DESIGN CONSIDERATIONS IN THERMOFORMED PACKAGING

By Michael A. Brown
Vice President, Marketing
Crystal Thermoplastics, Inc.

Thermoforming offers several unique advantages that facilitate production and enable it to accommodate a wide variety of package designs and budgets.

The importance of packaging in marketing and manufacturing processes has grown dramatically in the past decade. The shift toward a self-service format in the retail industry has created a greater need for packaging that allows consumers to examine products while, at the same time, preventing pilferage. On the other hand, today's competitive manufacturing environments demand greater cost efficiency and the ability to integrate with automated processes.

In the midst of these trends, thermoforming has enjoyed a period of significant growth, primarily because of its ability to meet the changing needs of manufacturers and retailers. Of all the packaging technologies available, thermoforming offers several advantages that facilitate production and enable it to accommodate a wide variety of package designs and budgets.

One of the primary benefits of thermoforming packaging to manufacturers is its relatively fast development cycle - as little as six weeks from the design phase to production. Another benefit, especially to manufacturers with JIT (Just-in-Time) production formats and/or limited warehouse space, is its ability to nest together. Because of this feature, thermoformed packaging takes up much less storage space than conventional set-up boxes or foam inserts. And, depending on the specific application and budget, thermoformed packages can be produced from a wide variety of materials.

Design Considerations

The first step in designing a package is to determine its function and role in the marketing process. But there are other factors, such as the need to integrate with a particular manufacturing process, that should be considered as well. The more information that is provided to a thermoformer, the more accurate the design recommendation and costestimate will be.

End Use. How will the package be sold and used? The primary consideration is the product itself, the type of application (consumer, medical, industrial, etc.), and the function the package performs.

For example, a package we developed for a reusable razor is designed not only to display the product well, but also to be used as both a storage and a travel case.

Cost and Perceived Value. The cost of thermoformed packaging depends primarily on the thickness of the material used, the size of the package and the tooling required. In some applications, attractive or especially durable packaging with a high perceived value can add to the perceived value of the product. For example, a manufacturer marketing a child's fishing pole set decided to use a sturdy, stand-alone thermoformed package with a carrying handle instead of the original package, an inexpensive-looking paper box. This manufacturer felt that the high perceived value of the package would make a significant difference in the marketability of its product.

Special Requirements. Certain packaging applications, such as the food, medical and electronics industries, have unique requirements concerning toxicity, permeability, clarity (clear or opaque), impact resistance, static dissipation, etc. The use of special materials to meet these requirements usually involves a higher cost.

Manufacturing Process. The ability of a particular package design to integrate with existing equipment and processes (automated or manual) will depend on the way it will be filled, handled, moved, stacked or stored, and

MICHAEL BROWN is vice president of sales and marketing for Crystal Thermoplastics, Inc., in Cumberland, RI.

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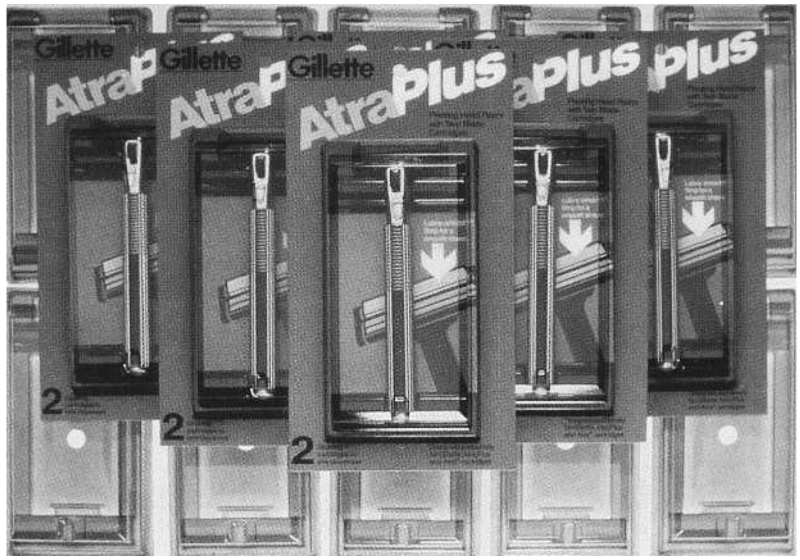
master packed for shipping. A package can also be designed to facilitate the movement of parts from one station to the next in an assembly line or manufacturing process.

