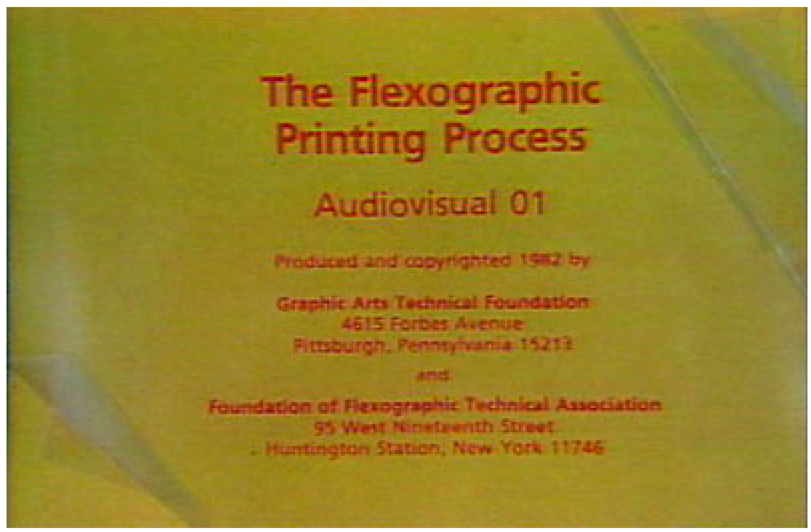
Graphic Communications Technology

Audio Visual 01

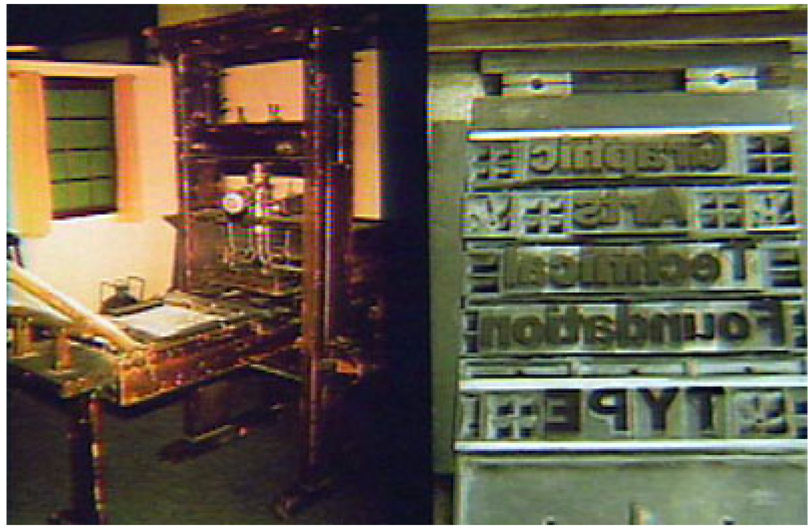
THE FLEXOGRAPHIC PRINTING PROCESS



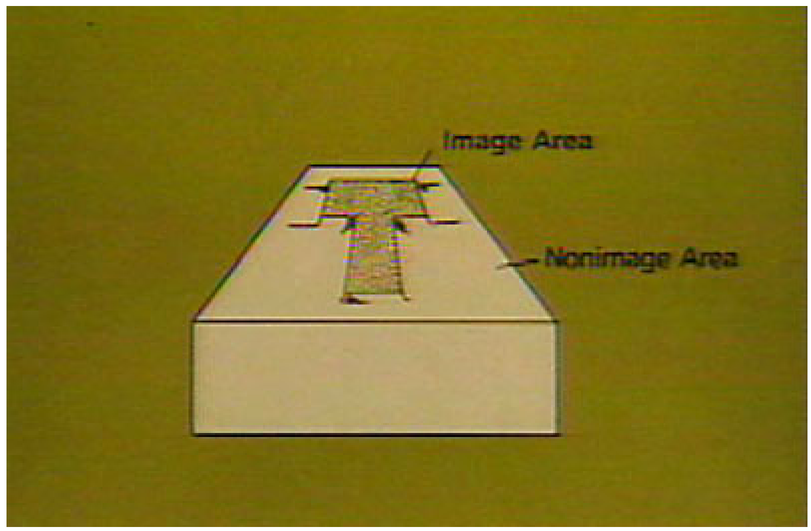
The Graphic Arts Technical Foundation and the Foundation of the Flexographic Technical Association present **The Flexographic Printing Process.** This audiovisual is intended to introduce the viewer to the printing process of flexography and to provide an overview of the versatile flexographic printing industry.

Flexography is one method of printing words and images onto foil, plastic film, corrugated board, paper, paperboard, cellophane, or even fabric. In fact, since the flexographic process can be used to print on such a wide variety of materials, it is often the best graphic arts reproduction process for package printing.

Flexography is related to the oldest printing process, letterpress, because both flexography and letterpress print from a raised image. In its original form, letterpress used individual metal characters called *types* and a mechanical press. The type was combined to form words and sentences and tightly arranged on the flat surface of the press. Then the raised areas were covered with ink. The message was formed when paper was pressed against the flat metal type.

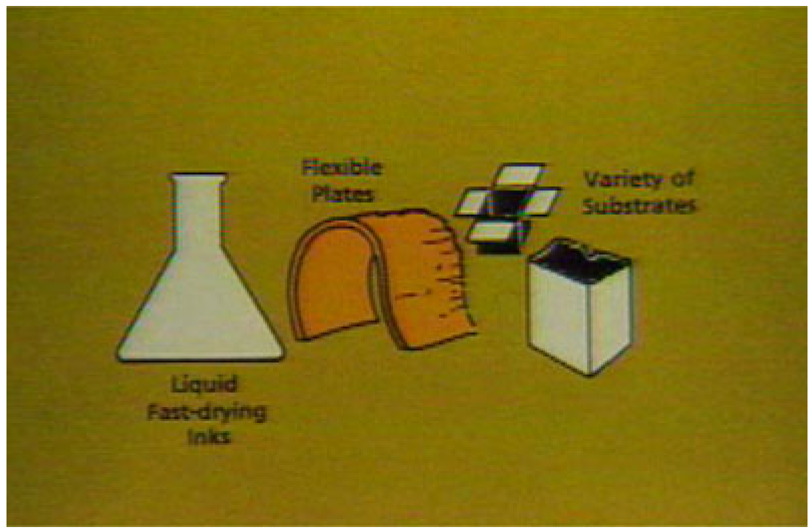


Since only the raised areas of the type, which print the message, are touched by the ink, they are called the **image areas.** The areas that are lower than the image areas do not receive any ink, and do not print. They are called the **nonimage areas.**



To speed up the slow process of pressing flat surfaces together, the printing press evolved from printing on a flat surface only to using a rolling cylinder, as with this cylinder press on the left. The type moved back and forth between inking rollers and an impression cylinder, which held the paper. To help meet the growing demand for printed products, printing from inked type soon moved to printing from an inked plate. Rotary letterpress prints from a molded or etched metal plate like the one on the right.

Flexography prints from a **flexible printing plate** that is wrapped around a rotating cylinder. The plate is usually made of natural or synthetic **rubber** or a photosensitive plastic material called **photopolymer.** It is usually attached to the plate cylinder with double-sided sticky tape.

