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The History of Printing

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Printing, a name used for several processes by which words, pictures, or designs are reproduced on paper, fabrics, metal, or other suitable materials. These processes, sometimes called the graphic arts, consist essentially of making numerous identical reproductions of an original by mechanical means. The printed book has thus been called the first mass produced product. The history of printing, which by its very nature is the most thoroughly documented of any history, is practically identical with that of relief or letterpress printing (printing from a raised surface). Historically, the bulk of all printing has been produced by this entirely mechanical method. Modern printing, however, increasingly relies on photomechanical and chemical processes.

Ancient Techniques

The application of signet stones is possibly the earliest known form of printing. Used in ancient times in Babylonia and elsewhere, apparently both as substitutes for signatures and as religious symbols, the devices consisted of seals and stamps for making impressions in clay, or of stones with designs cut or scratched on the surface. The stone, often set in a ring, was dabbed with pigment or mud and pressed against a smooth, resilient surface in order to make an impression.

The elaboration of printing from the simple stamping or signet-stone method to the process of printing on a printing press apparently occurred independently at different times in different parts of the world. Manuscripts copied by hand in ink applied with pen or brush were a significant feature of the Egyptian, Greek, and Roman civilizations. Such handwritten manuscripts were also produced in medieval monasteries and were greatly valued. In ancient Rome, commercial book publishers issued editions comprising as many as 5000 copies of such works as the epigrams of the Roman poet Martial. This copying work was done by literate slaves.

Printing in the East

By the 2nd century A.D. the Chinese had developed and put into fairly widespread use the art of printing texts. Like most inventions, it was not entirely new, because the printing of designs and pictures on textiles had preceded the printing of words in China by at least a century.

Two important influences that favored the development of printing by the Chinese were their invention of paper in A.D. 105 and the spread of the Buddhist religion in China. The common writing materials of the ancient Western world, papyrus and vellum, were not suited to printing. Papyrus is too fragile to be used as a printing surface, and vellum, a thin tissue taken from inside the hides of newly skinned animals, is an expensive material. Paper, on the other hand, is relatively strong and inexpensive. The Buddhist practice of making many copies of prayers and sacred texts encouraged mechanical means of reproduction.

The earliest surviving examples of Chinese printing, produced before A.D. 200, were printed from letters and pictures cut in relief on wood blocks. In 972, the Tripitaka, the sacred Buddhist scriptures comprising more than 130,000 pages, was printed entirely from wood blocks. A Chinese inventor of

this period progressed beyond wood blocks to the concept of printing entirely from movable type, that is, from individual characters arranged in sequence as in present-day printing. Because the Chinese language requires between 2000 and 40,000 separate characters, however, movable type did not seem practical to the early Chinese, and the invention was abandoned. Movable type made from molds was invented separately by the Koreans in the 14th century, but they also found it less practical than the traditional block printing.

Printing in the West

Movable metal type was first cast in Europe and printed with a printing press on paper by the middle of the 15th century. The invention appears to have been unrelated to earlier developments in the Far East, and the techniques differed considerably in detail. Whereas Eastern printers had used water-soluble inks, Western printers used oil-based inks from the beginning. In the East, printers made impressions simply by pressing the paper against the wood block with a flat piece of wood. The earliest Western printers in the Rhine River valley used mechanical presses derived in design from winepresses and made of wood. The Eastern printers who had used movable type held the letters together with clay or with rods pushed between the type. Western printers developed a technique of casting types with such precision that the letters could be held together by pressure applied to the edges of the tray containing the type for the page. In this system, a single letter a fraction of a millimeter too big could cause the letters surrounding it to fall out of the page. The development of a method of casting letters to precise dimensions was the essential contribution of the Western invention. The principles involved in printing had been used by European textile workers, in printing designs on cloth, for at least a century before printing on paper was invented.

The art of papermaking, introduced into the West in the 12th century, spread throughout Europe in the 13th and 14th centuries. By the mid-15th century paper was available in abundance. During the Renaissance, the rise of a prosperous and literate middle class increased the demand for quantities of reading matter. The rise of Martin Luther and of the Reformation and the subsequent religious wars were heavily dependent on the printing press and on the steady stream of printed pamphlets.

