

THE EVOLUTION OF PAPER MAKING

Consider how often you use paper. You might use paper for writing, wrapping, drawing or baking. Paper products are all around us—from books to greeting cards, from dinnerware to luggage, from paper towels to packaging materials, and more.

AD 105 is often cited as the year in which papermaking was invented. In that year, historical records show that the first paper was reported to the Chinese Emperor by Ts'ai Lun, an official of the Imperial Court. Ts'ai Lun was the first to make what we now commonly think of as paper from finely chopped mulberry bark and hemp rags. He mixed the materials with water, mashed the mixture flat, pressed out excess water and let it dry in the sun.

Recent archaeological investigations, however, place the actual invention of papermaking some 200 years earlier. Ancient paper pieces from the Xuanquanzhi ruins of Dunhuang in China's northwest Gansu province apparently were made during the period of Emperor Wu who reigned between 140 BC and 86 BC. Whether or not Ts'ai Lun was the actual inventor of paper, he has been given a place of honor in Chinese history for his role in developing a material that revolutionized his country.

As modern technology advanced, people started making paper mechanically or chemically, and not as often by hand. Even with these advances, however, the basic concepts remain the same.

In the 20th century, with the advent of plastic manufacture, some plastic "paper" was introduced, as well as paper-plastic laminates, paper-metal laminates, and papers infused or coated with different substances to produce special properties.

GLOBAL SPREAD AND TECHNOLOGICAL EVOLUTION

- Asia: Papermaking technology spread from China to Korea and Japan by 610 AD, where it became a crucial, refined craft.
- Islamic World: The technology reached the Islamic world in the 8th century, with major production centers developing.
- Europe: Paper arrived in Europe in the 11th century, with the first mills appearing in Spain. Italian papermakers later improved the craft by using water-powered stamping mills, adding watermarks, and using animal glue for sizing.
- The Americas: Indigenous cultures in Mesoamerica, such as the Maya, used *amate* (bark paper) as early as the 5th century AD.



Amate paper: fibers are flattened with a flat volcanic rock. San Pablito, Puebla, Mexico. Photo Luis Fernando Orozco Madero.



A model of the original paper-making machine invented by Louis Robert in France in 1799. In the museum of the Frogmore Paper Mill. Photo Chris55.

INDUSTRIALIZATION AND MODERNIZATION

- **First Paper Machine:** In 1798, Nicolas-Louis Robert in France created a machine to produce continuous sheets of paper.
- **Production Improvements:** In 1820 England, Thomas Crompton invented heated steam cylinders for drying paper on-machine, significantly increasing production speeds.
- **Contemporary Times:** Today, paper is manufactured from wood pulp or recycled fiber, with advancements focusing on sustainability and specialized uses.

THE PROCESS OF PAPERMAKING



RAW MATERIALS FOR PAPER ■ The material of choice for the European papermaker was cotton or linen fiber from rags. The rags were sorted, cleaned, and heated in a solution of alkali, at first in an open vat and later under steam pressure. After draining and seasoning, the rags were then washed and macerated to a pulp, which was then bleached to remove the final traces of dyes and the residual darkening from the cooking process.



PAPER MOLDS ■ To form a sheet of paper, the papermaker dipped a paper mold into the vat of stock and lifted it out horizontally, trapping the fibers against the screen of the mold. Paper molds were made by hand from parallel lengths of wire laced together together with fine wire or thread or from woven wire mesh.



DRYING THE SHEET ■ After forming, the papermaker removed the sheet from the mold and placed it on felts or woolen cloths for pressing. In the European papermill, a stack of paper sheets and felts, called a “post,” was placed in a large wooden screw press, and all the workers in the mill were summoned to tighten the press by pushing or pulling a long wooden lever. An average 2-foot post might be reduced to 6 or 8 inches in this way.

After pressing, the sheets were strong enough to be lifted from the felts and hung to dry, usually in groups of four or five to prevent wrinkling and curling. Drying was usually carried out in the highest level of the mill, away from soot and dust.

SIZING AND FINISHING ■ To make the paper less absorbent, the dried sheet was dipped in animal gelatin or glue. Such sizing was more important for writing papers than for printing stock, since printing inks were thicker and did not soak into the paper so easily. The first method for smoothing the sheet was simply to burnish each sheet by hand with a glossy stone; a water-powered hammer smoother was developed in the early 17th century.

Top: Rags being made into paper pulp. Middle: Use of a paper mold to make a sheet. Bottom: Paper being pressed. Images courtesy of Pam DeLuco and Craft in America.