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THE PACKAGING DESIGNER'S BOOK OF PATTERNS



The Packaging Designer's Book of Patterns

Lászlo Roth and George L. Wybenga



VAN NOSTRAND REINHOLD
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To Gabrielle and Betty

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The Packaging Designer's Book of Patterns

Preface

Here is the first definitive collection of patterns and structural designs for paperboard packaging, point-of-purchase displays, and other three-dimensional graphic products. This workbook contains over 450 patterns and structural designs that can be adapted for packaging. The designer may choose among hundreds of alternative carton and box structures, which may be used as they are, modified, or adapted to create exciting new structures. The patterns are accompanied by a description of the historical and technical origins of the materials and methods used. Special attention is given to computer-aided design as an engineering tool that offers new insights into carton and box design and manufacturing.

Paperboard packaging has a profound impact on the U.S. economy. In 1988 about \$16 billion was spent for paperboard packaging, accounting for 45 percent of total expenditure for packaging. Today the United States leads the world in the use of paper and paperboard, with a per capita consumption of over 600 pounds per person per year. There are more than 5000 plants in the United States that manufacture and convert paper and paperboard. In addition, there are about 530 carton manufacturers with 752 plants and a total employment of 80,000. The corrugated board industry includes 795 companies with 1427 plants and a total employment of 118,000.

The packaging materials industry serves every major retail environment—in many ways it has shaped the American lifestyle. If it is to continue to thrive, it must be creative and innovative. It must be market oriented and must continually supply new methodologies and new solutions to environmental problems.

Along with sensitivity to environmental problems, creativity should be the designer's most important consideration. This workbook may be used not only as a reference for structural design but also as a source of exercises in learning to stimulate creative skills. The cartons shown in this book are designed to depict generic styles whenever possible. Each illustration is accompanied by the name that is commonly used to describe the style. The grain direction of all folding cartons is horizontal

unless otherwise indicated. The flute direction of all corrugated cartons is vertical unless otherwise indicated.

Some of the packages currently in use are patented or have patent-protected features for use on proprietary packaging machines. Where appropriate, patented features are indicated. The packages that appear on the following pages are patented or contain patented features: 173, 193, 205, 214, 238, 245, and 301.

The reader is advised that patented features are protected by patent law and may not be used in practice without the express permission of the patent holder. For information about patents, contact the U.S. Patent Office.

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Lászlo Roth
George L. Wybenga

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Introduction



17th Century Dutch Paper Mill

Paper is among the noblest of human inventions. It is worthwhile, therefore, to begin with a short history of papermaking.

Before books could be written and preserved, a writing surface had to be developed that was light, not too bulky, and easily stored. The first great advance was the Egyptians' use of papyrus in the third millennium B.C. Sheets of beaten papyrus stems were fastened together into scrolls, some more than 120 feet long, that could be rolled up for storage. After papyrus came parchment, which was perfected in Asia Minor in the city of Pergamum (from which its name is derived) in the second century B.C. Animal skins had long been used as a writing surface in Greece and Rome, but it was in Pergamum that methods were evolved for the production of a durable, velvet-smooth parchment that could be written on on both sides.

For hundreds of years all paper was made by hand from



Detail of an Egyptian papyrus scroll (ca. 2500 B.C.).

rag pulp. The use of wood fibers to make paper was discovered in the mid 1800s. In 1840 Friedrich G. Keller in Germany invented a way to grind logs into a fibrous pulp; this method produced a rather poor quality of paper, as all parts of the wood—not just the fibers—were used.

Paper as we know it today was first made in China in 105 A.D. Ts'ai Lun, a member of the court of Emperor Ho Ti, succeeded in turning husks of cotton fibers into paper pulp. This method spread throughout China, Korea, and Japan and as far west as Persia. In 751 A.D. Moslems captured a Chinese paper mill in Samarkand and learned the method of papermaking. They brought the method to Spain around 950 A.D., and by the thirteenth century paper mills had been established throughout western Europe, first in Italy and then in France, Germany, England, and Scandinavia.

