



A GUIDE TO PLASTIC ROTATIONAL MOLDING

IN THIS GUIDE, WE WILL COVER:

Overview of Plastic Rotational Molding

- Advantages of RotoMolding
- Plastic Molding Process Comparison
- The Rational Molding Process

Critical Design Considerations for Rotationally Molded Parts

- The Nominal Wall... the Frame of your Product
- Uniform Wall Thickness
- Non-uniform Wall Thickness
- Flat Surface Limitations
- Parallel wall separation
- Requirements for corner angles
- Draft angles for easy removal
- Designs using internal and external undercuts

Rotational Molding Tooling

- Fabricated Molds
- Cast Aluminum Molds
- CNC Molds
- Epoxy Molds

Mold-in-Graphic Options

Typical Projects

A ROTATIONAL MOLDING OVERVIEW

Rotational Molding is a unique plastic molding process used to produce large hollow parts. Often referred to as rotomolding, because the molds are slowly rotated in an oven spreading the resin inside using centrifugal force to fill the walls of the mold. Depending on the purpose of part, wall and corner thickness can vary to suit that requirement. This is critical for water and air tight containers and tanks.

Rotational molding is a versatile manufacturing option with many benefits over standard thermoform, injection and blow molding. This process makes it possible to design very large hollow pieces in virtually any shape, size, color and configuration. Generally, pieces are lightweight with strong structural integrity.

The process uses a variety of mold types and molding machines that contain loading, heating and cooling areas. Once a mold is bolted to one of the machine's rotating arms, the pre-measured plastic resin is loaded. Several molds on as many as three arms can be used at the same time. The molds then move into the oven and rotate on both the vertical and horizontal axis. The melting resin adheres to the mold and lays down a thick even coating, filling in areas that need more structure. The rotating continues during the cooling cycle where the part retains an even thickness.

