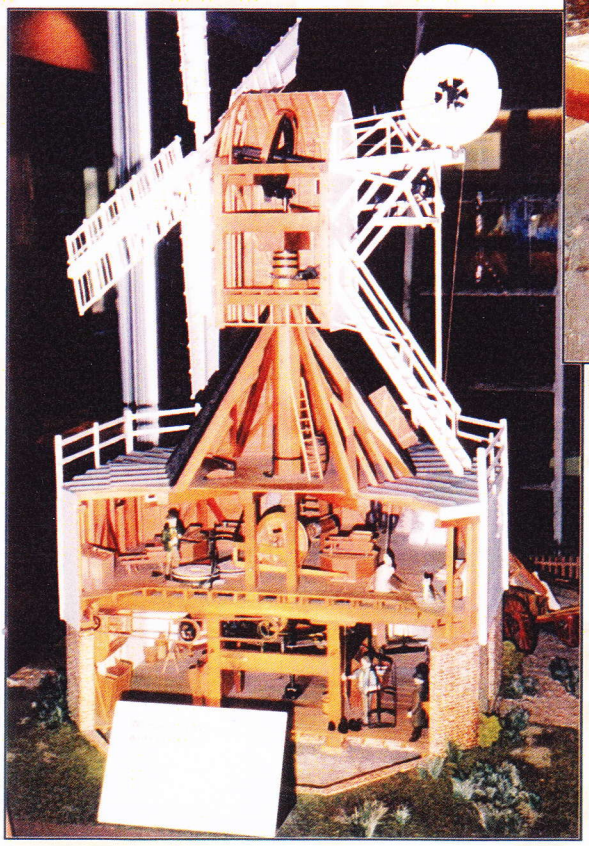
WIMBLEDON WINDMILL MUSEUM

TEACHERS' NOTES

ENGLISH
MATHEMATICS
SCIENCE
DESIGN & TECHNOLOGY
HISTORY
LOCAL HISTORY
GEOGRAPHY
ART

Find out about windmills and how they work

Experience "hands on" flour making



enjoy our display of working models

THE WINDMILL MUSEUM AS AN EDUCATIONAL RESOURCE

Traditional windmills can make a positive contribution to education across a wide range of the curriculum - **English, Mathematics, Science, Design and Technology, History, Geography and Art.** The following briefing notes are intended to give teachers an overview of these opportunities from which they can select appropriate material.

For many years schools have visited the Wimbledon Windmill Museum on a regular basis because of the opportunities for cross-curricular studies. The museum offers a direct teaching service that can be adapted to the needs of individual classes. The children may handle many of the exhibits in the museum and 'hands-on' activities are encouraged. The children are shown sheaves of wheat and early farm tools used for harvesting and threshing, and encouraged to grind flour for themselves using a hand quern. The advantages and disadvantages of wind and water power are discussed and the development of wind powered milling from the earliest Persian and Greek mills to modern aero-generators is illustrated using a large number of working models. The children are invited to 'spot the differences' between early and late mills. These differences include not only technical developments but also the introduction of glass in windows and paint on woodwork.

The change from toll milling (a service provided by the Lord of the Manor for his tenants) to merchant or commercial milling and its effects on the community and the design of mills is explained. A detailed model of Wimbledon windmill in its working days shows how power was transmitted from the sails to the milling machinery and examples of this machinery are displayed. There are gear wheels and shafts made from timber and cast iron, bronze bearings, governors, sail shutters, millstones and a flour-dressing machine. Finally, because the mill was converted into living accommodation after it ceased working in 1864, one room has been retained and furnished with artifacts, as it would have been in about 1870.

The small shop attached to the museum sells publications, post cards, pencils, badges, maps, model kits and cut out sheets for making windmills. There are also packs containing samples of wheat, grain and whole meal flour.

ARRANGING A VISIT

School visits to the Windmill Museum on Wimbledon Common can be arranged by telephone - **020 8947 2825.**

Admission Charges

Admission charges are £2 per child with a minimum charge of £25. There are no charges for accompanying adults.

Preparation

It is helpful if children have been given some understanding of:
i) The historical period i.e. pre-industrial Britain or, at a more basic level, the fact that things have not always been the way they are now.
ii) Sources of energy.
iii) The seed-flour-bread making chain of events.

