A *Brief Account of* PAPER

WHAT IT IS MADE OF

HOW IT IS MADE

WHAT IT IS USED FOR

WHY YOU SHOULD USE MORE PAPER AND PAPER PRODUCTS

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THE PAPER FOUNDATION

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To Make the Nation Paper Conscious

AN ORGANIZATION COMPOSED OF PAPER MANUFACTURERS, CONVERTERS, MERCHANTS AND SALESMEN TO PROMOTE A WIDER USE OF PAPER AND PAPER MADE PRODUCTS

Enquiries relating to paper will be gladly answered at the Information Desk at the Paper Exhibit, A Century of Progress World's Fair, or may be addressed to The Paper Foundation, Inc., Conway Bldg., 111 West Washington St., Chicago, Illinois.

A BRIEF ACCOUNT OF PAPER

Of What Is Paper Made?

PAPER is mainly composed of fibres matted together in sheets.

These fibres are technically known as "CELLULOSE" and are derived from cotton and linen rags, straw, rope and various kinds of trees. They are also reclaimed from all sorts of waste papers.

Corn stalks, Bagasse (the stalk of sugar cane) and Esparto, a grass peculiar to Spain and Algeria, are also used. The latter is used in England and on the Continent but not in America.

Cotton linters, the fibres of which are too short for textiles, are also used to a limited extent.

All these materials must first be converted into pulps.

How Are Pulps Made?

THE crudest form of pulp is made mechanically, by grinding peeled logs into a fibrous condition, and is called "GROUND WOOD." Such pulp is not pure Cellulose, as it contains non-fibrous material called "LIGNIN," which discolors and decays under the influence of sunlight and air. Ground Wood pulp contains only about 53 per cent of Cellulose fibres. It is good for papers and boards for temporary uses, such as News-print and Box-boards. Being low in strength it is mixed with stronger pulps to facilitate manufacture and to be sufficiently strong for its intended uses.

Pure Cellulose pulps are made by various chemical processes, the object of which is to dissolve the non-cellulose matter of the raw material, leaving only the pure cellulose fibres. Such fibres

are seemingly imperishable under the ordinary conditions. Specimens of paper nearly 1000 years old, made from cotton rag pulp, are still in existence. There is no evidence that papers made from properly prepared chemical wood-pulp will not last for years, but this sort of pulp has only been commercially made in the United States since 1882. Samples of paper containing it exist which are forty to fifty years old. Recent improvements in the technical control of paper-making indicate that excellent papers can be made from wood cellulose as well as from rag. Ordinarily the rag papers have more physical strength, but their strength depends upon the quality of rags used. New rag cuttings, for example, are preferred to old or colored rags in making papers in which permanency is an important factor.

What Else Does Paper Contain?

In order to adapt paper for the thousands of different uses various non-fibrous materials are usually introduced, although there are a few papers, such as filter papers, from which all material other than pure cellulose fibres should be excluded.

These non-fibrous materials include mineral substances, such as china clay which improves the opacity and printing qualities, and which may also be applied to the surface as a coating to make glazed paper for half-tone printing or for box-coverings.

Sizing:

In order to overcome or lessen the natural absorptive nature of paper-making fibres, except when such properties are desired as in blottings or napkins, towels, etc., "sizing" agents are introduced. Two types are used: Animal, such as gelatin, and vegetable, such as Rosin Soap. In the making of surface-coated papers Casein, a product from skim-milk, is employed because of its adhesive quality.

Sizing such as Rosin is mixed with the pulp before the paper is made, but animal sizing is applied to the surface of paper in

the making. In the manufacture of writing papers and index cards, both kinds of sizing are used in order to resist penetration and spreading of writing fluids.

In the manufacture of the majority of printing papers surface sizing is not necessary or desirable, because printer's ink is thick and slow to dry, hence a moderately absorptive paper speeds the printing by the penetration of the ink. Fast running presses require paper that, like News-print, is almost totally unsized.

Coloring:

Pigments and aniline dyes are widely used in paper-making. Even so-called white papers are given a pleasing tone by the addition of slight amounts of pink or blue. Color is principally added to the pulps before the paper is made, but certain very brilliant hues can only be obtained by surface staining, while cheap grades of cardboard or "Bristol," such as tickets are printed on, are also surface-colored for economy's sake.

How Are Papers Waterproofed?

Certain papers must be water-resisting, some must be grease- and blood-proof, others must exclude air so far as possible. Such papers require special treatment. These resisting properties are acquired both by the mechanical treatment of the pulps and by chemical immersion or the application to the surface of wax or oil.

Paper for Packaging:

By the appropriate method, paper may be made transparent and waterproof, and grease-proof, like "Glassine," or water-, grease- and blood-proof, like Vegetable Parchment. The former is popu-

lar for packaging cigarettes, candy boxes, etc., and the latter for wrapping meats, or in cooking, as it will not disintegrate in water.