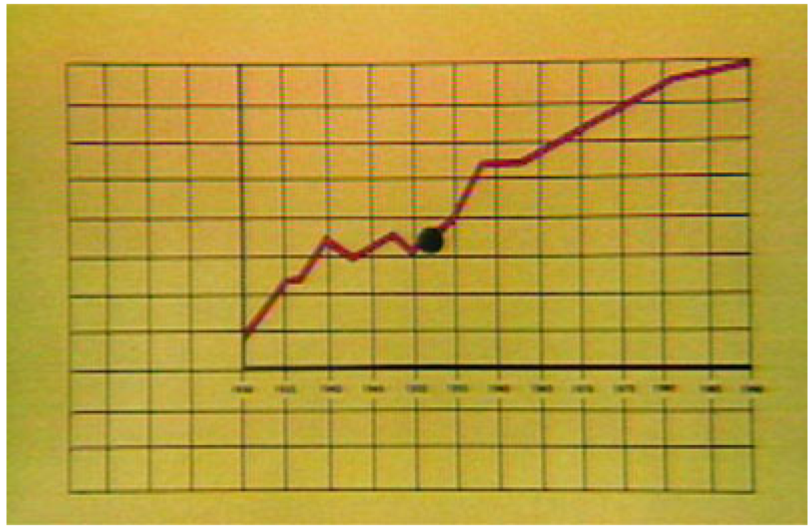


Flexography was first called **aniline printing** because early flexographic inks contained dyes derived from aniline oil--a liquid extracted from the indigo plant. These dyes were dissolved in spirits, making a quick-drying ink. The combination of a flexible plate, quick-drying ink, and the ability to print on such a wide variety of materials or substrates made this process excellent for package printing.

The invention of **cellophane** in **1930** started a revolution in modern packaging. This clean, nonabsorbent film could not be practically printed by any other printing process. But flexography's quick-drying inks were excellent for this new material. Cellophane gave a tremendous boost to package printing along with **polyethylene**, a stretchy, synthetic plastic that became popular in the early **1950s**.

But one factor slowed the growth of aniline printing: the aniline oil used in the inks was thought to be harmful to food. Along with new developments in inks, the Food and Drug Administration confirmed the safety of aniline inks in 1949. However, some food manufacturers still refused aniline printing.

Concerned about the image of the industry, packaging representatives decided to search for a new name. **In 1952, the term "flexography" was born.** It quickly gained worldwide acceptance, and the process rapidly expanded.



From its beginning as a kind of rubber-stamp printing, flexography has developed into an advanced technology and grown to include full-color printing of numerous products on every conceivable substrate. These include gift wrap, paper cups, labels, ice cream cartons, plastic bread bags, printed paper plates, and shopping and grocery bags. As with other printing processes, to reproduce a message, flexography must start with an idea and a design.

To prepare artwork that will be printed by flexography, the paste-up artist traditionally followed the comprehensive layout of the graphic designer, which showed what the final piece should look like. It accurately indicated where all the type and design elements were to be placed, and in what colors they should print. The artist prepared the display type, body copy, and illustrations and pasted them onto a stiff based sheet. This was called a paste-up or mechanical.

Dr. Waite's note: like all contemporary printing processes, flexographic prepress is now done using off-the-shelf graphic software like Macromedia Freehand.

It is important to note that, due to the thickness and softness of flexographic plates, the image stretches or elongates as the plate is drawn around the plate cylinder. Thus, images to be reproduced using flexographic printing must be created slightly shorter than their specified final size. A formula can be used to calculate the "stretch," but it is beyond the scope of this discussion.

After the completed paste-up had been proofread and approved, it was sent to the camera department to be photographed with a large process camera like the one you see here. Photographing the artwork produced a film negative, which was used to make the printing plate.

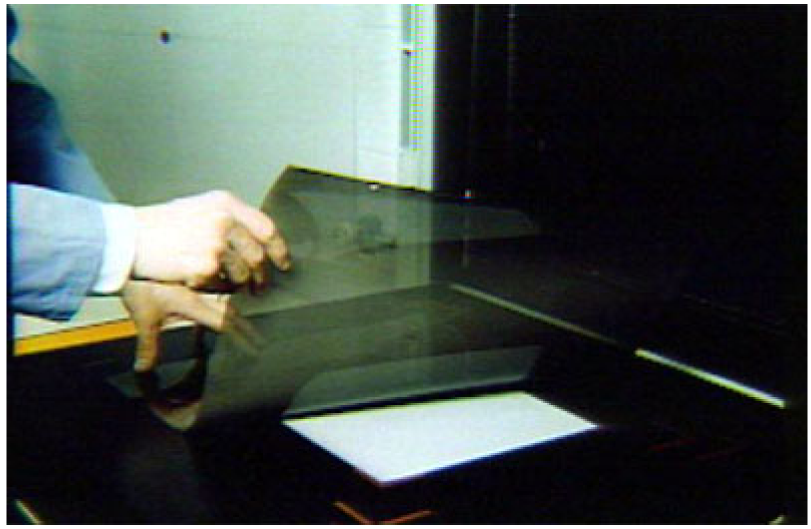
Dr. Waite's note: today, film is generated using an imagesetter rather than a process camera.

As in other forms of printing, there are two kinds of artwork used in flexography. The first kind is **line art,** which is solid areas, pen-and-ink drawings, or type. Solid black line art is pasted directly onto the paste-up as seen on the left. The photographic negative of the paste-up shown on the right will provide the pattern for the flexographic plate. Note that the negative contains only black and clear areas--no grays.

Dr. Waite's note: line art is best produced nowadays using vector graphic software such as Adobe Illustrator or Macromedia Freehand, or with page layout software such as QuarkXPress or Adobe InDesign. Line art may also be scanned from original drawings, but care must be taken to capture sufficient resolution to avoid pixelization.

The second kind is **continuous-tone art.** Continuous-tone art is any artwork that contains tones of light and dark areas rather than a solid color only. Examples of continuous-tone art are photographs, transparencies, paintings, or shaded drawings. Here is an original continuous-tone photograph on the left, and the negative made from the photo on the right. Since flexographic plates print only even layers of ink in the image areas, continuous-tone art must be converted to another form to be printed. Note that the negative film contains many different gray areas in addition to the white and black areas.

A photograph or other continuous-tone illustration must be rephotographed with a graphic arts process camera through a special halftone screen. The screen breaks up the image into different-sized dots.



Dr. Waite's note: today, continuous-tone images are reproduced in two stages: first, the image must be digitized using a scanner or other digitizing device. Care must be taken to capture enough data to provide sufficient resolution for the size of image to be printed as well as its halftone screen resolution. The scanned image is then placed onto a page in a page-layout program. When the completed page is output to a printer, imagesetter, or platesetter, the page-layout program converts the digitized image into halftone dots.

The screening process is called **halftoning,** and the resulting image is a **halftone.** When printed, the image will resemble the original photograph, with the smaller dots producing light shades or **highlight** areas and the larger dots making the dark shades or **shadow** areas. Note the original photo on the left and a close-up of its printed halftone on the right.

