THE HISTORY OF LITHOGRAPHY

Alois Senefelder invented lithography in 1798. From its modest beginnings, it has become one of the largest industries in the United States—a part of the Printing Industry, which is the third largest manufacturing industry in the U.S.

For many years, indeed over a century and a half, lithography was a very small segment of the printing industry, used mainly by artists to produce prints. However, during the late 1800's and throughout the twentieth century, great advancements in technology made lithography into the most popular form of printing in the United States.

The history of lithography occurred in four major steps: 1) The invention and early use of the process; 2) The introduction of photography to the process; 3) The addition of the offset press to the process; 4) The revolution of the lithographic plate.

THE INVENTION OF LITHOGRAPHY

Alois Senefelder was the son of a German actor. During his early life, he was compelled by his father to study law, which he disliked. He had a love for the theatre, but, alas, he found he had little talent as an actor. He did, however, become very successful at writing plays. Several of his works were published; however, the profits were very slim and this prompted Senefelder to seek a less costly method of reproducing copies of his plays.

In an attempt to reduce his publications costs, he tried to produce his own copperplate engravings. Making reverse images in copper was a very difficult process, a process that required much time and practice to master. Thus, Senefelder decided to practice his engraving on slabs of Bavarian limestone instead of the costly copper.

In the mean time, Senefelder needed a liquid that could be used to correct his frequent mistakes on the genuine copper plates. For this, he found a mixture of wax, soap, lampblack, and rainwater were satisfactory.

The two materials, limestone and the "correction fluid" became the primary ingredients of lithography.

By experimenting, Senefelder found that an image drawn onto the limestone with his correction fluid would repel water, while the surface of the stone itself would hold it. He found he could first wet the entire stone then apply ink, with a roller, to the entire stone to replenish the ink on the image. The stone, which held water, repelled the greasy ink; the "correction fluid," which is greasy and thus repels water, accepted additional ink. The chemical process is known as the *Principle of Lithography.*

Because lithography is based on a chemical principle, Senefelder preferred to call the process *chemical printing*.

From the invention of lithography on, the entire life of Senefelder was devoted to the lithographic process. In 1817, he designed a press that featured automatic dampening and inking of the plate. He was well recognized by his contemporaries, received many prizes and medals, and died very comfortably as the Bavarian Royal Inspector of Lithography.

Lithography was a very easy medium for the artist. He simply drew one picture on the stone which was then used to reproduce many copies of the identical image on paper. Because of this, the process became popular throughout the world, including the United States.

Lithographic stones.

The first lithograph appeared in the United States in 1819. The most popular lithographic product were prints depicting the contemporary scene. *Currier and Ives* are the best-known American lithographic printmakers of the day, but there were a host of others besides them.

Demand for lithographic prints and other products continued to grow, and by 1871, "there were at least 450 hand operated and about 30 steam presses in the United States.

TRANSFER PROCESS: In another of Senefelder's experiments, he found an additional attribute of lithography: a drawing or writing done in special ink on special paper could be transferred from the paper to the lithographic stone where it became the printing image. This allowed the artist to draw the original *reading right* instead of backwards, which was necessary when drawing directly onto the stone. The same process could used to transfer an image printed by other printing processes onto the stone. This allowed several identical images to placed on the same stone, thus increasing productivity. It also helped increase the popularity of lithography as a copying process because previously printed images could be transferred to the stone to be reproduced.

DIRECT ROTARY PRESSES: In the beginning of the twentieth century, the position of lithography weakened within the printing industry due to great strides in the efficiency of letterpress machines. Lithography was a slow process due to the *flat bed design* of its presses. What was needed was a rotary method. But, the rotary method required a plate that could be bent around a cylinder. Obviously, litho stones could not be bent around a cylinder! Senefelder had foreseen the use of chemically treated metals as the base material for lithography. By experimentation in the late nineteenth century, it was found that zinc and aluminum could be effectively used as lithographic plates, thus allowing the use of rotary presses.

The first rotary lithographic presses printed directly from the metal plate to the surface of the paper. Because of the abrasive action caused by the rubbing together of plate and paper, the image on the plate soon wore off. Because of this, the direct rotary presses never became very popular.

THE INTRODUCTION OF PHOTOGRAPHY

The making of lithographic plates was a long, tedious task requiring much hand labor. A method of making plates easier and quicker was needed. The transfer process, previously described, had many technical difficulties, and began to lose popularity. Lithography found a great partner in photography to produce printing plates. Thus, the marriage of lithography and photography, *PHOTOLITHOGRAPHY*, took place.

Joseph Niepce, a French scientist, produced the world first photograph in 1826. This development, and those that followed, made possible the halftone process: i.e. the act of breaking down an original photograph into dots and varying sizes suitable for press reproduction.