Size and Weight. Normally, of course, the size of the product will determine, to a large degree, the size of the package. But other factors, such as merchandising guidelines, may indicate a particular size preference or design. Tight size constraints may require partial assembly of a product or a special packaging arrangement, such as a single package for a set of related products. Size, weight and durability of the package should all be considered in conjunction with manufacturing/assembly operations and shipping requirements.



Design Options

The versatility of the thermoforming process provides a wealth of design options and materials from which to choose. The package designs listed below are general categories, some of which overlap. Most package designs are customized to fit the particular needs of the product and manufacturer.

Blister Pack. Also known as a surface seal blister, this type of thermoformed package is generally the most lightweight and least expensive and usually includes a heat-seal, coated-card (SBS Board) backing, which provides ample room for graphics. Blister packs normally use a light-gauge plastic, from 7.5 to 15 mils, and offer several production advantages. They have the fastest production and sealing speed and require the least expensive sealing equipment, sealing tooling and loading equipment.

This type of package is most often used for products that are lower-priced, lightweight and of a medium to small size. Blister packs are ideal for hanging products but can also be designed for stacking or self-standing applications. Split blisters (front and back), or sandwiches, can also be used to encapsulate a product inside a hinged or two-sided card, providing greater strength and rigidity. Product size and weight can be limited by the strength of the seal (blister to card) or the thickness (gauge) of the blister or card. Blister packages typically have the lowest perceived value of thermoformed packaging designs.

Clamshells. Another familiar package design, a clamshell totally surrounds the product in a two-sided enclosure. A clamshell is made from almost twice as much plastic as a blister pack, in gauges from 15 to 30 mils, and is consequently more expensive. Clamshell designs also involve slower production speeds but normally integrate well with automated filling and sealing processes.

There are two basic types of clamshell designs: reusable, or recloseable and permanently sealed.

A reusable clamshell, as the name implies, is designed to be reopened and closed many times and typically is used for long-term storage of a product. It is normally hinged, and the two parts of the shell are joined by tacking, welding, labels or tape. A lightweight, uncoated card insert or a pressure-sensitive label is often used in place of a blister pack's more expensive coated-card backing. (However, the costs saved in a lighter-weight card are outweighed by the additional cost of the heavier gauge plastic.) The tooling is more complicated, and expensive, because of the type of mold and the close tolerances - for friction seals, etc. - that are usually involved.

A reusable clamshell is ideal for dispensing small products sold in multiples, such as office supplies, and for products that will be stored in the package, such as a reusable razor. Because of its convenient storage capabilities and easy accessibility, this design is also used extensively for packaging of industrial components and replacement parts.

In constrast, a permanently sealed clamshell is designed for one-time use and normally replaces a box in a variety of packaging applications. Before sealing, this type of package can be hinged or in two separate halves. (Hinging provides some benefits, such as protection during an assembly process, but can present problems for some automated assembly equipment.) A permanently sealed clamshell usually provides a complete seal (plastic to plastic) and has a card surrounding the product. Tooling and production costs are relatively high, owing in part to the typically large package size and the sealing processes involved.

There are three types of sealing processes used for permanently sealed thermoformed packaging: RF (radio frequency), sonic and impulse. In RF sealing, high-frequency radio waves are used to bond the two halves of the package together. Sonic sealing refers to the use of vibration to achieve the same result. In the third process, Impulse sealing, electrical resistance is used to produce heat, which bonds the plastic together.

Because permanently sealed clamshells require a more complicated sealing process than the reusable type, the associated costs for the process are higher. Not only is the sealing equipment and tooling more expensive, but sealing speeds are slower, which translates into higher costs per package for the manufacturer.

On the other hand, permanently sealed clamshell packages offer high resistance to pilferage, making them ideal for high-priced items or for a group of related products, such as sporting goods or home-care items.

A-frame configurations that provide stand-alone capability are especially well suited to self-service retail displays. Consistent with their cost, permanently sealed clamshell packages tend to convey a high perceived value for the product being packaged.