Liquid Containers:

PAPERS, thin and thick, for food wrapping, for drinking cups or for liquid containers, are usually treated with wax or paraffin.

Building and Packing Paper:

PAPERS for building purposes are saturated with asphalt solutions or laminated with an asphalt centre, sometimes strengthened by the introduction of sisal threads, bagging or cheesecloth. The latter are also used for extra strong bags, case-lining and waterproof protection for export shipment.

How Is Paper Made?

THE basic principle in all paper-making for every sort of paper is the same mechanically, so far as forming the fibres selected and pulped. Various grades of pulps are selected in accordance with their suitability for the given purpose; either Rag, Groundwood, or chemically prepared Wood-pulp. Of the latter the principal kinds are known as "Soda Pulp" (a soft pulp made from poplar, aspen and chestnut), "Sulphite Pulp" (strong, bleached or unbleached, made from spruce, principally), "Sulphate" (an extra strong pulp made from spruce and from Southern pine, used largely for "Kraft" wrappings), "Manila" and "Jute" (made from old ropes), "Straw," and "Paper Stock" (waste papers, graded or mixed, de-inked or not as required).

"BEATING." The pulps and other materials selected for any given paper must first be "beaten" so as to break them down into individual fibres, and mixed with such other ingredients as

are needed. This preliminary step is accomplished in a so-called "Beating Engine," consisting of a large oval tub, equipped with a heavy roll of large diameter and weight, which is shod longitudinally with metal blades. It rotates over a "Bed-plate" in which other blades are imbedded and can be adjusted in its position so as to be either close or far from the bedplate. Large amounts of water are used to enable the pulp to circulate, and it is reduced to the desired consistency by the cutting and brushing action of the "Beater Roll."

When suitably conditioned, sized and colored, the pulp is drained into a large chest, from which it is pumped into a "Refining Engine" that gives it a final treatment and helps to make the fibres the desired length as well as to break up any knots of "stuff," so that each single fibre will be free from its mates. At this point the pulp is called "Stuff" and is thinned by additional water, which acts as a carrier, holding all the fibres separate and in suspension.

In this condition it passes into the "machine chest," where an agitator keeps it stirred up to prevent the fibres from matting together or settling toward the bottom of the chest. The consistency and uniformity of the stuff must be maintained constant in order that the paper may also be uniform in formation and thickness.

PAPER-MAKING. Having gotten the fibres completely apart, it is the function of the paper-maker to get them together in a uniform layer. The hand process which preceded modern machines serves well to explain the underlying principles of continuous machine-making of paper.

In order to make the single sheets of paper by the ancient method, the paper "stuff" is introduced into a vat. Here it is kept stirred so that the fibres in the water may be evenly distributed. The craftsman, called a "Vat-man," works with a mold consisting of a frame covered with woven wire cloth. A removable frame called a "deckle" is held on the top side of the mold by the hands of the vat-man, thus forming a shallow tray or sieve. His next step is to dip it into the vat, bring it out in a level position, and in so doing the pulp fibres are deposited upon the surface as the water in which they were suspended drains through. The distribution of the fibres is controlled by a skillful sidewise shaking so that they sink uniformly upon the wire cloth.

Now the sheet is formed, and as the water drains away, the fibres mat together, but are in a gruelly condition from the water still retained. It calls for great skill to remove the matted pulp without damage. To do this it is first necessary to set aside the deckle, invert the mold and by careful manipulation, press or "couch" the sheet upon a moistened piece of woolen "felt." Proper handling will cause the new-formed sheet to adhere to the felt, whereupon a second wet felt is laid over the paper, and the operator repeats the process until a suitable number of sheets have been piled up.

Paper's Affinity for Water:

Paper fibres, having a high affinity for water, retain large amounts like a sponge until it is squeezed out. So long as they are in the wet state the fibres are limp and would disintegrate at the slightest touch. Their cohesion sets in as the water departs, so the next step in paper-making is to expel the water that will not drain away by leaching or by gravity. To accomplish this, the pile or "post" of paper is placed in a powerful press. Ancient presses were operated by a screw but modern ones are worked by hydraulic force. The pressure must not be too hard, as the sheets would crush, but with the correct application of pressure they hold their formation, which becomes more dense and cohesive. Thus after the pressure has been released, it is not a difficult matter for the trained artisan to peel off the felts and remove the paper, sheet by sheet, to the poles over which it is suspended to dry. At this stage there still remains about 70 per cent of water in the paper. After sufficient exposure to the air, the moisture content drops to about six per cent. Paper's affinity for moisture never allows it to become "bone dry," but acting like a barometer it varies in moisture content in ratio to atmospheric conditions about it.