Henry Talbot, of England, used the first halftone screen for the reproduction of photographs about 1852. About 33 years later, Frederick Ives, an American, designed and made the first PRACTICAL halftone screen that consisted of two exposed glass negatives with lines scribed equidistant on each of them. They were cemented together so that the lines would cross at right angles. (Max Levy, of Philadelphia, succeeded in 1890 in developing a precision manufacturing process for these screens.) An original photograph would be rephotographed while the halftone screen was placed in front of the new film. The squares created by the crossing of lines on the glass plates would focus the light coming from the original photograph into dots. The lighter areas of the original, reflecting more light to the film, would be represented by large dots; the darker areas of the original reflected less light, resulting in smaller dots. Thus, a *halftone negative* was produced. The

halftone process made possible the quality reproduction of original photographs without the need to engrave or draw them onto the printing plate. Soon after the invention, major newspapers began using more and more illustrations in their article, although the average "man on the street" never knew what was happening.

PHOTOLITHOGRAPHY: is the act of making a lithographic printing plate by photographic means. A French chemist, Alphonse Louis Poitevin, invented it in August 1855.

> Poitevin coated the stone (grained for halftone picture) with a solution of potassium bichromate and albumin, equalizing the coating with a towel. Dried, exposed under a negative, washed with water, rolled up with greasy ink which only adhered to the parts which had become insoluble by exposure to light, but did not adhere to the moist parts. The stone was then etched and printed by the usual lithographic manner.

It became clear that it was impractical to coat the stone directly and expose it to light. As a result, experiments were conducted into the use of the transfer process, previously described, to transfer a photolithographic image from a support base to the stone. Other experiments were carried out to transfer the photolithographic images to a metal (zinc) plate. These processes worked, but had the inherent problems of any transfer process.

PROCESS COLOR PRINTING refers to the full color reproduction of a color original using only three color of ink: yellow, magenta, and cyan. James Le Blon first conceived it in the late 1600's. He based his work on Newton's theory of color, made his first color separation by eye, and printed it by engraving process. The prints were beautiful, but the process failed to become popular

Three-color printing, in the modern sense, is closely related to the development of color photography.

Probably the most important man in the history of process color printing is Louis Ducos du Hauron. He outlined, in 1868, the idea of reproducing objects in their natural colors by the superimposition of three photographically produced pictures in magenta, cyan, and yellow. He also experimented, in 1870, with process color lithography using three colors of ink instead of three continuous tone photographically-produced pictures. Rather, du Hauron used three overlapping halftone images, one each in magenta, cyan, and yellow. He also emphasized the importance of adjusting exposure time for each image so that no excess of any color would appear.

Although halftone photography, photolithography, and process color printing were very important steps in the history of lithography, they were, at that time, unable to be put to much practical use due to the limitation of the lithographic press. Both the flat bed litho stone press and the rotary direct press had to many limitations, so lithography lay dormant waiting for new impetus

THE ADDITION OF THE OFFSET PRESS

The image area on a photolithographic plate is delicate. For this reason, the abrasive action cause by direct contact with the paper surface on flat bed or direct rotary presses caused the image to quickly wear away from the plate. The offset press removes t h e direct contract between plate and paper by the addition of a rubber blanket surface. The plate image is transferred to the rubber blanket which, in turn, transfers the image to the paper or other substrate. Therefore, the offset is a method of "indirect" printing. The press design is shown below.

A model of a three-cylinder offset-lithographic press.

The lithographic offset press had its origin in England about 1875. The press was a lithographic stone flat bed press designed for metal decorating (printing on metal). An intermediate cylinder, covered with a specially treated cardboard, transferred the printed image from the litho stone to the sheet metal. About five years later, the cardboard covering was changed to rubber.

Credit for the first use of the offset process in the printing of paper goes to Ira Rubel, a paper manufacturer from Nutley, New Jersey. He produced sulphite bond, then lithographically converted it into bank deposit slips. It is generally agreed that Mr. Rubel discovered the use of the offset press for paper printing in about 1904 or 1905.

The press Mr. Rubel used was a flat bed stone machine. The particular machine he had was equipped with a rubber covered impression cylinder to help in the transferring of the images from stone to paper. Whenever the feeder (a person, not a machine) missed feeding a sheet while the press was in operation, the stone printed its image to the rubber covered impression cylinder. The next impression thus had an image on both sides: direct litho on the front as well as an image transferred from the rubber on the back. Mr. Rubel noticed that the image produced on the back of the sheet was much sharper and clearer than was the direct litho image. This was due to the fact that the rubber, being soft, was able to press the image onto the paper better than the stone, which was hard. He decided to design a press which printed every image from the plate to the blanket and then to the paper.

Mr. Rubel and another lithographer, A.B. Sherwood, joined forces and produced 12 offset machines. However, Rubel's death in 1908 ended his experimentation.