Facilities

There is free parking for cars and coaches adjacent to the windmill. There are toilets and a café nearby. The windmill is surrounded by heath and woodland, which provides an opportunity to combine a visit to the museum with a nature walk and there is an Information Centre nearby covering the history and natural history of the Commons.

There is more information on our web site: www.wimbledonwindmill.org.uk

and on the Commons Conservator's web site:

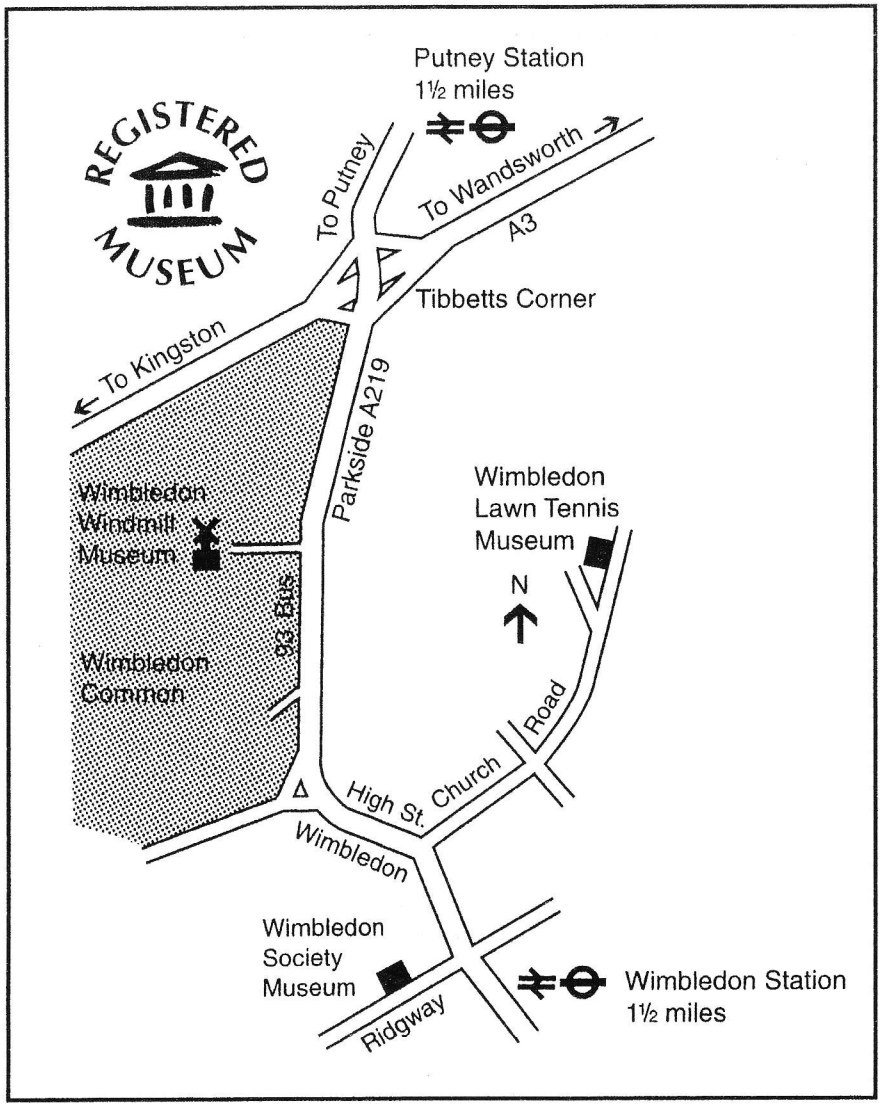
www.wpcc.org.uk

Wimbledon Windmill
museum

Windmill Road
Wimbledon Common
SW19 5NR

open April to October
Saturdays 2.00 - 5.00pm, Sundays &
public holidays 11.00am - 5.00pm

SCHOOL GROUPS AT OTHER TIMES BY ARRANGEMENT
(TEL: 020 8947 2825)



Windmill Road is off Parkside (A219). The 93 bus route runs along Parkside linking Wimbledon Station [District Line, Main Line and Tramlink] and Putney Station. There is free parking for 300 cars and a café adjoining the windmill.