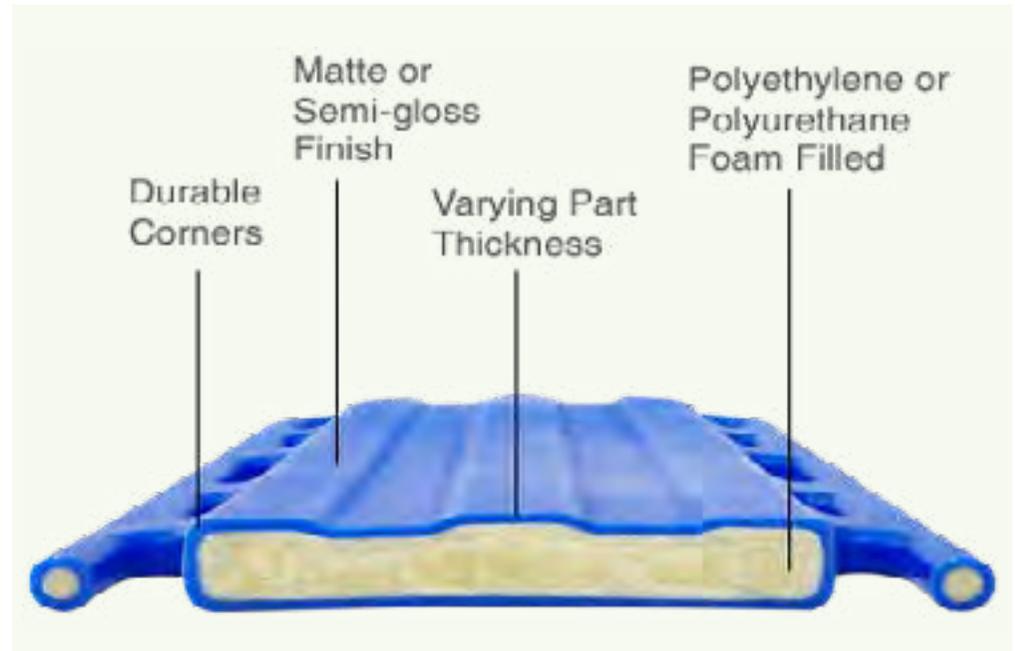


Plastic Molding Process Comparison

| Molding Process | Injection | Reaction Injection | Blow | Vacuum Forming (vacuumforming) | Compression | Extrusion | Rotational | Thermoforming | Twin Sheet Foaming | Selective Lazer Sintering | Rapid Prototyping | Lost Foam Casting (for making molds) |
|--------------------------|--|---|---|---|--|---|--|--|--|--|---|---|
| Process Description | Heated plastic is injected into mold | Plastic is injected into mold and cures from chemical reactions | A parison (tubular plastic charge) is attached to a mold and then filled with air | Heated plastic sheet is stretched over mold and suctioned into the form | Heated plastic charge is compressed to shape of the mold | Heated plastic is forced through a die creating a long part | Plastic charge is placed in mold which rotates, bi-directionally, in oven | Heated plastic sheet is stretched over mold | Method of Thermoforming that welds 2 plastic sheets into one 3D product | Plastic material is heated with a laser until its particles adhere to each other | Photosensitive plastic is cured by a laser in layers | Part is coated and pressed into sand. Metal (or other material) is poured into depression |
| Ideal Purposes | Creating small and/or critical tolerance parts | Panels, Enclosures, housings, automotive parts | Bottles, various containers | Product packaging, speaker casings, car dashboards, aerospace | Automotive parts, textiles, large pattern pieces | Tubing, piping, fiber optics | Containers, fuel cells, Large/complex products, housing, enclosures, concept products | Disposable cups, containers, lids, trays, blisters, clamshells, vehicle door and dash panels, refrigerator liners, utility vehicle beds, and pallets | Pallets, portable toilets, housings, tanks, air & ventilation ducts, enclosures, cases, toys, flat and transportation related products | Concept or highly specific/critical tolerance designs | Concept designs | Making molds and duplicates of concept designs |
| Low Mold Cost? | | X | | X | X | X | X | | X | N/A | N/A | N/A |
| Low Unit Cost? | X | | X | | X | X | X | | | | | |
| Quick Turn Around Time? | X | | X | | | X | X | | X | | | |
| High Strength Parts? | | X | | | X | X | X | X | | | | |
| Complex Part Geometries? | X | X | | | | | X | | | X | X | |