It was estimated that a certain writing paper contained 2.3 per cent of moisture at a relative humidity of 30 per cent, 6.3 per cent at a relative humidity of 60 per cent (which is a normal condition of the air), and 13.5 per cent of moisture with a relative humidity of 90 per cent.

The Effect of Drying:

As paper dries, the fibres shorten a trifle and shrink in diameter. That is the secret of paper-making, for it causes the tangled mass to tighten together. The converse is true when a piece of paper is wet. Everyone must have observed that most paper breaks more easily as it becomes wetter, and if thoroughly soaked, is ready to disintegrate at a touch.

It is less generally recognized that paper alters in dimensions under changing atmospheric conditions, often to the embarrassment of printers.

As the paper is separated from the felts it naturally tends to assume the weave or texture of the felt. This gives it its characteristic surface, which however may be smoothed to a glossy finish if desired, by a process known as calendering, or it may be embossed and decorated.

Now bearing in mind the principles of paper-making by the hand process, let us briefly consider how man's ingenuity contrived to make it in a continuous web instead of slowly, sheet by sheet.

Paper Machinery:

In place of the mold, an endless woven-wire belt was arranged over a level series of rolls, terminating in a pair of heavier rolls, the top roll jacketed in a seamless felt. The belt, or "wire," as it is called, is set in motion and a uniform stream of paper "stuff" is flowed upon it. Naturally the result is the same as in the hand process, with the very important difference that it is continuous, and the stream of fibre-laden water soon converts itself into a web of paper in the making. The pressure of the felt-jacketed "couch roll" imparts sufficient density to the web so it may be passed over upon an endless felt blanket which conveys it between "press rolls." There is a series of such rolls, which act continuously, expelling more and more water until it is impracticable to depend further on pressing. At that stage there is some

70 per cent of moisture remaining in the web. The next step is to pass the web over a series of steam-heated dryers, cylindrical in form, which can be synchronized in speed so as to carry it along without breaking. Finally there is a "stack of calenders" through which the paper is threaded if a smooth finish is wanted, or if the rougher finish is preferred, some of the rolls are raised to allow the web to pass between to the "reels," upon which the full width of the paper is wound. In order to produce the widths as ordered, the full width web is passed under adjustable slitters which split it to the dimensions specified, and each individual width is wound into a separate roll, or cut off into sheets of a given length at the end of the machine.

The Fourdrinier Machine:

THE type of machine just described is known as the "Fourdrinier," and was named after two London stationers who were the financial backers of Louis Robert, the inventor, whose first machine was erected in England in 1804 and revolutionized the paper industry.

This machine can make but a single web of paper, but the thickness may be varied within certain limits, from a tissue to a moderately thick card. Only by pasting two or more sheets together could this limit be exceeded.

The Cylinder Machine:

THIS led to the invention of the "Cylinder" paper machine by John Dickinson of England in 1809, and made possible the formation of paper boards, now the largest production item in the whole industry.

On this machine, the formation of paper in a web employs the very same principles as the hand mold, but does it continuously. Simple as the construction is, the management calls for experience to produce paper of uniform character.

A cylindrical wire-cloth-covered mold revolves in a pulp vat.

The paper "stuff" is admitted through the floor of one compartment and the fibre-laden water escapes by gravity through the meshes on its way out through an aperture in the end of the cylinder, leaving a layer of fibres over the mold.

An endless felt runs tangent to the top of the mold and between it and a rubber-covered press-roll. The pressure enables the felt to pick up the web as it forms, and carry it forward to the press-rolls and thence to the dryers. From that point onward this paper machine varies only in details from the Fourdrinier machine. Its advantage is that a number of these cylinders may be arranged in series, so that the product of each vat is picked up on top of the next preceding one, thus enabling a web consisting of as many as six or more plies to travel along together, forming one homogeneous endless sheet.

While tissue papers are sometimes made on single cylinder machines, the main application of the "Cylinder" machine is in the manufacture of thick paper and paper boards.

Hand Process Vs. Machine:

THUS has man's ingenuity supplanted the ancient art of papermaking, which is not less an art than of old, as no machine can turn out good paper without highly skilled workers possessed of excellent judgment. The largest sheet commercially made by hand was 31 by 53 inches. The great weight of the sheet required six men in place of three usually employed. The general run of hand-made papers varied in size from 25 by 20 inches to 15 by 12½ inches, and three thousand sheets a day constituted a good day's work.

Today three men can manage a machine capable of making twenty-five tons in 24 hours, and larger crews are needed for the bigger machines, but six men can handle the largest, many of which can make fifty tons of paper in a full day's run of 24 hours.