Johann Gutenberg, of the German city of Mainz, is traditionally considered the inventor of Western printing. The date associated with the invention is 1450. Both Dutch and French historians of printing have attributed the invention to people in their own countries and have produced considerable supporting evidence. The books of the first Mainz printer, however, particularly the book known as the Gutenberg Bible, far surpass in beauty and artisanship all the books that reputedly preceded them. Gutenberg's great accomplishment undoubtedly contributed decisively to the immediate acceptance of the printed book as a substitute for the handwritten or manuscript book. Books printed before 1501 are said to belong to the incunabula era of printing.

In the period between 1450 and 1500, more than 6000 separate works were printed. The number of printers increased rapidly during the same period. In Italy, for example, the first press was established in Venice in 1469, and the city had 417 printers by 1500. In 1476 a Greek grammar was printed wholly in Greek type in Milan, and a Hebrew Bible was printed at Soncino in 1488. Also, in

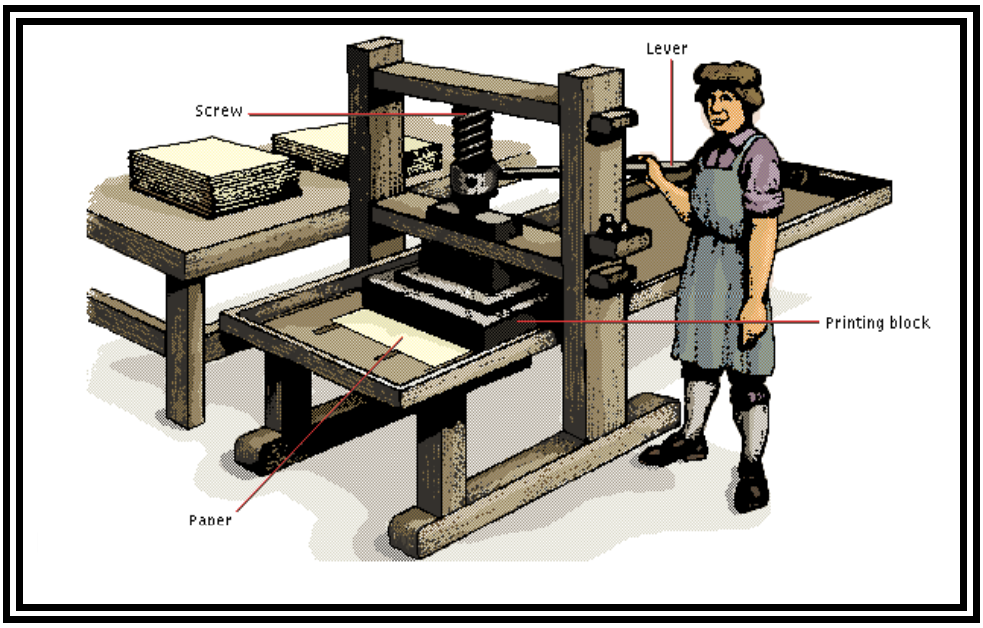
1476 printing was brought to England by William Caxton; in 1539 Juan Pablos set up a press in Mexico City, bringing printing to the New World. Stephen Day, a locksmith by profession, came to Massachusetts Bay in 1628 and helped establish the Cambridge Press. He is often considered the earliest printer in the New England region. In 1639, The Freeman's Oath, a broadside, was issued from this press, followed in 1640 by the Whole Book of Psalms or Bay Psalm Book and an almanac.

The printers of northern Europe produced mostly religious books, such as Bibles, Psalters, and missals. Italian printers, on the other hand, printed chiefly secular works, for example, the newly revived Greek and Roman classics, the stories of secular Italian writers, and the scientific works of Renaissance scholars. An important early use of printing was in pamphleteering; in the religious and political controversies of the 16th and 17th centuries propaganda pamphlets were widely circulated. The production of these pamphlets made considerable work for the printers of those days.

Printing Presses

The machine used to transmit the ink from a printing plate to the printed page is called a press. The first printing presses, such as those of the 16th century and earlier, were screw-type presses designed primarily to bring pressure on the printing form, which was placed face up in a flat bed. The paper, generally dampened, was pressed against the type by the movable surface, or platen. The upper parts of the posts of the press often were braced against the ceiling, and after the form was inked the platen was screwed down against the form. The press was equipped with rails on which the form could be slid out of the press and then back onto the bed, so that the platen did not have to be raised far. Nevertheless, the operation was slow and cumbersome; such a press produced only about 250 impressions an hour, printing only one side of the paper at a single impression.