| Pros | Quick turn around and very detailed parts | Low mold costs, strong flexible parts | Fast, cheap production | Flexibility in molding structures | Can mold large and intricate patterns, very low cost, Ultra large basic shape production | Low cost and quick turn around | Very strong, flexible, cheap parts. Several finishing and production options. Complex geometries are possible. | Strong and flexible parts | Stiff, more structural parts | Useful for extremely critical dimensioned designs, no mold costs | Excellent for scaled down concept models | Great for making molds and rarely duplicates of parts our of specific metal materials |
| Cons | Weaker parts than other processes, Very high upfront costs | Long process times, expensive raw material costs | Weaker parts, limited geometry | Only adept at making shallow parts, Processing can be difficult, limited geometry | Poor product consistency, heavy flash issues | VERY limited geometry | Very small tolerances are difficult to form, slower than high-speed processes | Slower processing and very difficult to form complex geometries | Limited geomtry, additional machines req'd for various materials, parts aren't as flexible | Very high costs, slow process, size limitations | Very expensive, fragile, cannot be easily modified, Size Restrictions | Not useful for production and expensive |

ADVANTAGES OF ROTATIONAL MOLDING

- Parts originally assembled from several pieces can be molded as one piece.
- Manufacturers can produce consistent, stress-free wall thickness and strong outside corners.
- Engineers can select the best materials and additives for their application making the parts weather resistant, flame retardant, or static free.
- Designers have the option of adding inserts, threads, handles, minor cuts and fine surface detail.
- Large and small parts can easily be produced. Since there is no internal core, minor changes can be made to existing molds making the process more cost effective. Parts are formed with heat and rotation, unlike injection molding, which requires high pressure.
- Material and production costs are lower because lightweight materials replace heavier and often more expensive materials.
- Manufacturers can get their product through prototyping and to market quickly.