(Note: the halftone dots were lost in the conversion of the right-most photo to a web-friendly jpeg image.)

To print a **color** photograph or transparency by flexography, the original must also be rephotographed in a way that breaks the colors that you see into different halftone negatives. The image can then be reproduced as different-sized dots for printing yellow, magenta, cyan, and sometimes black. This rephotographing is called **color separation**, and these four colors are called **process colors**. Each process color is printed separately on the press, yet together they produce the colors that you see in a full-color printed product.

Dr. Waite's note: today, the color separation process is handled within either the color scanner's proprietary software or in a bit-mapped-image editing program such as Adobe Photoshop.

Unlike separating colors into dots to produce full-color photographs, to prepare artwork such as type or illustrations that will print in more than one solid color, an overlay must be made for each additional color. These overlays represent what are called **flat** or **spot** colors. Each overlay is used to make a separate platemaking negative, and each plate will be inked with a separate color when put on the press.

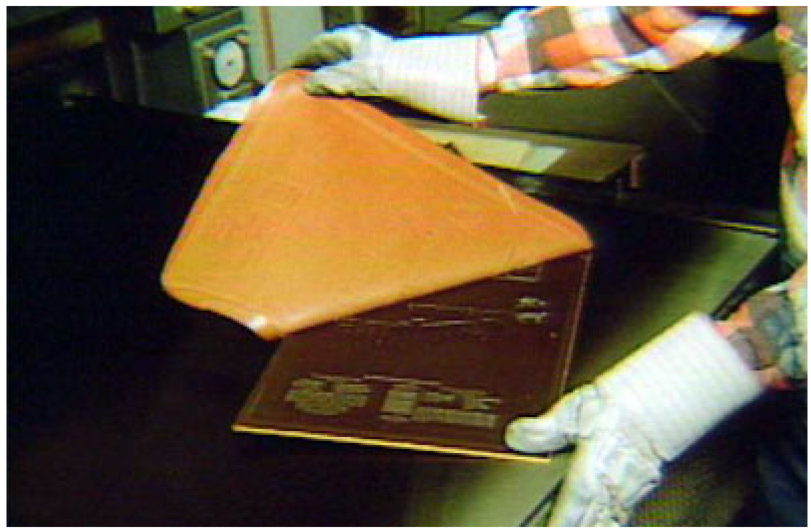
Dr. Waite's note: the process is essentially the same when using page-layout software. Non-process colors are specified using a spot color "book" such as the PANTONE MATCHING SYSTEM. When printing to a laser printer, imagesetter, or platesetter, the page-layout program can output a grayscale "rendition" of the colors or a separate sheet for each color.

After the paste-up is completed and separate negatives are shot of the base art and overlays (or film is output using an imagesetter), the negatives are used to make either rubber or photopolymer flexographic plates. There are three basic steps in rubber platemaking. First an engraving from the negative is made by placing the negative over a light-sensitized metal sheet and exposing it to intense light in a vacuum frame.

Then the metal sheet is etched with acid in an etching machine and becomes an engraved pattern of the negative with the images areas high and the nonimage areas low.

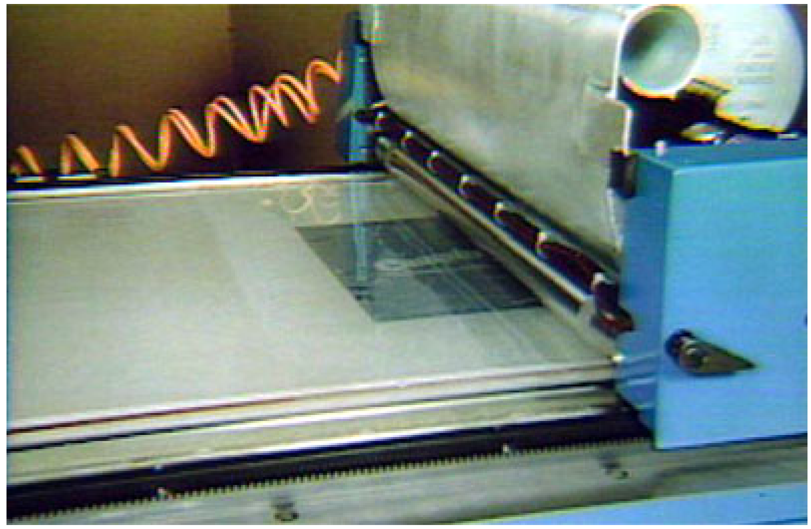
The second step is making a mold from the engraving by pressing the metal engraving against a heated matrix material that hardens in the molding press. Molding pressure is generated by hydraulic power to the bottom table, or platen, as seen here, The top platen stays stationary.

The third and final step, making the rubber plate from the matrix, is also accomplished with the molding press. The relief image is formed on the rubber plate by pressing the matrix against it under sufficient heat, time, and pressure, The plate is stripped from the mold while still warm.

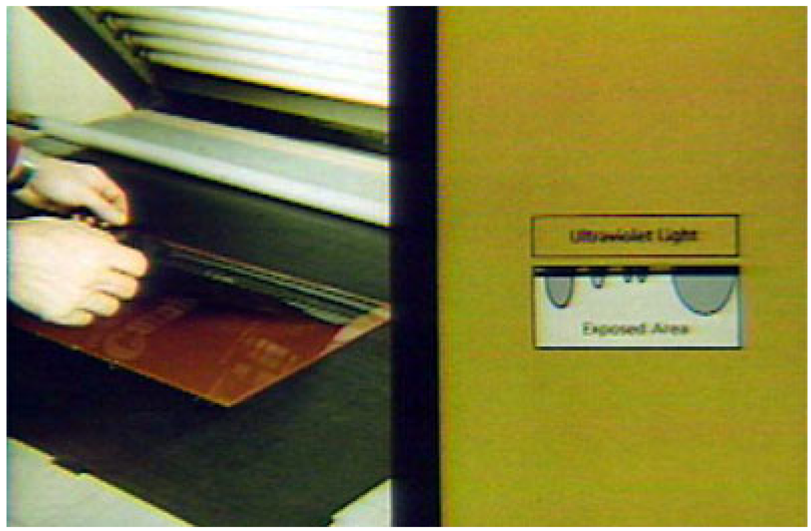


Unlike the rubber plate, which must have an engraving made from a negative, the sheet photopolymer plate, shown here on the right, is made directly from the negative by placing the negative over a precast sheet of light-sensitive photopolymer and exposing it to ultraviolet light.