In the 17th century, springs were added to the press to aid in lifting the platen rapidly. Presses made of iron were introduced about 1800, and about that time levers were substituted for the screws that brought the platen down onto the bed. These levers were rather complex; the first portion of travel on the lever bar had to bring the platen down most of the way, and the last portion of travel of the bar had to move the platen the remainder of the distance and apply great pressure. Although the best hand presses of this period produced only about 300 impressions an hour, much larger forms could be used with metal presses than with wooden ones, and therefore the press operator produced many more pages at each impression.



Lithography

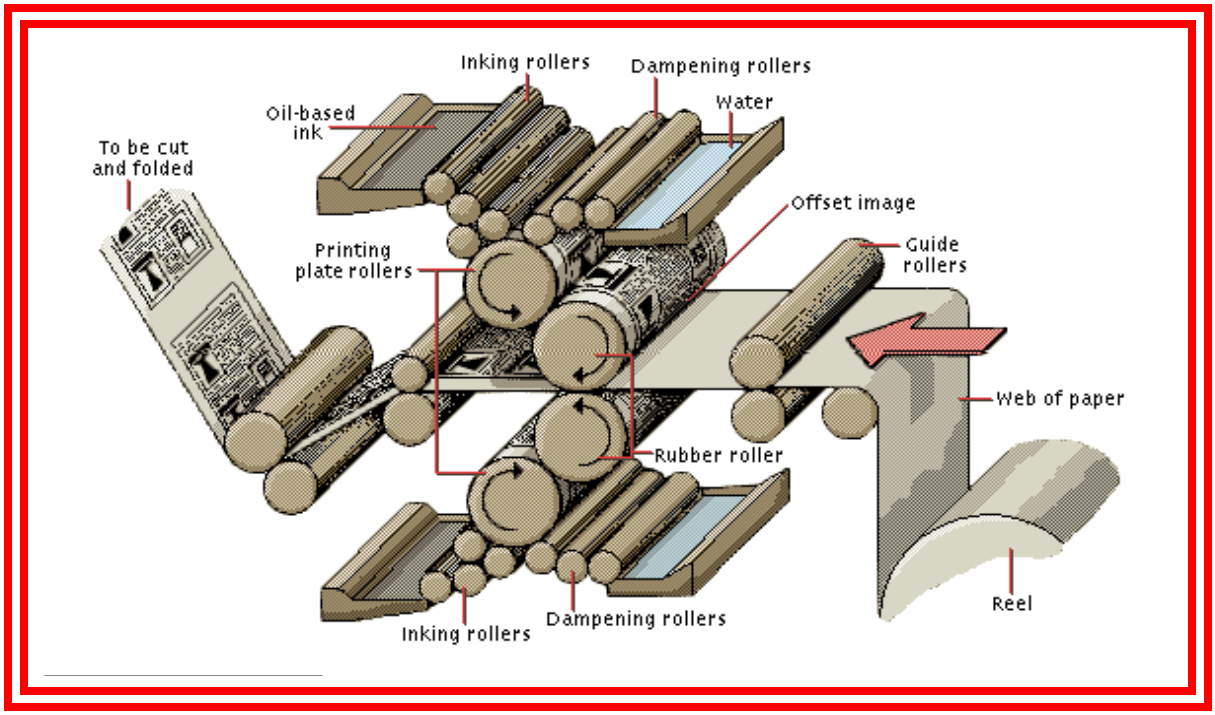
By far the most important and versatile printing process today is offset lithography. The underlying principles were established at the end of the 18th century by a German map inspector, Aloys Senefelder, who was experimenting with methods of producing limestone relief printing surfaces using an acid etching process. Senefelder found that a wet limestone surface would repel an oil-based printing ink, and that an image drawn on the surface with a grease pencil would repel water and attract ink. Any drawing on the stone surface could be reproduced by bringing a damp sheet of paper into contact with the freshly inked image. This cycle could be repeated several hundred times before the drawing could no longer be faithfully reproduced.