ROTATIONAL MOLDING PROCESS

The rotational molding process uses biaxial rotation and high temperature to fill the mold and form the plastic part or component. The rotomolding process is ideal to produce large, hollow, one-piece parts.

Sterling Tech operates “Carousel” type rotational molding machines with at least 3 “arms” with multiple molds positioned on each. In its simplest form, one arm is being loaded and unloaded, one arm is rotating or spinning in a gas-fired oven molding the parts, and the third arm is being air or water cooled. Each arm may contain 2,4,7 up to 10 separate molds per process cycle. The rotomolding machine’s arms move independently from one another allowing a variety of mold sizes with different receipts for heating and thickness.

Each part being molded has its own recipe for production. This includes the amount and formulation of the resin, rotation speed, oven temperature and processing or heating time. Cycle times can be long... often up to 30 minutes. With these longer cycle times, rotationally molded parts typically have run lengths ranging from just a couple to hundreds of parts with annual order quantities as low as 50 up to thousands of parts.

Ensuring proper product design is critical for manufacturing and assembly optimization as well as the general success of the product itself. Rotational molding designs and prototypes using 3D solid model rendering and rotolog tooling capability studies are used to help guide customers through the intricacies of the rotational molding process.



With pending ISO 9002 certification and drawing from techniques outlined in Six Sigma, World Class and Lean Manufacturing, Sterling Technologies is dedicated to delivering superior quality. Process controls include rotolog tooling capability studies to optimize product quality throughout the run.

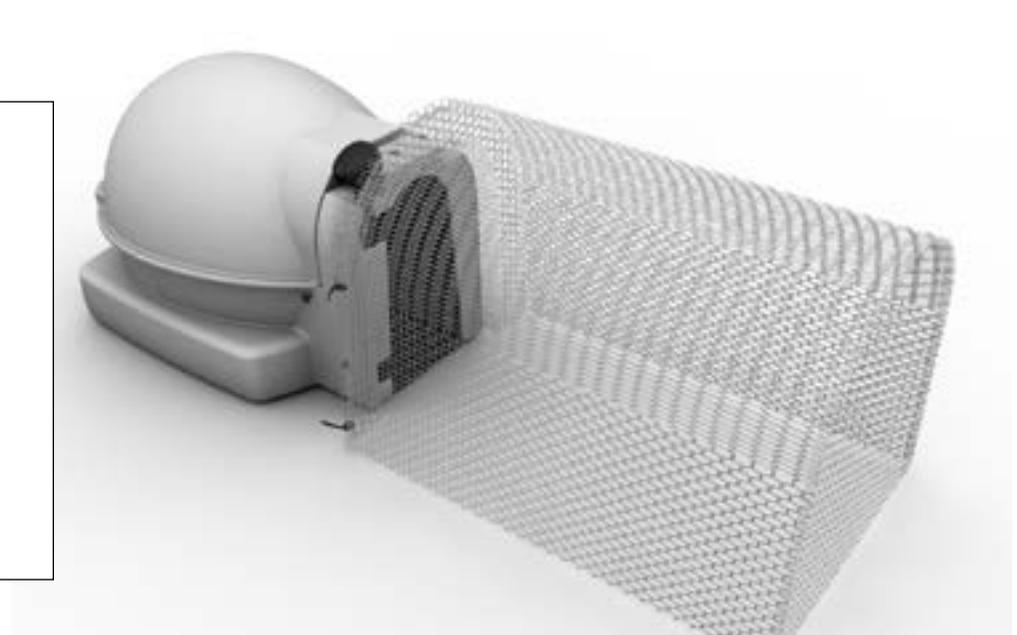
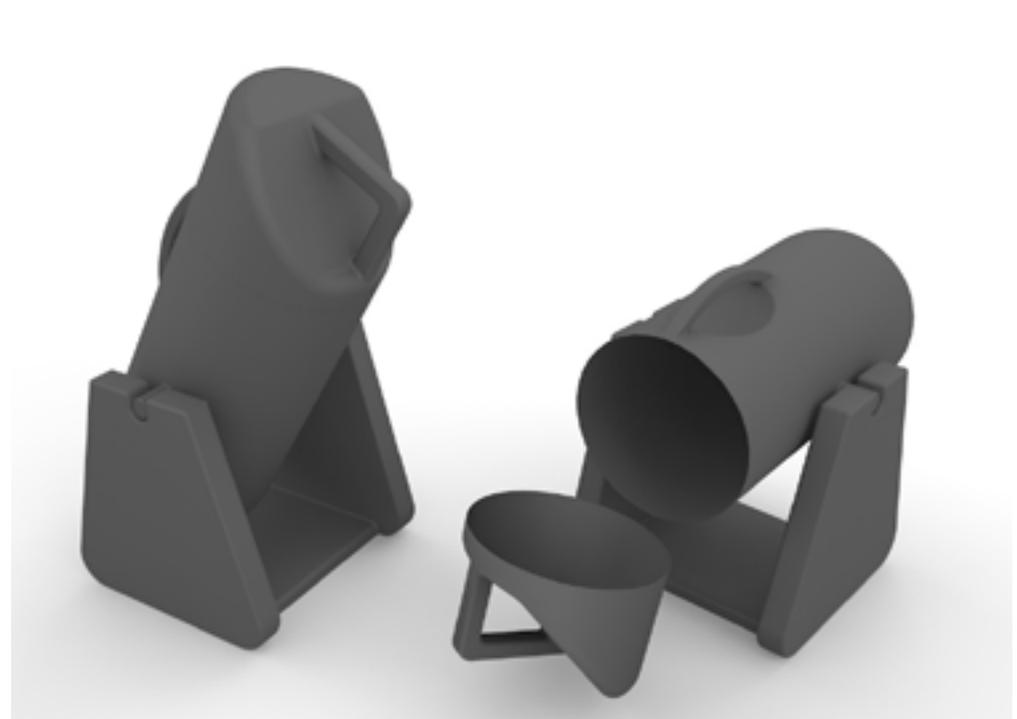