The first paper mill in America was built in 1690 by William Rittenhouse near Philadelphia. Sheets of paper were produced one at a time until 1799, when Nicholas Louis Robert developed a continuous process. (This method was patented in England by the Fourdrinier brothers and is known by that name.) In 1817 the first cylinder-type papermaking machine, which can produce a better quality of paper in a continuous process, was invented by John Dickenson.



Egyptian scribe using paper made from papyrus.



Early Chinese print on paper (ca. 300 A.D.).

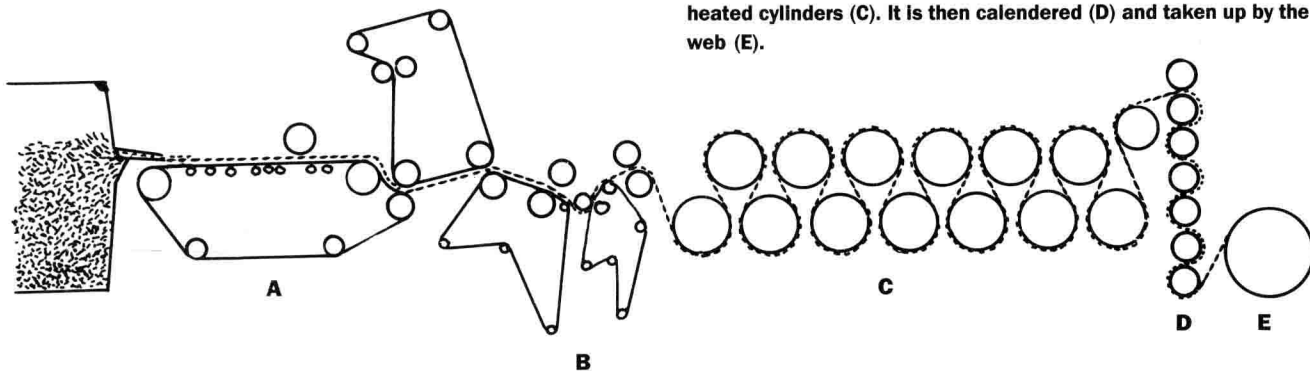
MODERN PAPERMAKING

Today almost all paper is manufactured from wood. Cellulose fibers (which account for 50 percent of the content of wood) are the primary ingredient, followed by lignin (about 30 percent), which acts as a fiber binder or glue.

Water plays an important role in modern papermaking. The manufacture of 1 ton of paper requires about 55,000 gallons of water, most of which is recycled. The papermaking process also uses sulfur, magnesium, hydroxide, lime, salt, alkali, starch, alum, clay, and plastics (for coating). There are two basic types of paper: fine paper for writing and paper for printing and industrial use (packaging).

The first step in manufacturing paper from wood is to remove the bark. The cheapest way to separate the fibers is to grind up the wood by forcing the logs against grindstones submerged in water. The water carries off the wood fibers. In this process everything is used, and the paper produced is of low quality. Another, more frequently used process is chemical pulping, in which the wood is chipped into small pieces, the fibers are extracted through a chemical process, and the unusable material is eliminated. Chemical pulping is more expensive, but it produces better-quality paper.

Diagram of a paper mill (greatly simplified). The pulp is ejected in a thin layer onto the conveyer-sieve (A). The pulp is then pressed through a great number of cylinders (B) and dried by a series of heated cylinders (C). It is then calendered (D) and taken up by the web (E).



Chemical pulping creates a pulp, which is then refined by washing and separating the fibers. Refinement, a time-controlled process during which the manufacturer can add various chemicals to increase bonding, texture, and water resistance, increases the quality and strength of the paper. Pigments (for coloring) and coatings (plastics) can also be added at this stage.

Once the pulp is prepared, it goes to one of two types of machines: the Fourdrinier or the cylinder machine. Modern papermaking machines are huge. They can be as long as a city block and several stories high. They produce paper up to 30 feet wide at a speed of 3,000 feet per minute, resulting in 800 miles of paper per day! The primary papermaking machine is the Fourdrinier. Most Fourdrinier machines make only one layer of material, although they can be equipped to make several layers.