In the old times only a few kinds of paper were made; book, writing, hanging, and cardboard (pasted). Today the variety is almost uncountable. As new requirements arose, new sorts of paper were produced to meet them until it might almost be said that ours is the "Paper Age."

Converted Paper Products:

PAPER IS VERSATILE—ITS USE SAVES MONEY

PAPER has outstepped its ancient bounds as the hand-maiden of printing, thanks to modern science, and today can be transformed into a wide variety of products. "The finished sheet can be porous or dense, strong or weak, thick or thin, white or colored, stiff or flexible, absorbent or waterproof. It can be dull or shiny, transparent or opaque, light or heavy. Experience has shown that it can compete successfully with such materials as steel, glass, rubber, cloth, cotton, wood, cork and stone.

PAPER CUTS MANUFACTURING COSTS

"Paper is used to cut manufacturing costs; and to increase the qualities of manufactured products. It is used for educational purposes and in the promotion of sales. Its protective resistance against the elements, and against chemicals, abrasion, and rupture is universally recognized." Any industrialist on the outlook for improved methods or lower material costs should ponder this statement. He should consult some paper expert, who perhaps can show him the way to new profits by the use or adaptation in part, of paper products.

THE MERCHANT'S BIG OPPORTUNITY
WOMEN NEED PAPER'S HELP TO SAVE LABOR

The merchant owes it to himself and to his trade to become more familiar with the many economical and attractive paper commodities and to organize real Paper Departments in his store, to serve the needs of domestic life; to lighten the labor of the housewife by emancipating her from much toil by the substitution of the up-to-date paper towels, napkins, doilies, cups, dishes, etc.; to improve her cooking by the use of vegetable parchment, in which food can be prepared without loss of flavor and valuable vitamins that now escape; to enable her to cook onions or cabbage without scenting her home. The same Vegetable Parchment laid into the roasting pan absolves her from the disagreeable task of scouring greasy remains. Moth bags are another necessity which paper satisfies.

HYGIENE IS PROMOTED BY PAPER

Then for hygienic reasons, paper should be better known. The children's school luncheons should be wrapped in waxed paper to prevent contamination and to protect their clothing from penetrating grease. When folks catch cold, the only wise preventive from spreading the germs is to use the soft paper tissues for handkerchiefs. If unfortunately tuberculosis finds a victim, he should protect his family by using sputum cups of paper which can easily be burned. Many of the other sanitary paper preparations have become indispensable to milady, so why not extend the benefits of paper in her home?

BUILDING COSTS CUT BY PAPER
HOME FURNISHINGS OF PAPER COST LESS

In the building of that home, paper can help to protect from the elements, from heat and cold and at a lower price than other materials. Paper is the best of insulating material. The old house can be cheaply repaired on the outside by attractive siding or roofing materials of paper origin. The floors may be covered with linoleum-like rugs or imitation rush carpeting at a very modest cost. Paper window shades, lamp shades and decorative flowers of most life-like appearance can make interior decorating very inexpensive and attractive.

VISIT THE PAPER EXHIBIT AT CHICAGO'S WORLD'S FAIR

The list of available paper articles is too large to cover, but the art of merchandising them appears to lag behind. Perhaps the Paper Industry is at fault in this respect, but the Paper Foundation's Exhibit at A Century of Progress in Chicago has striven to give an object lesson in paper. There you could see a "House of Paper," complete in all its appointments because of Paper Products. Indeed the buildings of the Fair itself have demonstrated how costs can be cut by using special paper products in walls, roofs and floors.

A study of these economical aspects of paper and paper products is equally important to manufacturers seeking to reduce production costs, and to the general public. The use of suitable paper products always spells ECONOMY.

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PAPER'S PROGRESS

A. D.	
105	Discovery of the art of Paper Making by a Chinese.
751	Arabs defeated Chinese in battle and learned of Paper Making from prisoners.
1102	Paper first made in Europe.
1498	First mill started in England.
1690	Rittenhouse started first American Paper Mill at Roxborough, near Philadelphia.
1798	Louis Robert of France invented the Fourdrinier Machine.
1809	John Dickinson of England invented the Cylinder Machine.
1827	First Fourdrinier Machine set up in United States.
1840	Ground Wood invented in Germany by Keller, whose observations of wasp's nests inspired the idea.
1854	Soda Pulp invented in England by Watt and Burgess.
1866	Sulphite Pulp invented by Tilghman in the United States.
1882	Sulphite Pulp first made by C. S. Wheelwright of Providence, Rhode Island.
1884	Sulphate Pulp invented by Dahl.
1886	Ground Wood first made at Curtisville, Mass., by Pagenstecher.
1890	By this time a new Paper Industry had been built up in the United States.
1933	America now produces half of the Paper output of the World.

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