Registered Charity No. 1015265

web site: www.wimbledonwindmill.org.uk

A General Introduction

Windmills give a link to earlier ways of living, the harnessing of natural forces to produce power, early forms of machinery and the use of different materials to achieve ingenious solutions to practical problems.

Cereals, such as wheat, have been cultivated from plants of the grass family for over ten thousand years but because the seeds were hard, crushing them into flour required hard abrasive material such as stone. Early methods involved the use of pestle and mortar, saddle stone and the hand quern. Examples of all these are shown and can be used in the Museum.

The quern comprises one stone turning above another with a hole in the centre into which the grain is placed. It became the basis for mechanical flour-making because it allowed continuous production. At first the stone was turned by hand, then in Roman times by animal power or waterpower. The power of the wind was not used for milling until the eighth century in the Middle East and until the twelfth century in this country.

Waterpower has many advantages over wind power. A stream of water can be relied upon, except in extreme conditions of frost or drought. A stream of water always flows in the same direction. The speed remains relatively constant and the volume can be controlled. A surplus of water can be stored and used when needed. The wind, however, does not always blow. It does not always blow in the same direction or at the same speed and it cannot be controlled or stored for use at another time. It is therefore a very unpredictable and unreliable source of power.

Windmills were not built from choice but from the necessity to produce flour in areas where there were no suitable streams. This is why there are more windmills in the East and South of England where the land is flatter and there are fewer fast flowing streams.

The machinery used to drive millstones was similar in windmills and watermills but in the case of the latter it could be housed in a simple, fixed building adjacent to a stream. A windmill needed to be built on an exposed site. The sails would only work if they faced into the wind so the building on which they were mounted had to be turned to face the wind every time it changed direction. The covering of the sails also had to be changed when the strength of the wind changed. A windmill was therefore much more difficult to build and manage than a watermill.

Early windmills in this country were timber buildings balanced on a central post, which acted as a pivot on which the building could be turned. These were known as Post Mills.

Later mills were built in the form of a tower with a timber-framed cap on which the sails were mounted. With this type of mill only the cap turned into the wind and the fixed building below could accommodate more machinery. Tower Mills were normally built of brick or stone but where these materials were not readily available the tower would be timber framed and it was then known as a Smock Mill.

In early mills the machinery was almost entirely of wood with only a small amount of wrought iron for fixing and strengthening components. With the development of cast iron in the latter part of the 18th century the machinery changed and larger mills were built. At the same time, the efficiency of mills and windmill sails was improved by many ingenious inventions.

It was the import of harder grain from overseas in the latter part of the 19th century that led to the demise of the windmill. It was found to be more efficient to grind the grain between iron rollers than between stones. The growth of an efficient railway system also meant that large factory mills could be built near the ports and the flour distributed throughout the country. Now it was no longer necessary to have watermills or windmills to serve every small community and by the end of the 19th century most of them had stopped working.

More detailed explanations of these points can be found in the following sections.

ENGLISH

Speaking and listening

A windmill is very different from the buildings and machines with which pupils are familiar in everyday life. When visiting the Museum they will be told about these differences and invited to comment and ask questions. A picture will be built up of life at a different time when people had to rely more on their own skills and labour rather than machines. The ideas and inventions that were developed to overcome practical problems will be explained and the children will be invited to spot the differences in the way things were done. Imagining themselves in a time when life was different (when things which they now take for granted did not exist) can be the basis for further verbal or written exploration of the subject.