Paper produced by a Fourdrinier machine is smoothed by a stack of highly polished steel rolls, a process known as calendering. The finished paper is then cut, coated, and laminated.

Another frequently used papermaking machine is the cylinder machine. This machine makes heavy grades of paperboard, generally using recycled paper pulp. The pulp is built up in layers. Since paperboard is much thicker than paper, the drying operation is far more extensive. Large steam-heated cylinders drive the excess moisture out of the paper. A coating is then added to create a smooth surface.

The great advantage of the cylinder machine is that it uses large amounts of recycled paper in thick layers to provide strength.

Paper is bought on the basis of the weight (or basis weight), in pounds, of a ream of paper. (A ream is equal to 3,000 square feet of surface.) The thickness of paperboard is expressed in caliper points, which are stated in thousandths of an inch (usually written in decimals). Since most papers are laminated or coated with other materials, caliper points are

rarely used today to specify weight. The paperboard used in folding cartons is specified according to the size of the carton or, more often, the weight of the item that goes into it. A glass bottle for 3.5 fluid ounces of fragrance, for example, would require a folding carton with a thickness of approximately 18–24 points.

The thickness of paper can be controlled by means of calendering, pressing, and laminating. High-quality paper is up to 12 points thick; paperboard varies in thickness from 12 to 70 points.

About 20 million tons of fine papers are used for printing and writing annually. Five and a half million tons are used for packaging. Tables 1, 2, and 3 list the major boxboards and papers used in packaging. The uses, content, and characteristics of these packaging materials are described.

PRINTING, FINISHING, AND DIE-CUTTING

Folding cartons are manufactured using three main processes: printing, die-cutting, and finishing.

Printing Methods

Several methods of printing are available; they include letterpress, offset lithography, gravure, flexography, and silk screen. Each method is suitable for particular types of jobs.

The *letterpress* method transfers ink from a metal plate directly to the sheet paperboard. This is one of the oldest methods of quality printing. New technologies have rendered it almost obsolete. *Offset lithography* has replaced letterpress because of its production efficiency and high-quality color reproduction. New high-speed presses and computer-aided systems, along with technological advances in inks and coatings, have made “offset” the most popular process for printing on folding cartons. In this process specially sensitized metal plates are chemically treated to accept ink. The ink is transferred from

Table 1. BOXBOARDS USED IN PACKAGING: CYLINDER MACHINE GRADES

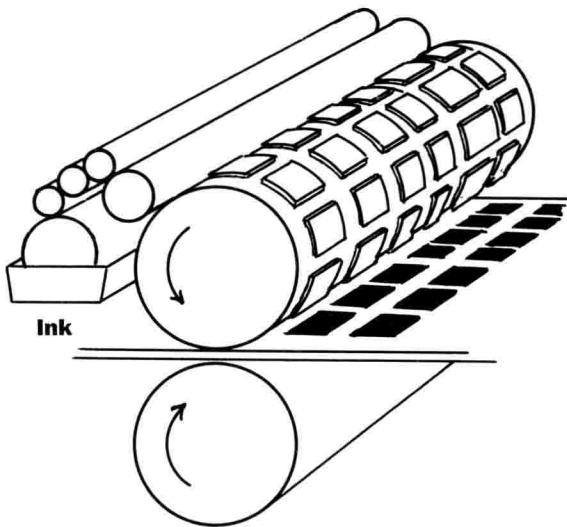
Board	Uses	Chief Characteristics
Plain chipboard; solid newsboard; news vat-lined chip; filled news	Used in the manufacture of set-up boxes.	100% recycled. Lowest-cost board produced; not good for printing. Color: light gray to tan. Adaptable for special lining papers.
White vat-lined chipboard	Higher-grade set-up box with white liner.	Adaptable for color printing.
Bending chip	Folding cartons for light items.	100% recycled; excellent bending. Lowest-cost board for folding cartons.
Colored manila-lined bending chip	Same as bending chip.	Bright white liner; excellent for color printing.
White-lined 70 newsback	Used for folding cartons, posters, displays.	100% recycled. Smooth white board.
Clay-coated boxboard	Used for quality cartons.	Very smooth white board with excellent printing surface.
Solid manila board	All carton uses, including food.	White liner and manila back.
Extra-strength plain kraft-type board	Used for hardware, automotive and other machine parts, toys.	Recycled. Available in various colors. Excellent bending ability.
Extra-strength white-lined or clay-coated kraft-type board	Used for heavy objects requiring durability and strength.	Recycled. Top liner is white, back is brown. Available in pastel shades.

