the full twenty-four hour format easier.



Above: A sundial in Reggio Calabria, Italy.