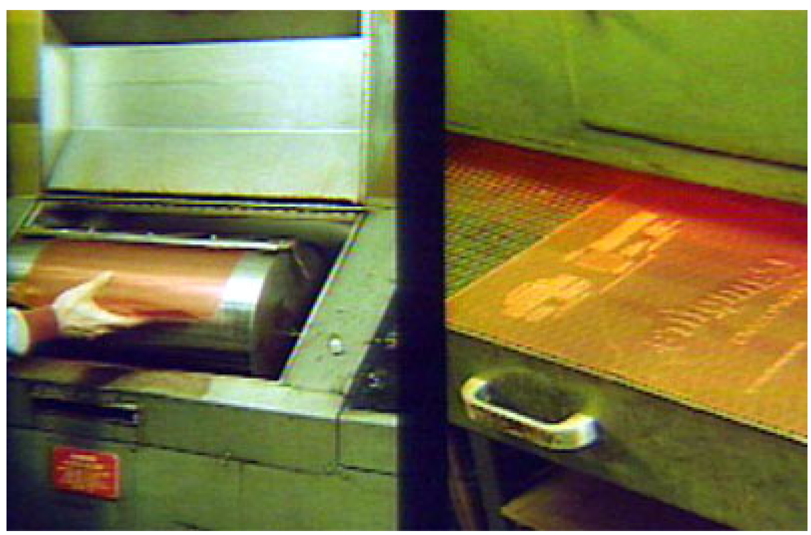
Instead of using a precast sheet of photopolymer, **liquid photopolymer** can be used to make a plate. The liquid photopolymer platemaking system uses a trough of clean, slightly yellow photopolymer that flows like honey. Like the precast sheet plate, the liquid plate is made in direct contact with the negative. A motorized carriage moves over the negative depositing a layer of liquid along with a plastic backing sheet, Plate thickness can be easily altered for specific jobs when using liquid photopolymer, while precast sheets come in predetermined thicknesses.



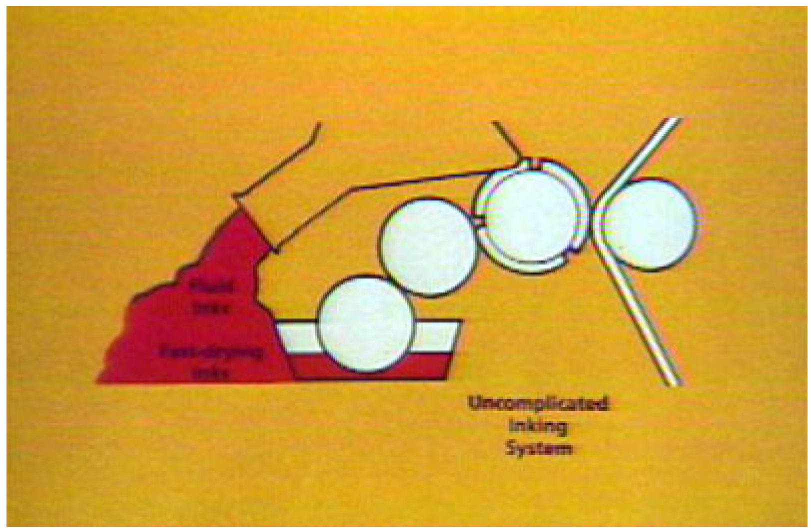
On the left a negative is being placed over a precast sheet of photopolymer in an exposing unit. But in both sheet and liquid photopolymer platemaking the photopolymer is exposed through the negative by ultraviolet light, as shown on the right. The exposure causes the polymer to harden in the image areas of the negative.



Next the exposed plate is put into a processor, which removes the unhardened polymer from the nonimage areas, leaving the relief image areas. The plate then goes into a drying unit for further hardening and drying.



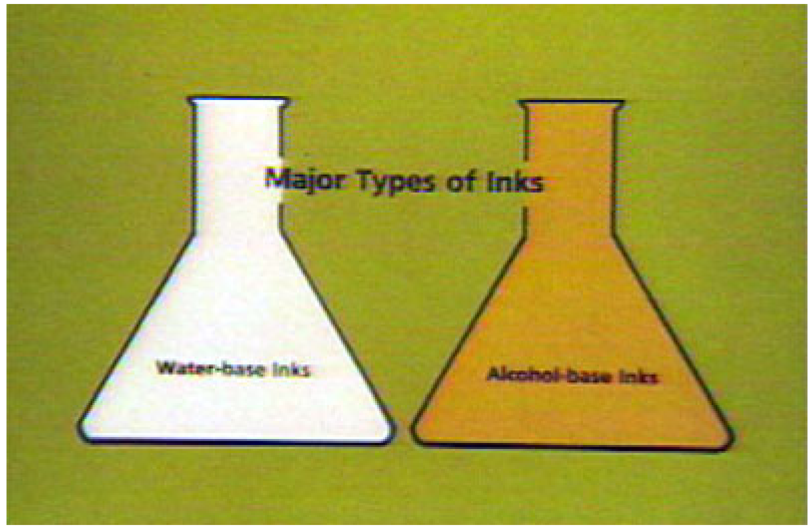
In order to determine if the finished plate will print accurately once on press, the plate is mounted on the printing cylinder with double-sided sticky back in a mounting and proofing machine. Once attached to the plate cylinder, the plate is inked with a roller, and then rolled against a piece of proofing paper that is attached to an impression cylinder. The plate and proof are then inspected for precision. If approved, the plate is now ready to be printed.



Flexography uses thin fluid inks. Unlike the slow-drying paste inks of letterpress and lithography, the fluid inks of flexography dry rapidly. One advantage to using fluid inks is that they require a short and uncompleted inking system. Fewer rollers are needed to meter the amount of ink from ink pan to plate than when using paste inks.

Another advantage to using fluid flexographic inks is the ability to accurately print a given color of ink on top of an already-printed ink. This is called **ink trapping.** Since flexographic inks dry so quickly, even between colors, trapping problems can be eliminated. Therefore, flexographic presses can print many consecutive colors at high speeds with one pass through the press.

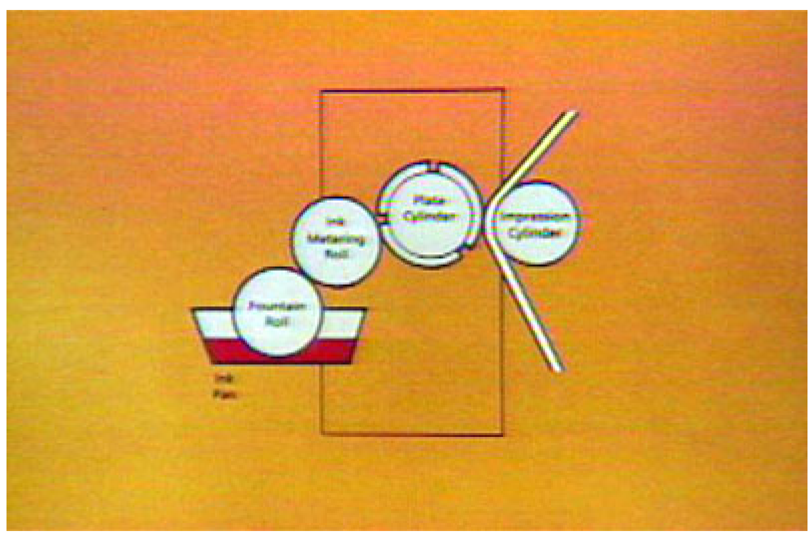
The two major types of fluid inks used in flexography are **water-base** and **alcohol-base**. Alcohol-base inks are most often used to print on nonabsorbent substrates such as film and foil. Water-base inks most often are used on absorbent substrates such as paper and paperboard. Although, with changing technology, water-base inks are also used on nonabsorbent substrates.