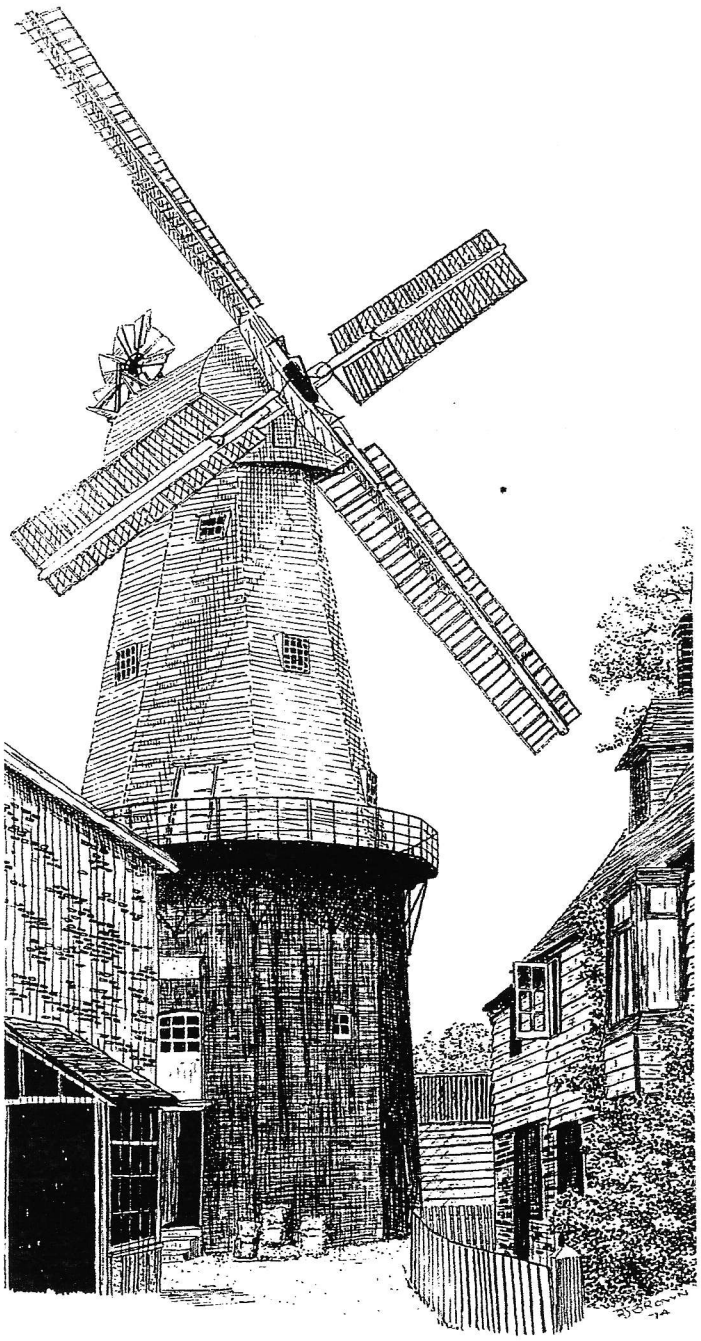
Reading and understanding

There are illustrations and captions, which provide an exercise in reading and understanding. Books on wind and water mills, flour and bread making are available from the museum. For pre-visit reading, Discovering Windmills by John Vince and Wimbledon Windmill by Norman Plastow provide a good introduction.

There are many examples of poetry relating to mills.

Writing and Extending Vocabulary

The visit should provide plenty of inspiration for exercises in prose and poetry. New words to which pupils will be introduced include gear, cogwheel, pulley, shutter, meal, threshold, sickle, scythe, flail and even pickthank. For those who are really keen there is a glossary available covering over 400 words used in milling - it is entitled "The Quant in the Glut Box on the Sprattle Beam".



Cranbrook Mill, Kent by R.J. Brown

Behold! A giant am I!
Aloft here in my tower,
With my granite jaws I devour
The maize and the wheat and the rye
And grind them into flour.

Henry Wadsworth Longfellow

MATHEMATICS

Numbers

There are opportunities for counting and calculating e.g. the number of cogs or teeth on a gear wheel. If gear wheels are of different sizes their speed will differ in the same proportion (see diagram below).

Shapes and Measurement

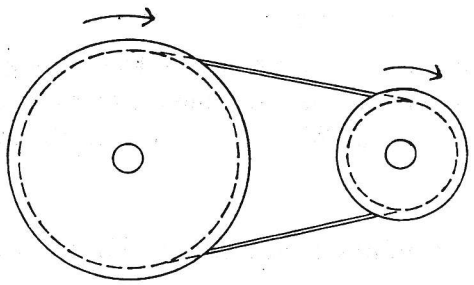
There are models of many shapes of windmill; cuboids, cylindrical, conical, hexagonal and octagonal, with caps in the shape of domes, and prisms. Wimbledon Windmill itself has a tower in the form of a truncated cone over a two storey octagonal building.

Handling

The size and weight of sacks of grain and flour can be considered. The standard sack of flour that a miller had to carry on his back weighed 120 kg., 280 lb. Or 20 stone. There are several types of scales on display for weighing as well as chutes and elevators for moving grain and flour.