Table 2. BOXBOARDS USED IN PACKAGING: FOURDRINIER MACHINE GRADES

Board	Uses	Chief Characteristics
Uncoated solid bleached sulfate	Waxed, polycoated, or plain frozen-food cartons.	Strong white board. Hard sized for water resistance and extended service under freezer conditions. Good bending. 100% sulfate pulp.
Clay-coated solid bleached sulfate	Cartons suitable for pharmaceuticals, cosmetics, hardware.	Excellent printability, scoring, folding, and die-cutting; ovenable. Outstanding merchandising appeal. Takes all types of coatings. 100% sulfate pulp.
Clay-coated solid unbleached sulfate	Heavy-duty packages; beverage carriers; folding cartons for food, cosmetics, textiles, housewares.	Strong, moisture-resistant board. Excellent printing surface.

Table 3. PAPERS FOR PRINTING, LABELING, AND DECORATIVE PACKAGING

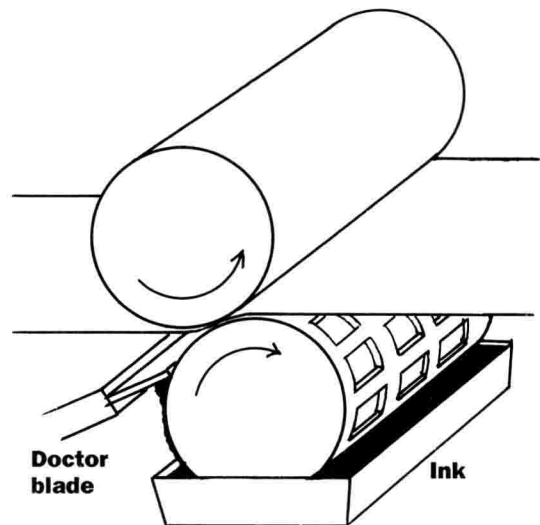
Type	Uses	Characteristics
Flat or dull finish, coated and uncoated	Box wraps for gifts, cosmetics, jewelry.	Smooth, excellent printing surface. Good for embossing.
Glossy finish, supercalendered	Labels, displays, box coverings.	For quality printing. Embosses well.
Cast coated	Box wraps, gift wraps, labels.	Smooth, high gloss. Brilliant white and colors. Excellent printability. Scuff resistant.
Flint	Box and gift wraps, labels for cosmetics, gifts.	Extremely fine-quality surface, high gloss. Wide color range.
Friction glaze	Box covering. Good appearance at low cost.	High glaze. Scuff resistant. Economical.
Metallic-finish Argentine	Box wraps and overwraps, luxury items. Gift packages.	Has decorative effect of foil but is less costly. Lacquer lends gold or colored look.
Foil	Decorative packaging and labels.	Aluminum laminated to paper backing. Wide range of brilliant metallic colors. Expensive.
Gravure printed	Boxes, displays, labels, platforms.	Printed with metallic powders mixed with lacquer.
Half-fine, half-fine embossed	Specialty boxes for cosmetics.	Embossed, continuous metallic surface. Wide color range. Elegant, rich.
Pyroxylin	Box coverings, food wrappers for high-quality items.	Metallic tones. Bronze, aluminum, or copper ground into pyroxylin lacquer.
Vacuum metallized	Labels for canned goods, batteries; wrappers for food and confectionery products.	Produced by vacuum metal-vapor deposit method.
Flock	Platform coverings, linings for gift boxes.	Flock of cotton adhered to surface of paper to create soft, velvety look.
Foam paper	Protective cushioning for wraps, platforms, pads, box coverings.	Foamed polystyrene sheet laminated to paper. Lustrous finish; wide range of colors.
Glitter	Box coverings, platforms.	Specks of metal embedded in paper surface.
Iridescent or pearlescent coating	Luxury items, wraps, platforms.	Mother-of-pearl effect.
Tissue	Used for jewelry, flowers, fruit, hosiery. Specially treated and designed for visual appeal.	Treated for texture, water resistance, printability.
Glassine	Laminated trays for candies and other food products.	Grease and oil resistant.
Parchment	Wrapper, liner for greasy or oily items.	Water resistant, high wet strength. Lacquered or waxed base.
Polyethylene and saran-coated kraft	Widely used for food products. Cereal and cracker cartons, bread wraps.	Excellent barrier to moisture.



