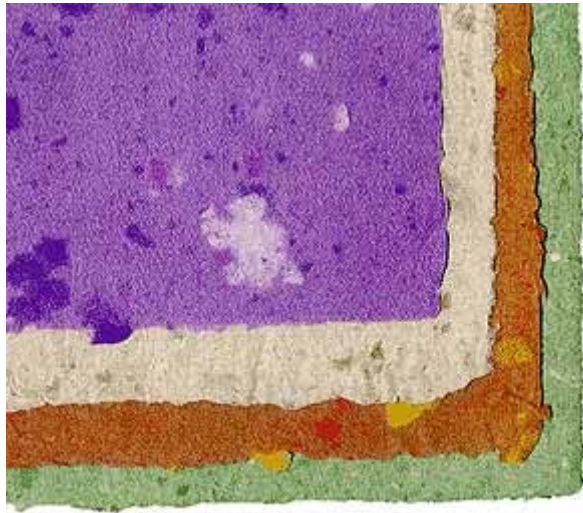


Paper



What is paper?

Paper is a network of plant fibres laid down as a flat sheet. It is made from a suspension of plant tissues in water known as pulp. Most pulp is made from wood, but recycled paper and other plant sources, including hemp, cotton, esparto grass, sugar cane bagasse and bamboo, can also be used.

History of paper-making

Our word paper is derived from the Egyptian 'papyrus', which was applied to sheets of writing material made by pressing together strips of the stems of the sedge, *Cyperus papyrus*. Paper as we know it, made up of a mesh of randomly arranged

plant fibres, was invented by the Chinese in the second century AD.

In AD 105 a Chinese court official, Ts'ai Lun, produced a paper web from a slurry of paper mulberry (*Broussonetia papyrifera*) fibres in water. A small amount of the slurry was lifted up in a rectangular sieve consisting of a sheet of silk surrounded by a frame. The sieve was shaken gently to spread the fibres evenly and, as the water drained off, they settled to form a sheet which was then dried in the sun. This process produced a long-lasting, high quality paper, as can be seen from the samples preserved in the British Museum. Chinese paper-makers found that they could vary the characteristics of the paper produced by using different plants as the sources of fibres.

Over 600 years later, a Chinese paper-making factory in Samarkand was captured by an Arab army. The Arab conquerors used the expertise of the Chinese paper-makers to set up factories throughout the Moslem world and paper-making techniques first arrived in Europe when the Moors conquered Spain. The raw materials for paper-making were hemp and linen rags, including some from the wrappings of mummies. The first paper-mill in Britain was built in Hertfordshire in 1488 and was referred to in a book printed by Caxton in 1490.

By 1800 paper-making factories were using 24 million tonnes of rags per year and supplies of the raw material fell short of requirements. The search for a cheap, readily available and easily renewable substitute began. A French biologist observed that wasps' nests were made of a form of paper which the wasps produced by macerating wood and he suggested that wood might be a suitable material for papermakers to use. The first recorded use of wood for paper-making in Europe was in 1769 but it was not until 1840 that paper made entirely from wood pulp appeared. The first newspaper to be made from an all-wood pulp, the *New York Times*, appeared in 1870. Early wood pulps were made by grinding logs between two slowly spinning stones. Pulp made by dissolving the woody substances in cell walls using strong chemicals did not appear until 1851.

The paper-making process was made faster and cheaper by the invention of the Fourdrinier paper-making machine, which used a continuous wire-mesh belt instead of individual paper moulds for forming a sheet of paper. This machine was first used in England in 1803 and finally ended the slow process of paper-making by hand.

What is paper used for?

Paper is used for all types of printed material, from exercise books to encyclopaedias. The type of paper varies according to the final use and life time of the product. Banknotes, which must be strong and durable, are made from high-quality pulp derived from new cotton rag trimmings and flax. Paper's absorbency is another valuable property that is put to good use in tissues and various other cloths used for soaking up liquids.

The packaging industry also depends on a continued supply of paper. It is combined with layers of plastic film, metallic foil or fabric in a process known as lamination. It is water-proofed, waxed or glazed, moulded or embossed, coloured, coated and printed. Recent developments in packaging of liquids use chemically produced pulp, bleached white and coated with plastic to form a clean, water-resistant, attractive container.

A high proportion of paper is made in the form of paperboard (nearly half of all paper in the USA) which is used in many different types of packaging. Folding cartons, so important in packaging, were first introduced in 1880. Corrugated card, made from sheets of corrugated paper between two sheets of paperboard, is useful because it is light but strong. Although the pulp used must be strong, whiteness is not necessary, so the semi-mechanical or the chemical processes, without added bleaches, are employed at the pulping stage.

Other specialist products made from paper include insulation for electrical boards, printed circuits for the electronics industry, filters for many applications, disposable clothing for medical uses, bandages, car filters and fascia boards, damp-proof courses, fireworks and shot-gun cartridges. Special treatments can be applied to make paper flame resistant or capable of holding security information that is only visible under ultra-violet light. Paper can also be spun into string and used for tying and sealing or for making furniture and floor-coverings.

Handmade papers are often preferred for high-quality book publishing as well as for conservation purposes in the repair of old books and paintings. Many print-makers and water-colour artists also depend on handmade papers and in China and Japan they are used widely for ceremonial purposes. Because the fibres in hand-made paper tend to be considerably longer than those in mechanically produced paper, it is much stronger and can be used, after oiling to make it waterproof, for house partitions, windows and umbrellas.

Who uses paper?

The international character of paper is reflected by the fact that 90 countries produce paper and nearly every country in the world consumes it. In 1987 212 million tonnes of paper were produced worldwide and 46 million tonnes entered world trade. In the mid 1950s 60 per cent of the pulp used in the domestic industry of the developing countries was imported but this proportion had been reduced to 25 per cent by 1986.

In the UK, consumption per head of paper and paperboard in 1986 was about 143 kg, compared with 293 kg in the USA and less than 6 kg in India. The increased drive for literacy in the developing countries will affect the world-wide demand for writing and printing paper. A 1 per cent improvement in literacy in these countries could result in a 1 per cent increase in the annual consumption of these products.

Will there be a future supply of paper?

The Food and Agriculture Organisation have predicted that the pulp and paper industry will continue growing at least to 1995 with total world-wide demand rising to between 246-255 million tonnes. In 1984, over 65 per cent of the paper consumed world-wide was derived from wood pulp with 25 per cent coming from recycled waste paper. However by 1995, waste paper consumption is expected to

increase to meet a third of the total predicted world demand for pulp. Limits to the amount of waste paper that can be pulped are set by treatments to some pulp that make it unsuitable for recycling.

Foresters are breeding disease-resistant, fast growing trees to increase the supply of pulpwood. In 1984 94 million genetically improved conifer seedlings of loblolly pine (*Pinus taeda*) were planted in American forests. Plantation owners there forecast that these trees, when mature, will meet the projected demand for pulp and paper in the USA well into the twenty-first century.

Of the 20,000 species of tree known, only 40 softwoods and hardwoods are considered suitable for processing into pulp at present. Research into the commercial possibilities of other species is progressing so that areas of natural forest and woodland that are felled can be used more efficiently.