The next major force in the development of the offset lithographic press was Charles Harris of the Harris Automatic Press Company. He designed an offset press around a rotary letterpress machine. He thus needed a metal plate so that it could be bent around a cylinder. This metal plate was situated at the top of the machine, where both ink and water rollers could touch the plate. Directly below the plate cylinder, and in contact with it, was the blanket cylinder around which a blanket wrapped was wrapped. Finally, the bottom cylinder was the impression cylinder that gave pressure to the paper passing between it and the blanket in order to transfer the image to the sheet. At this point, the machine was still hand fed. But, in a few years, automatic feeders would be added to the machine resulting in presses very similar to the ones now in use. The offset lithographic press had six systems: feeder, feed board/register, dampening, inking, printing, and delivery.

The success of the offset press was a strong stimulus for other manufacturers to enter the field. Many adaptations of the process appeared including perfecting (prints on both sides of the sheet at once) and web fed (feeds from rolls rather than sheets of paper) designs. Now, the offset lithographic press is a marvel of efficiency and perfection, utilizing many electronic and computer controls.

Because the offset press removes the direct contact between plate and paper, the plate lasts many times longer than on direct litho presses. Also, because the offset press is rotary rather than a flat bed design, production speeds can be greatly improved. For these reasons, the offset press allowed the photographic inventions of halftone photography, photolithography. and process color to become very popular within the lithographic field. At the present time, when one thinks of color, he automatically thinks of lithography and offset printing. Thus, its is generally agreed that the offset press brought lithography from a relatively unimportant part of commercial printing into the number one spot in the industry

THE EVOLUTION OF THE LITHOGRAPHIC PLATE

One of the most important elements of quality lithographic printing is the quality of the plate. It, more than anything else, determines how the image will print as well as the

number of problems to be solved in order to maintain good print quality.

The original litho plates were limestone, as previously discussed. As the industry grew, two major problems occurred with the stones: 1) They were heavy, difficult to store, and expensive; 2) They could not be bent around the cylinder of a rotary press.

Metal plates were introduced to help solve this problem. At first, the image was transferred from a master image to the metal plate. Later, Poitevin's work with sensitizing litho stones was applied to metal plates. Bare metal plates were coated with potassium bichromate and albumin, placed in a special whirling machine which rotated the plate at high speeds to equalize the coating across the entire surface of the plate, exposed to light under a negative, washed with water to remove the unexposed coating, and inked. The ink adhered only to the exposed sections.

Every step of the above process was carried on in the lithographer's own shop. Due to the fact that the process was very complicated and that the chemistry of the solutions had to be just right, there were many problems in the making of plates. The unexposed plate coating had little shelf life; therefore, plates could not be coated in advance.

In the 1940's work was done by many scientists to invent a method for pre-coating plates in a factory to assure uniformity and consistency. Most of these plates were paper based, and thus, not suitable to long runs.

The first practical pre-coated (or pre sensitized) aluminum plate was developed by the 3M company in 1951. The plates had a coating with a longer shelf life, had a uniform surface, and were easy to develop. The plate required four steps: 1) exposure of the pre-sensitized plate to high intensity blue carbon arc light; 2) removal of the unexposed coating with Gum Arabic; 3) application of a special image developer; and 4) a reapplication of Gum Arabic to act as a protective layer. The process was immediately approved by lithographers and removed the worst obstacle of the commercial printer in the production of good quality work.

Since the 1950's, much work has been done to improve the pre-sensitized plate. Plates are now available in which no image developer need be applied: the entire image is pre-coated and the non-exposed area is removed after exposure. This type is called *subtractive* while the former type is called *additive*.

In the late 1970's, a further advancement was introduced in plate making. Plates were made that required no special developing agents after exposure: the unexposed subtractive coating was removed with water. This product was called the "Aqualith" plate and was also developed by the 3M Company.

In the 1990's, Toray, a Japanese firm, introduced the first effective waterless lithographic plate. Instead of the non-image area attracting water, the Toray plate's background area repels ink while its image area attracts ink. The process requires modifications of the offset press to keep the ink rollers cold. Otherwise, ink will stick to the non-image areas.

SUMMARY

Like any other industry, the lithographic printing industry has had a history with major events, each event interdependent upon the others. The major events in the history of lithography included the invention of the process in 1798; the introduction of photography to the process in the early and mid 1800's; the introduction of the offset press in the early 1900's; and the evolution of the lithographic plate which had been ongoing since the beginning of the process but saw its greatest improvement in 1951 with the successful development of the 3M pre-sensitized plate.

The major events listed above have increased the popularity of the lithographic process. This is evidenced by the increase in the number of lithographic printing firms (3000% increase from 1900 to 1970).