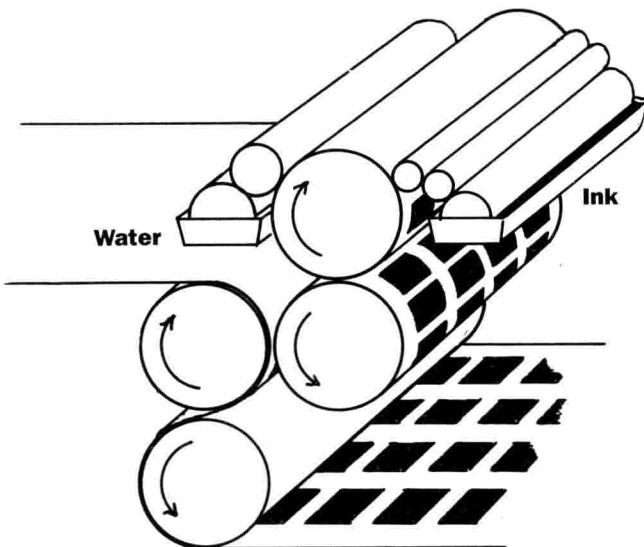
Letterpress: The ink is applied to the raised surfaces of the plate and transferred to the substrate.

the plate to a smooth rubber blanket roller, which then transfers the image to the paperboard.

Gravure printing is used for high-quality reproduction in large-quantity runs (i.e., millions of copies). Specially etched printing cylinders have cells that accept and store inks. A “doctor blade” wipes off excess ink as the cylinder rotates to the impression cylinder, where the plate cylinder transfers the image to the paperboard. Gravure printing can be accomplished on an in-line web press, which is known as *rotogravure*, or on a sheet-fed press, which is called *photogravure*.



Gravure (Intaglio): The ink is applied over the entire plate, scraped off the surface by the doctor blade, and transferred from the ink wells onto the substrate.

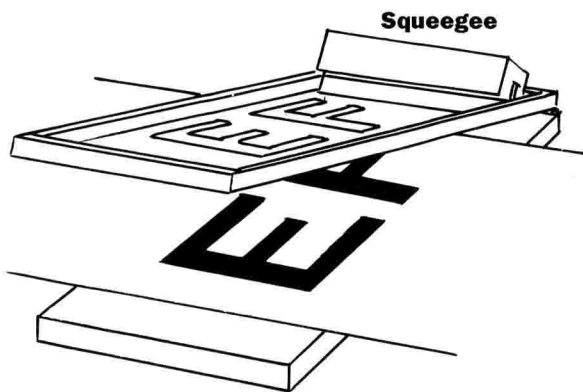


Offset lithography: The ink is picked up by the pre-wetted plate, which transfers the inked image to the offset blanket, which in turn transfers the image onto the substrate.

Flexographic printing is similar to letterpress printing. It uses a raised positive composition plate made of rubber or plastic. High-speed in-line web presses are used. This process has been associated with low-quality simple line art printing, but recent technological breakthroughs with fast-drying inks have made flexographic printing a low-cost, high-quality method for medium production runs.

Silk screening is a simple method of color printing in which a fabric mesh stretched over a frame is used instead of a printing plate. A stencil-type design is adhered to the mesh and pigment is "squeegeed" through the stencil. A separate "stencil" is required for each color used. (See diagram.)