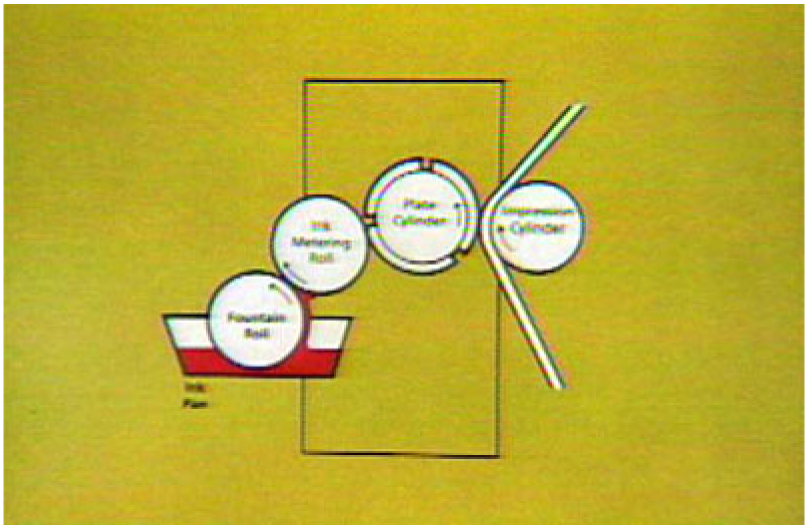
In order to meet the often rigid specifications of today's flexible packaging requirements, the inkmaker should know:

1. If the package will be exposed to sunlight, heat, cold, or moisture,
2. How the package will be handled.
3. If the ink must be resistant to such things as perspiration, soaps, alkalies, acids, alcohol, oil, fat, butter, or adhesives.
4. What the surface to be printed will be.
5. And finally, what type of press will be used--and at what speeds.

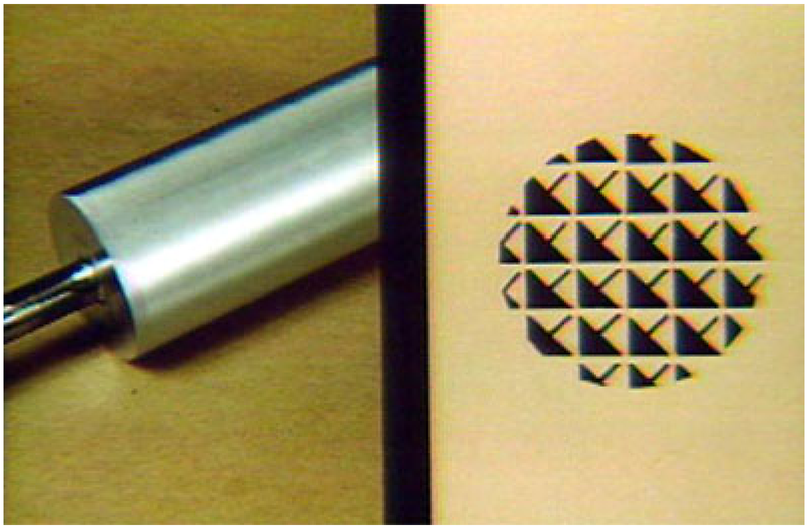
As mentioned earlier, flexographic presses are less complicated than those used for other printing processes. The typical flexographic press includes the four rollers shown here. A rubber **fountain roll** turning in an ink pan delivers ink to a steel or ceramic **ink metering roll** and then to the **plate cylinder.** The paper or other substrate to be printed then passes between the plate cylinder and a polished metal **impression cylinder.**



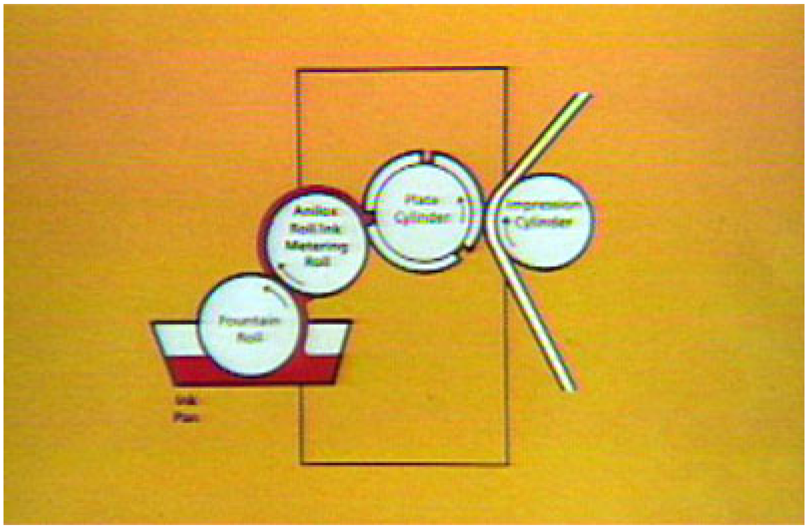
The purpose of the fountain roll is to pick up a heavy flow of thin ink from the ink pan or fountain and deliver it to the metering roll. The fountain roll and metering roll are set to rotate under pressure against each other. The fountain roll is driven slower than the metering roll causing it to squeeze away excess ink from the surface of the metering roll.



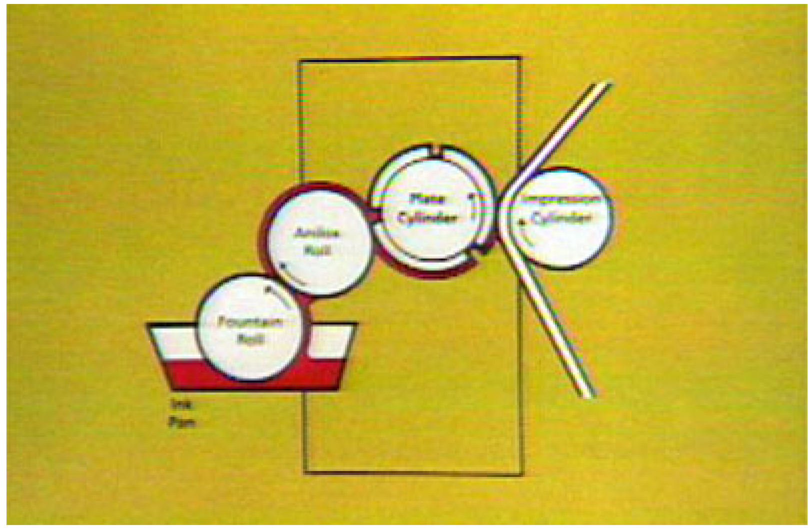
The typical ink metering roll is referred to as the **anilox roll,** seen here. The anilox roll surface is engraved with tiny uniform cells that carry and deposit a uniform ink film onto the plate. The cells are so small that they must be magnified to be seen. Anilox rolls with varying sizes and configurations of cells carry different amounts of ink depending on printing requirements.