Box Inserts. Also known as a tray or a platform, a box insert is designed to be a package within a package. A box insert

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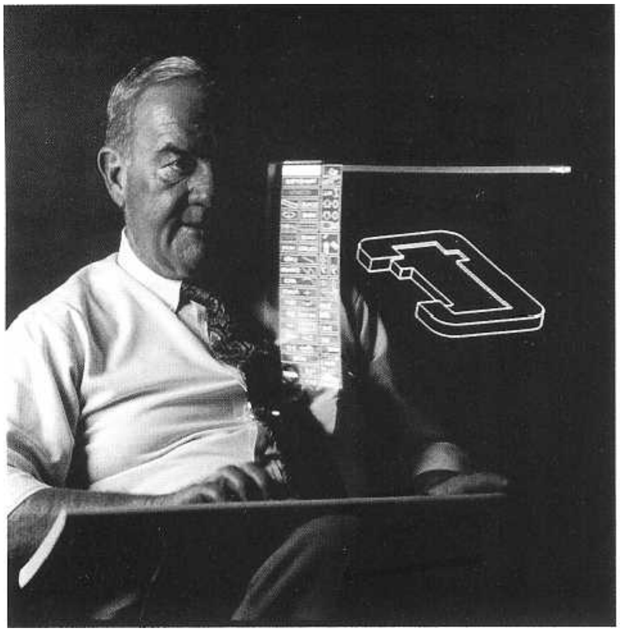
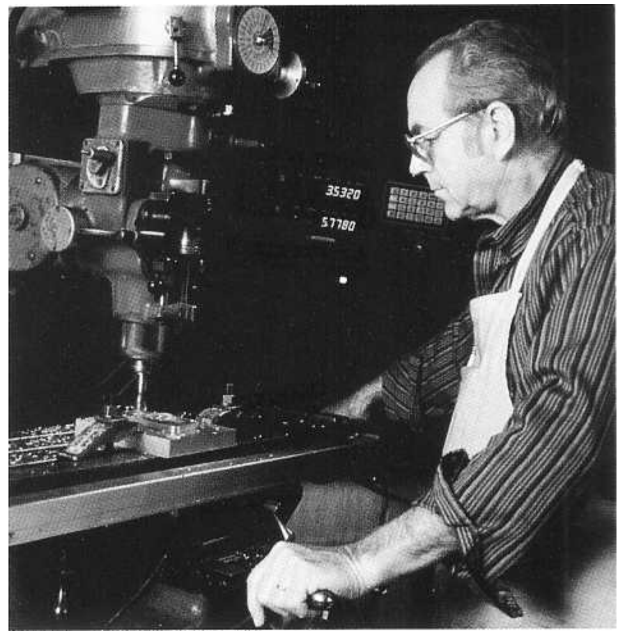


A thermoformer's technical staff should be able to work directly with design engineers from the manufacturer to assist in developing and producing a package that best meets the design and budget requirements.



Part of analyzing the cost-efriciency of a package design is determining what type of tooling will be used for the mold(s). Individual molds can be machined via a CAD/CAM system, or a pattern can be made with multiple castings.

prevents package contents from shifting and allows products to be displayed attractively with a box lid open or through a window. Costs vary considerably, depending on the material used and the tooling required. Typically, box inserts are produced in gauges ranging from 15 mils up to 50 or 60 mils and sometimes in materials that have textures altered for a more glamorous look. Recommended for automated assembly lines, box inserts adapt easily to robotized feeding and filling lines and conveniently stack or nest for storage or transfer.

Box inserts or trays are commonly used for consumer products (like game boards), to store medical products and for industrial applications, such as shipping inserts in corrugated containers. In addition to their obvious functional value, box inserts can add considerable perceived value to a package. A typical example is a fine writing pen displayed on a plush, flocked, high-impact styrene insert in a hard case.

Material Selection

A wide variety of thermoplastics and specialty polymers are available to meet specific application needs. Some of the more popular ones include:

- Polyvinyl chloride (PVC)
- Polyethylene terephthalate (PET)
- Polyethylene glycol terephthalate (PETG)
- Polypropylene (PP)
- High-impact polystyrene (HIPS)
- High-density polyethylene (HDPE)

Material selection is affected by several variables, including clarity (clear or opaque), impact resistance, sealing techniques, operating and environmental temperatures, exposure to contaminants, budgetary constraints and end use. Shipping is also a consideration. An especially durable material may be required if rough handling or extreme temperatures are anticipated during shipping. If the package is to be shipped empty, special features, such as denesting lugs, can be included in the design to facilitate handling and loading.