Printing technology has changed in recent years to better meet the needs of carton manufacturing. Special coatings, varnishes, lacquers, and inks are available to give a bright finish or provide a moisture-proof barrier. Environmental problems have been alleviated by the introduction of water-based coatings and inks.



Silkscreen: The ink is squeegeed through a stencil adhered to the mesh of the silk onto the substrate.

Die-cutting

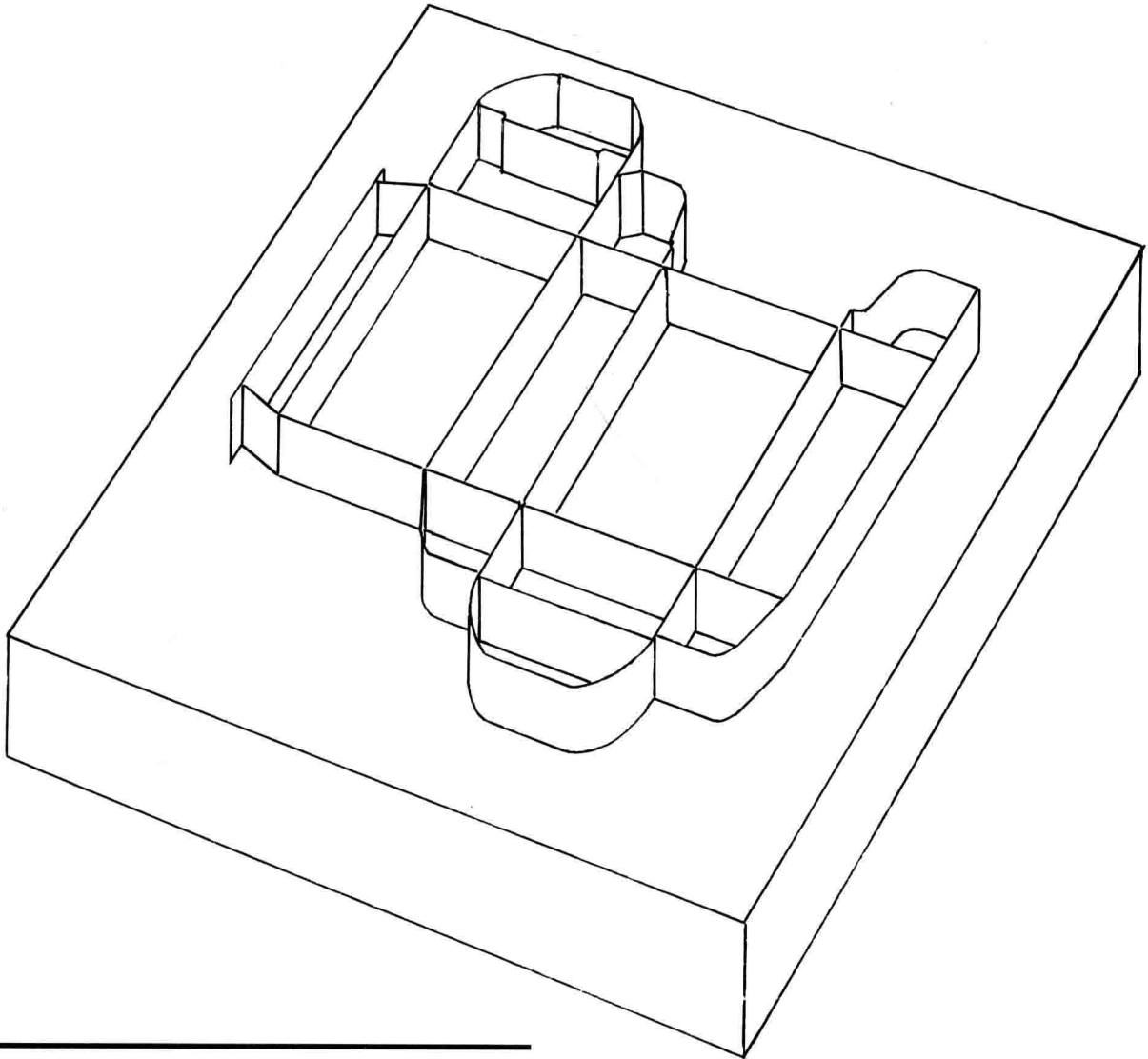
The process of *die-cutting* involves creating shapes using cutting and stamping dies. There are three methods of die-cutting.