There is a block and pulley in the Museum that can be used to illustrate how weight and distance travelled can be changed to make heavy weights appear lighter.

Pulleys and Gear Wheels



Power can be transmitted between pulley wheels by means of a belt and the speed of turning can be changed by using large and small pulley wheels. The large pulley wheel shown here is twice the diameter of the smaller one so the smaller wheel will turn twice as fast and in the same direction. The transmission of power relies upon friction.

In windmills, the force of the wind is used to turn the sails and thus the shaft to which they are fixed. However, there are two problems to be solved:

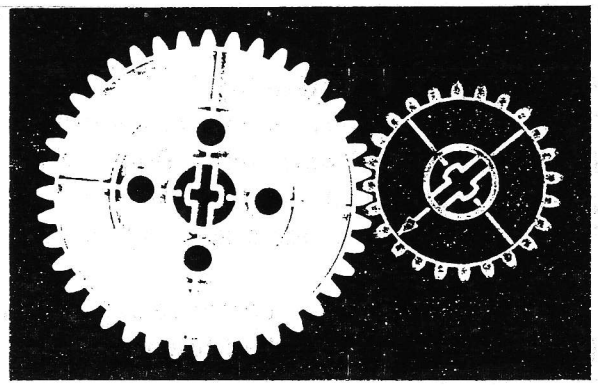
i) The sails turn in a vertical plane whereas the millstones need to turn in a horizontal plane.

ii) The millstones need to turn at a higher speed than the sails.

Gear wheels can be used to change direction as well as speed. A horizontal drive can be changed to a vertical drive by using a pair of bevel gears and if the gear wheels are of different sizes the smaller one will turn faster. The cogs or teeth on gear wheels allows them to transfer power without slipping.

Before the invention of bevelled gears the change in direction was achieved by using a face gear or contrate gear with a lantern pinion. (There are examples of many types and sizes of gear wheels in the Museum).

Note: The difference between cogs and teeth is that cogs are fitted into a wheel while teeth are an integral part of the wheel.



The ratio between these gear wheels is 5:3 (40 teeth to 24) so the smaller wheel turns five times to every three revolutions of the large wheel and in the opposite direction.

There are push button models of gears in the Museum to illustrate this and in the working model of Wimbledon windmill.

SCIENCE

Materials and their Properties

There are many examples of the uses of different materials. Brick, stone and timber for buildings; timber and metal for machinery. *For details of Materials see page 8.*

Forces and Motion

Wind power is used to drive machinery, which turns the millstones, sifts the meal and moves grain and flour around the mill but other forces, such as the force of **Gravity,** are used in mills. Having lifted grain to the top of the mill using wind power it is allowed to flow down again, from one machine to another, making use of gravity. Sometimes the two are combined; for example a steady flow of grain to the millstones is achieved by allowing it to fall down a sloping chute assisted by vibration, provided by the wind powered machinery.

Friction is used to stop the sails turning. An iron or timber band, fitted around the main gear wheel, is tightened to act as a brake. (The problems inherent in using friction should be noted i.e. wear of the component parts and the generation of heat, which can be dangerous.) Friction between leather belting and wooden pulley wheels is used to turn some machinery. Friction is reduced when oil or grease is used to lubricate the surface.

The force of Springs is also used. For example the wooden spring used to control the movement of the shoe feeding grain to the millstones and, on some mills, leaf springs to allow the shutters on the sails to open and close according to the strength of the wind.

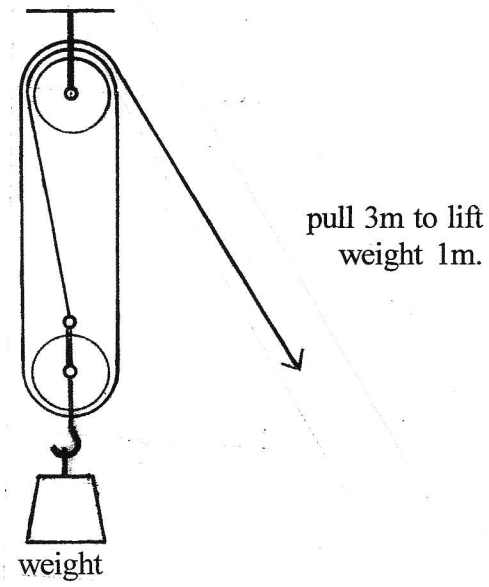
Centrifugal force is used to control the space between millstones by means of a governor. The governor has two suspended weights that turn in a circle. As the power from the sails increases the weights move outwards due to centrifugal force and move a series of levers that adjust the spacing of the millstones. *For gear wheels and pulleys see Mathematics.*

Equipment

In the Museum there is a hoist or 'block and tackle' for lifting heavy weights. This may be used to explain the differences between force, energy and power.