Getting Started

For the initial discussion with a thermoformer, it is helpful to have a blueprint or schematic diagram of the product and package design. The thermoformer will analyze the blueprint to see if it meets design requirements and can be produced efficiently. If it cannot, the blueprint should be modified with the thermoformer's assistance.

If a blueprint does not exist, the thermoformer can work with the product itself or its components, but several models or prototypes may need to be developed until the correct design is established. This will usually involve an extra charge and may lengthen the lead time needed to develop a package.

Part of analyzing the cost efficiency of a package design is determining what type of tooling will be used for the mold(s). Individual molds can be machined via a CAD/CAM system, or a pattern can be made with multiple castings. Machining will usually produce a better surface finish on the package but is best suited to repetitive, angular designs. Multiple castings are recommended for complicated package designs and are normally less expensive in the long run.

Selecting a Mold Design. In the early stages of design, it is necessary to decide whether to use male or female molds. Typically, male molds - in which material is molded over the form - are used for lower-quantity production runs because the initial cost of the mold and the setup time are about half that of a female mold. The drawback is that male molds require more space between mold cavities than female molds, which means more material is used per run, resulting in increased costs in high-volume runs.

With female molds, material is formed into the cavities. Female molds are preferred for particularly deep parts because they reduce problems associated with heat sealing. Female molds are also more economical for high-volume runs because they require less space between cavities and, thus, less material is needed.

Permanently sealed "A-Frame" clam shell configurations ***that provide stand-alone capability are especially well suited to self-service retail displays.***

Tooling

Costs for developing tooling - or production molds - for thermoforming are generally under $10,000 per project, considerably less than for a comparable injection molding project. The volume of the order will play a large part in determining the design of the mold. A small mold (only a few cavities) will be inexpensive, but the per-piece price will be fairly high. Conversely, a mold with many cavities will be more expensive initially, but with it more pieces will be produced per hour, thus lowering the cost per item.

Production

The primary decision to be made in the production phase is whether to use a fully automated or a semiautomated process. Fully automated processes have higher production rates but also have higher tooling costs and increased setup time. They are recommended for long and/or high-volume runs and for applications that involve small parts and multi-cavity molds, with too many items to be handled efficiently in a manual process.

Semiautomated operations run at slower speeds but generally involve lower tooling costs and shorter setup times. And, if a thermoformer trims off-line, special attention can be paid to that process, and each piece can be inspected individually. This type of operation is best for medical and low-volume applications or for molds with only a few, fairly large parts.

As in printing, setup charges are a large part of production costs. Blanket-with-split-release orders are a convenient way to lower the price per piece by limiting the number of setups and the related costs. Coupled with JIT shipping, they also allow the thermoformer to run a large quantity and ship according to a customer's schedule.

What to Look For in a Thermoformer

Because package design can be an involved and sometimes complicated process, it is important to select a thermoformer with quality equipment and facilities and a broad range of experience and capabilities.

Design Assistance. A thermoformer's technical staff should be able to work directly with design engineers from the manufacturer to assist in developing and producing a package that best meets the design and budget requirements.

Material Inventory. Select a thermoformer that has a good inventory of raw materials. If a firm must order materials for each production run, longer lead times will result.

Full-Service Capabilities. A thermoformer that provides a variety of prototyping, tooling and production processes can offer more options in meeting specific customer packaging requirements and more assistance in determining the most appropriate and cost-effective process.

Quality Assurance. One of the most important benefits a good thermoformer can provide is outstanding inspection, SPC and QA procedures that cover the entire manufacturing process. With proper QA programs, a thermoformer can reduce a customer's incoming inspection processes and related costs.

Thermoforming offers manufacturers cost-effective packaging technology with several unique advantages, including quick turnaround time and almost unlimited design possibilities. Understanding the design considerations involved in thermoformed packaging will help to ensure the selection of an effective package design and the right thermoformer - one which will produce a package that fits both the application and the budget.

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