The process, called chemical printing by Senefelder, quickly became a popular art medium because it enabled artists to produce multiple copies of freehand drawings. By the late 19th century, multiple stones were being used to transfer as many as 30 separate colors to a single sheet of paper to produce exquisite color lithographs that resembled fine watercolor paintings. Modern lithography uses only four-color inks for a wide range of natural color reproduction.

During the 19th century improvements included the development of the steam-powered press; the cylinder press, which uses a revolving cylinder to press the paper against a flat printing form; the rotary press, in which both the paper and a curved printing plate are carried on cylinders; and a practical perfecting press, which prints on both sides of a sheet of paper simultaneously. Large-circulation daily newspapers require a number of these presses, side-by-side printing identical material simultaneously. In 1863 the American inventor William A. Bullock patented the first web-fed newspaper press, which printed from paper in rolls rather than sheets. In 1871 the American printer Richard March Hoe perfected the continuous roll press; his device produced as many as 18,000 newspapers in an hour.

The Offset Principle

In the early part of the 20th century, it was discovered that ink could be transferred from the lithographic surface to an intermediate rubber surface and then to paper. The rubber intermediate, called a blanket, can transfer ink to paper and to a wide variety of materials that cannot be printed directly, including plastics and metals. Because the soft blanket conforms to the texture of the surface to be printed, lithographic image quality is greatly improved.



Offset Lithography Today

The function of the original stone printing surfaces is now served by thin aluminum plates, although other materials, such as stainless steel and plastic, can also be used. The plates are wrapped around the circumference of the printing cylinder and make direct contact with the rubber blanket cylinder. Rubber rollers carry ink and water to the plate surface. The ink is transferred first to the blanket cylinder and then to the paper.

Lithographic plates are the least expensive printing surfaces available today and this fact has contributed greatly to the success of the process. Aluminum plate materials have a thin surface coating of light-sensitive material, such as a photopolymer, that undergoes a solubility change when exposed to an intense source of blue and ultraviolet light. Images are transferred to the surface by exposing the plate through a film positive or negative. Some materials can be exposed directly, as in a graphic-arts camera or by a computer-controlled laser beam, thereby eliminating the expense of film and speeding up the plate making process. Modern offset lithographic presses range in size from small sheet-fed duplicators used for small, single-color jobs such as brochures and newsletters

to massive web presses capable of printing millions of copies of newspapers, magazines, catalogs, mailing pieces, and packaging materials in full color. No other process has such a broad range of applications.

With today's printing techniques, there are several different ways in which printing may be accomplished, such as lithography, letterpress, flexography, gravure, and screen printing. All of these printing techniques use simple mechanisms for rapidly applying colorants to substrates such as paper or plastic to form multiple reproductions of original images for mass distribution.

Multiple colors can be printed in one pass through the press. Spot color printing uses custom mixed inks to reproduce specific colors and is widely used in package printing, where large areas of uniform color are common. Process color printing uses four transparent inks-cyan (blue-green), magenta (red), yellow, and black-printed one on top of another in varying amounts. Color photographs and other artwork can be faithfully reproduced by this method.

Most modern printing presses transfer ink from a cylindrical printing surface to moving sheets or rolls of substrate. Presses that print on rolls, or webs, can achieve speeds of 600-900 m (2000-3000 ft) per minute. Presses that print on sheets are generally slower than web presses but can print on thicker substrates, such as Bristol board and sheet metal.

Since the 1960s, advancements in photography and electronics have had a profound effect on the manufacture of printing surfaces. Light-sensitive materials such as diazonium resins and photopolymers make it possible to produce durable printing surfaces photographically rather than mechanically. Computer-based systems allow the rapid production of the films used to transfer images to printing surfaces. Some printing surfaces can even be prepared directly by machines employing computer-controlled laser beams or diamond styluses. Images generated on computer systems and stored in databases can now be transferred directly to printing surfaces without any intermediate steps. Taken as a whole, these changes have been called the prepress revolution. As this electronic age in prepress continues, the newspaper printing industry as we know it today will continue to evolve and grow. New presses today are continuing to run faster and be more automated, which will further enhance both the efficiency of the process and the quality of the product produced.

References: "Printing," Microsoft® Encarta®
Grolier's Encyclopedia