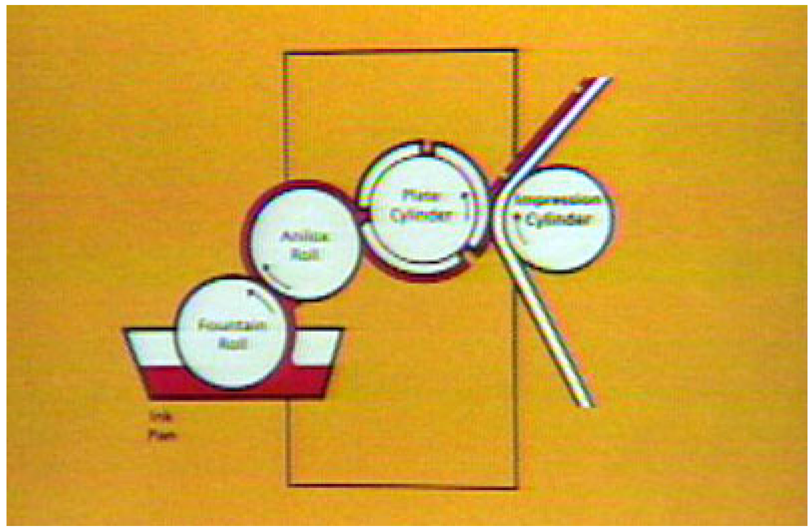
The purpose of the anilox roll is to pass on a thin, even layer of ink to the plate. The pressure and speed difference between the anilox roll and fountain roll leave the ink primarily in the engraved cells of the anilox roll.



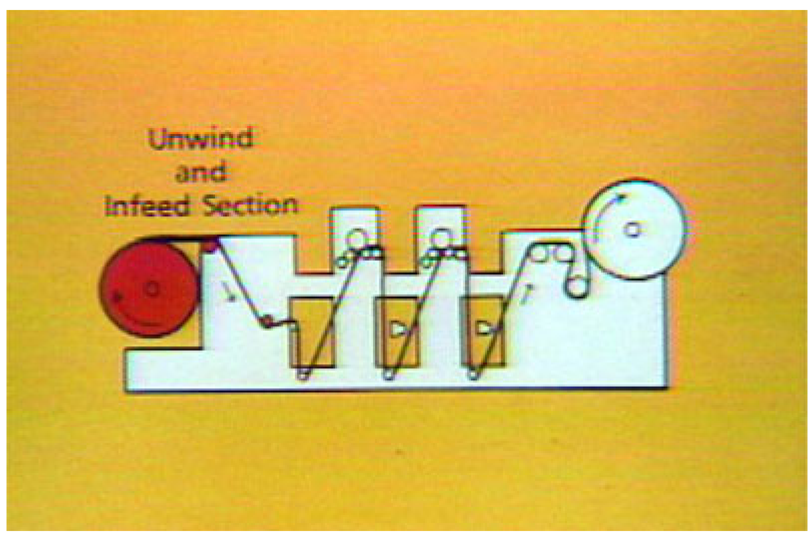
The plate cylinder is a metal cylinder placed between the anilox roller and the impression cylinder. The anilox roll contacts the plate that is attached to the plate cylinder and deposits its ink onto the raised image areas. Plate cylinders come in various sizes. To change the number of times an image prints or repeats around a plate cylinder, the existing plate cylinder can be removed and another easily dropped into position.



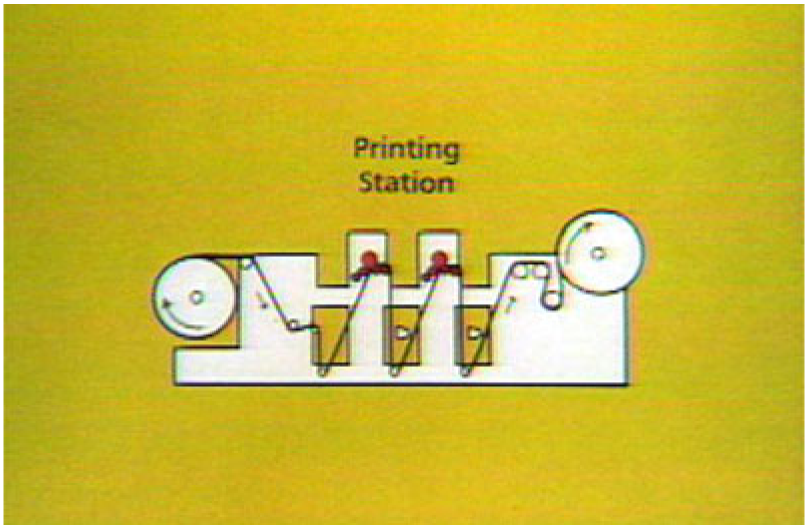
The material to be printed, or **substrate,** passes between the plate cylinder and the polished metal impression cylinder. The impression cylinder backs up and supports the substrate as it contacts the printing plate. The gap, or nip, between these two cylinders must be just right to give the proper printing pressure.



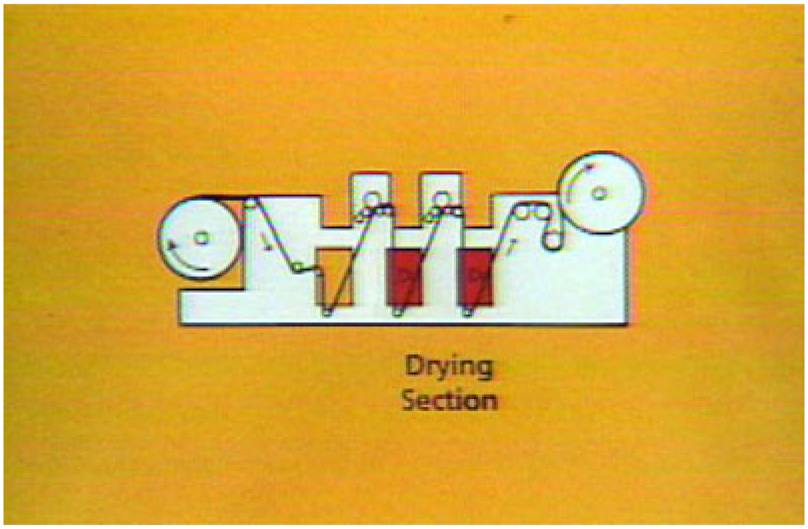
Flexo presses generally have four basic sections. Since most substrates are fed into the press from rolls, or webs, the first section is called the **unwind and infeed section.** The tension of the roll must be controlled just enough to prevent slack and wrinkles as the paper unwinds into the press.