A rope, which is fixed at one end, passes over two pulleys and the sack is attached to the lower pulley. The sack is thus supported on three lengths of rope. To raise the sack 1m., the free end of the rope is pulled 3m. This shortens each of the three lengths of rope by 1m and lifts the sack by that amount. If the sack weighs 30kg. then the amount of **force** required to move it is 3kg. But the amount of **energy** required to lift the sack 1m is 30kg. x 1m or 30kg.m. The pulley system enables weight and distance moved to be exchanged. Because the free end of the rope is moved 3m., only 10kg. of force is required to move the 30kg. sack.

30kg. x 1m. = 30kg.m = 10kg. x 3m.



Another way of looking at this is that because the 30kg. sack is supported on three lengths of rope, each rope has to carry only 10kg. By pulling the rope 3m, each length is shortened by 1m using a force of only 10kg.

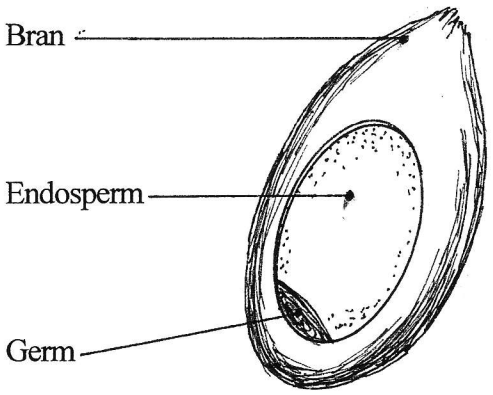
Force x distance x duration = **power**

LIFE PROCESSES

Corn

Corn is a general term for any cereal or grain bearing plant. Grain is the seed of the plant removed from the stalk by threshing and is the raw material used for making flour and as a feed for animals. Four types are commonly used in Britain; wheat, barley, oats and rye. Wheat is the most commonly used grain for making bread in this country.

A grain of wheat consists of three parts:



The Bran or brown skin (12%).

The Endosperm, which is the white kernel of the grain (85%).

The Germ, which is the embryo of the new plant (3%).

Suggestions for practical work in the classroom are:

i) Plant some grains of wheat on wet kitchen paper and keep it wet. In a few days it will sprout and start to grow.

ii) Plant grain outside in the spring and harvest it in early autumn.

iii) Use a magnifying glass or low powered microscope to examine grains and draw them.

Types of Grain

Wheat

This is a grain that contains a good balance of protein and gluten. It also contains starch and carbohydrates. Gluten is the substance that binds the flour together and, with yeast, produces an open texture in bread.

Bearded Wheat

There are many varieties of wheat. This one is particularly suitable for making pasta.

Oats

Oats are used for making porridge. The grain is roasted to make it crisp. This is then broken away by rough grinding between 'shelling' stones. The centre part of the oat, known as groat, can be milled to produce oatmeal for making porridge. Oats are also used as animal feed.

Rye

This grain is used in parts of Europe for making 'black bread'. Because the grain contains less gluten than wheat the bread tends to be denser and dryer than that made with wheat. Its best known use in Britain id for making Ryvita.

Barley

Barley is a grain used mainly for making malt for brewing beer, bakery and confectionery products. It is also added to soups and stews. Malt is produced by wetting the barley so that it starts to sprout and then drying it.

Other Grains and Seeds

There are other grains and seeds that can be used in the manufacture of bread. Soya Linseed, sunflower, pumpkin, millet and poppy seeds can all be added to give different textures and flavours to bread.

Maize

A cereal plant native to North America and known there as corn. It yields large grains set in rows on a cob. It can be ground into flour but in this country it is known as sweet corn and is used like a vegetable or for making popcorn.