Hollow die-cutting is done with a hollow die, which looks like a cookie cutter. This method is used exclusively for labels and envelopes. *Steel rule die-cutting* is used when a close register is required. Steel rules are bent to the desired shape and wedged into a $\frac{3}{4}$ " piece of plywood. The die is locked up in a chase on a platen of the die-cutting press. Several sheets can be cut at once. A flatbed cylinder press can also be used for die-cutting.

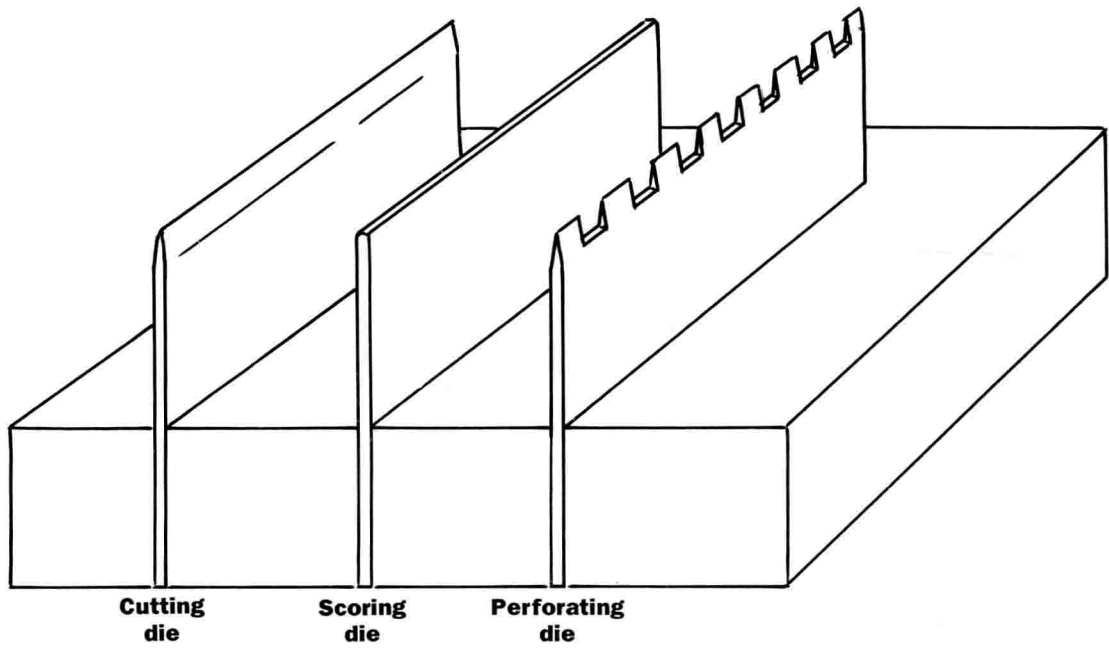
The third method of die-cutting uses *lasers*, which were invented by C. H. Townes and Arthur Schawlow in 1958. (The word *laser* is an acronym for "light amplification by simulated emission of radiation.") The laser beam, which can be concentrated on a small point and used for processes such as drilling, cutting, and welding, has become widely used in manufacturing, communications, and medicine. Since a laser beam is extremely sharp and precise, the resulting cut is very accurate and clean.



Laser cutout.



Steel rule die. This is a typical sample maker's die for a reverse-tuck carton. The die consists of scoring and cutting rules inserted into a sheet of plywood. A production die will have a great number of box layouts ganged so as to create as little waste as possible. Production dies are on either a flat sheet or a cylinder.



Dies for cutting, scoring, and perforating.

The steel die rule is completely embedded in the plywood, except where notches have been cut out of the bottom of the rule to prevent pieces of the plywood from dropping out.