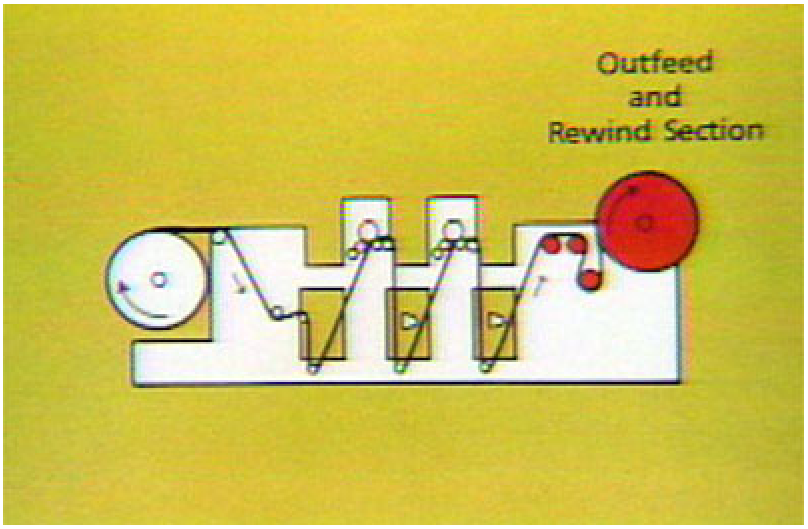
The next section is the **printing section**. One printing station has one fountain roll, anilox roll, plate cylinder, and impression cylinder. Most presses have two or more stations enabling them to print two or more colors.



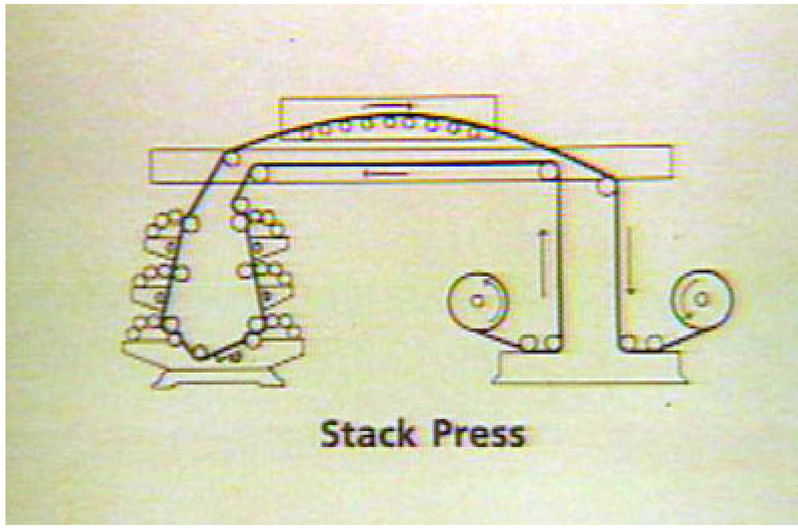
Most flexo presses have **drying sections.** Here high-velocity hot air dries the ink. Dryers are placed between printing units so that each color will dry before another is applied, as well as after the printing sections.



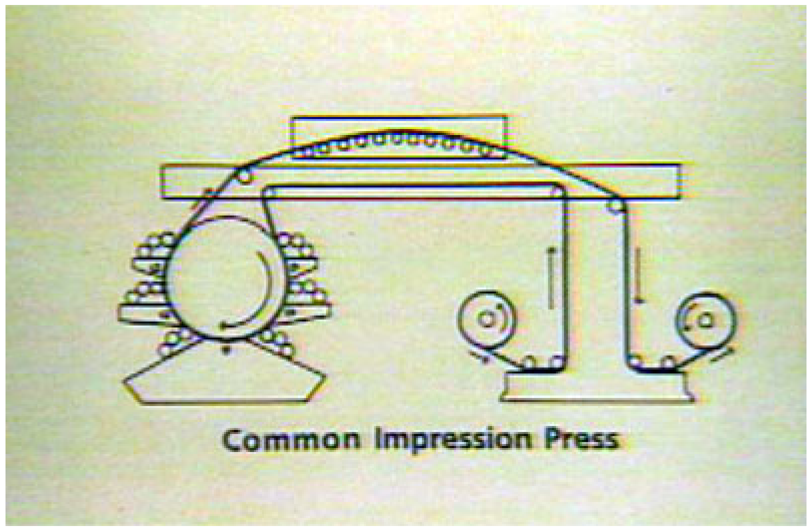
The fourth section of the press is the **outfeed and rewind section.** It is here that the webs are rewound after printing. This is referred to as roll-to-roll printing. Here again, the web tension must be controlled to keep the roll wrinkle-free and uniform as it rewinds.



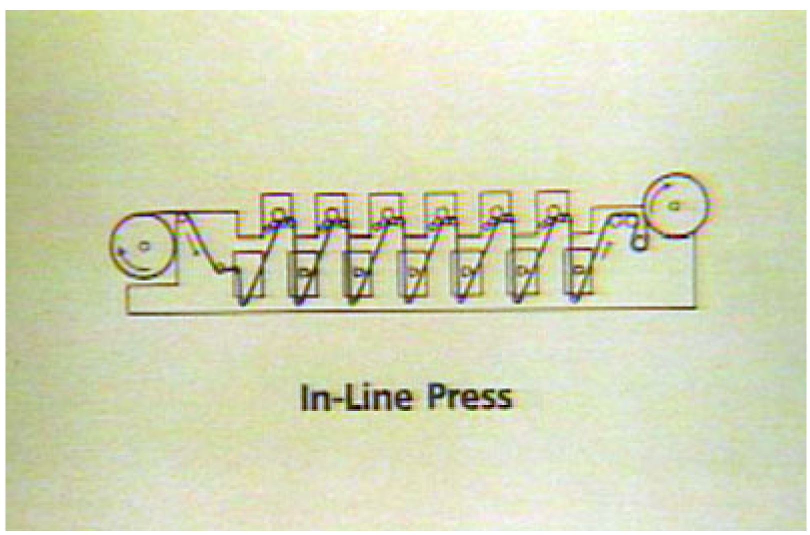
This type of flexo press is the **stack press**. The stack press has individual color stations that are stacked one over the other. Because of their configuration, stack presses are easily accessible, making on-press changes and servicing easy and economical.



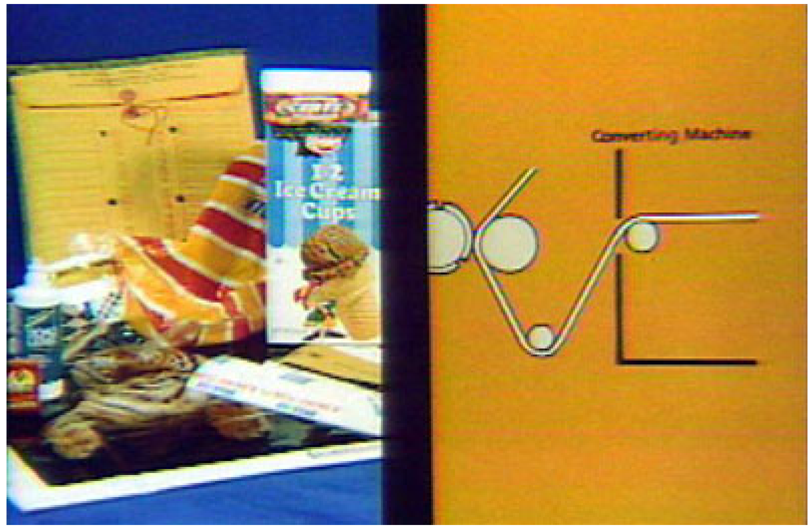
Another kind of flexo press is the **common impression, or CI, press.** The CI press supports all of its color stations around a single impression cylinder. The primary advantage of this press is its ability to hold excellent register, which is the placement of one color in relation to others.



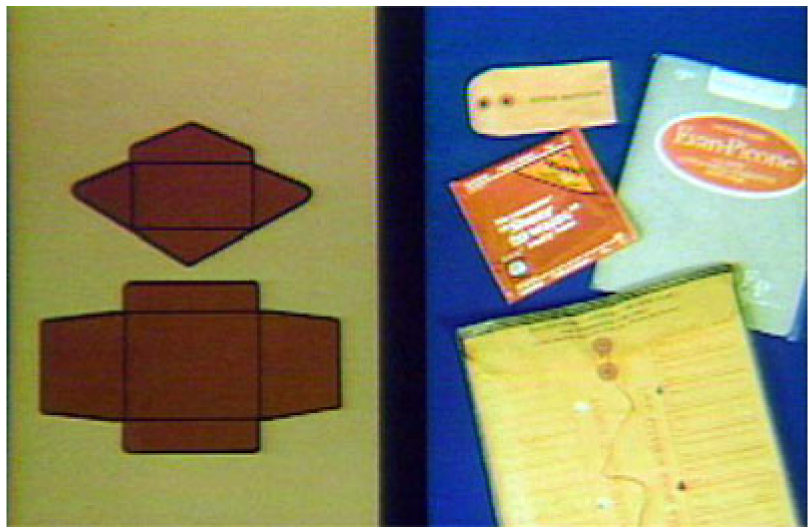
In-line presses contain multiple printing units that are arranged in a horizontal row, each standing on the floor. In-line presses are commonly used to print pressure-sensitive labels, corrugated board, and newspapers. One advantage of an in-line press is that additional operations such as diecutting can be done between color stations on the press.



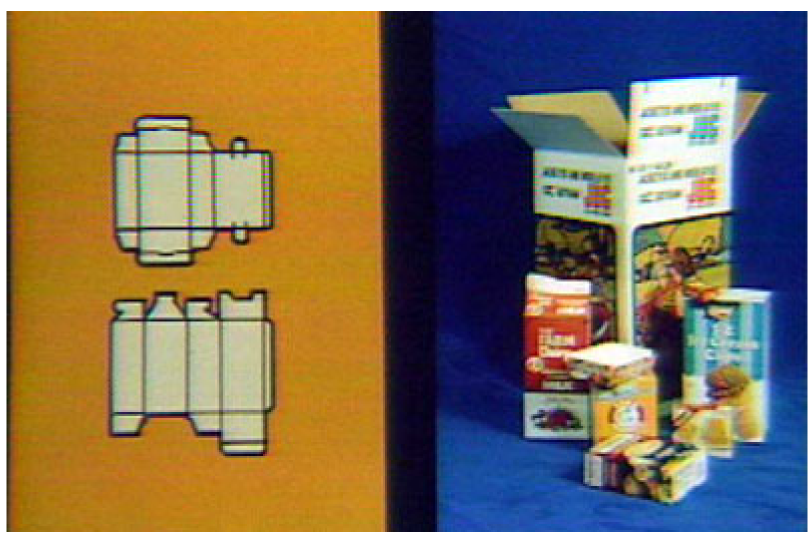
Although flexographic printing stops at the end of the press, the web is not always rewound. Instead of entering the rewind, the substrate can go directly to another machine that will convert it into its intended product. These include envelopes, folding cartons, plastic and paper bags, and pressure-sensitive labels, to name a few.



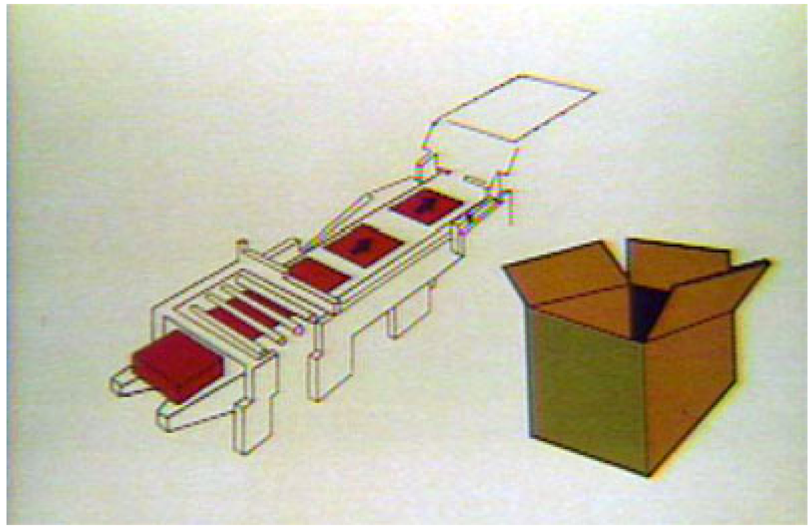
Printed sheets or rolls of stock are converted into envelopes by a metal die or pattern that cuts the stock into the desired shape. After diecutting, the envelopes are folded and pasted or sealed. The types and uses of envelopes manufactured nowadays are limitless. Here are some samples of envelopes commonly seen and used by consumers.



Folding carton containers are cut, creased, folded, and often glued by specialized high-speed converting machines such as pasters, slitters, or folders. Flexographic printing transforms one of the plainest materials--paperboard--into the irresistible packaging found in grocery and department stores worldwide.



Another versatile packaging material is corrugated board, used to contain everything from ice-packed seafood to fine china. Because of its rigidity and flutes, corrugated board does not wind through the press from a roll. Individual sheets are fed into the in-line press one by one. All of the rollers, including the printing cylinders, transport the board through the printing and converting operations. Corrugated board is so extensively used that it has been called today's "packaging workhorse."



Many different kinds of paper and plastic are converted into specialized bags. Examples are wraps and bags that are designed to conform to the shape of a single product such as bread bags, cigarette wraps, or the inside pouch of a cereal box. Or they can be preformed bags for consumer use such as square-bottom grocery nags, colorful gift-wrap bags, or fold-close-top food pouches.

Rolls of pressure-sensitive stock can be printed and then diecut, slit, or perforated into bumper stickers, decals for children's toys, stickers for autos, and labels for pharmaceuticals, mailing, and many grocery items. Here are examples of typical grocery items that are labeled with pressure-sensitive stock.

We have seen the characteristics and advantages of the flexographic printing process, but to fully understand the scope of the flexographic industry we only need to notice how many consumer products are printed by flexography. Our supermarket's shelves, freezers, and displays are filled with items whose packages are printed by flexo. In department stores, clothes, linens, wallpaper, and paneling all printed by flexography can be found. And plastic and paper bags again--printed by flexography--are used to carry all of these items home. Through its wide variety of applications, flexography has grown into a multibillion dollar segment of the package printing industry.

Eric N. Kruchkevich, author
Donna C. Mulvihill, editor

Special thanks to
Alpine Packaging, Inc.
Herbick and Held Printing
Latmer and Mayer Printing
Rippl Printing & Packaging
York Tape and Label Corporation

The Graphic Arts Technical Foundation and the Foundation of Flexographic Technical Association wish to give a special thanks to Matthews International Corporation.