DESIGNING A SOUND ROTATIONALLY MOLDED COMPONENT

THE NOMINAL WALL... THE FRAME OF YOUR PRODUCT

The nominal wall is the basic frame of your product. It is the single most important aspect of your design and it must be handled correctly for quality assurance. The thickness of the nominal wall will not only determine its strength, but also its load bearing capability. The thickness will have a direct effect on the cost of your overall product. The ideal minimum thickness of .125 inches provides a good compromise between cycle time, processing ease, strength of product, and cost.

The rotational molding process permits a designer to change the wall thickness of their product after the mold has been built, tested and sampled. This versatility is not common in other plastic processing techniques.



UNIFORM WALL THICKNESS

The general nature of rotational molding allows the thickness of the wall to be even throughout the finished part. This gives designers more flexibility with product design, even with the most unusual shapes. Although designers have gone as low as .090-inch wall thickness, a safe .125-inch minimum should be adhered to.

NON-UNIFORM WALL THICKNESS

Although rotational molding is known for its uniform wall thickness, non-uniform wall thickness can also be produced with some limitations. Several techniques are used successfully to produce items like vertical storage tanks with gradually thickening wall near the bottom where the weight limit is greater.

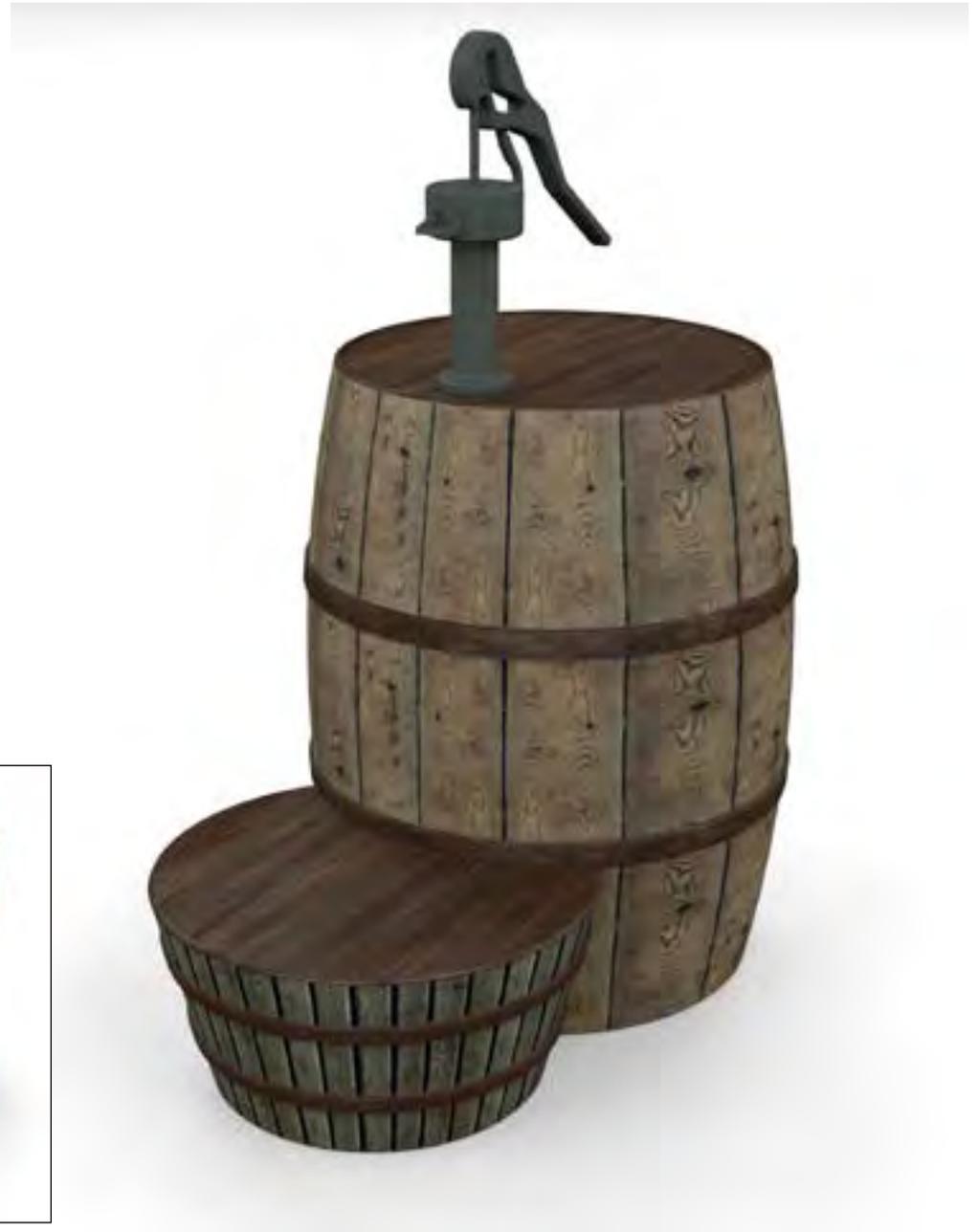


FLAT SURFACE LIMITATIONS

Rotational molds are formed without internal cores, making it difficult to assure flat space on large panels. Many experienced designers are able to make adjustments in designs to accommodate the lack of flatness with the use of reinforced ribs, providing a .015 inch-per-inch crown on flat surfaces or using decoration or lettering to mask the curvature of the product.

PARALLEL WALL SEPARATION

Due to the nature of rotational molding, it is important that sufficient space is left between parallel walls in a mold design. The liquid or powered plastic must be in contact with all surfaces of the cavity to ensure regular cooling times and preventing molded-in stress. Although a three times wall thickness separation is achievable, a four to five times wall thickness separation is recommended.



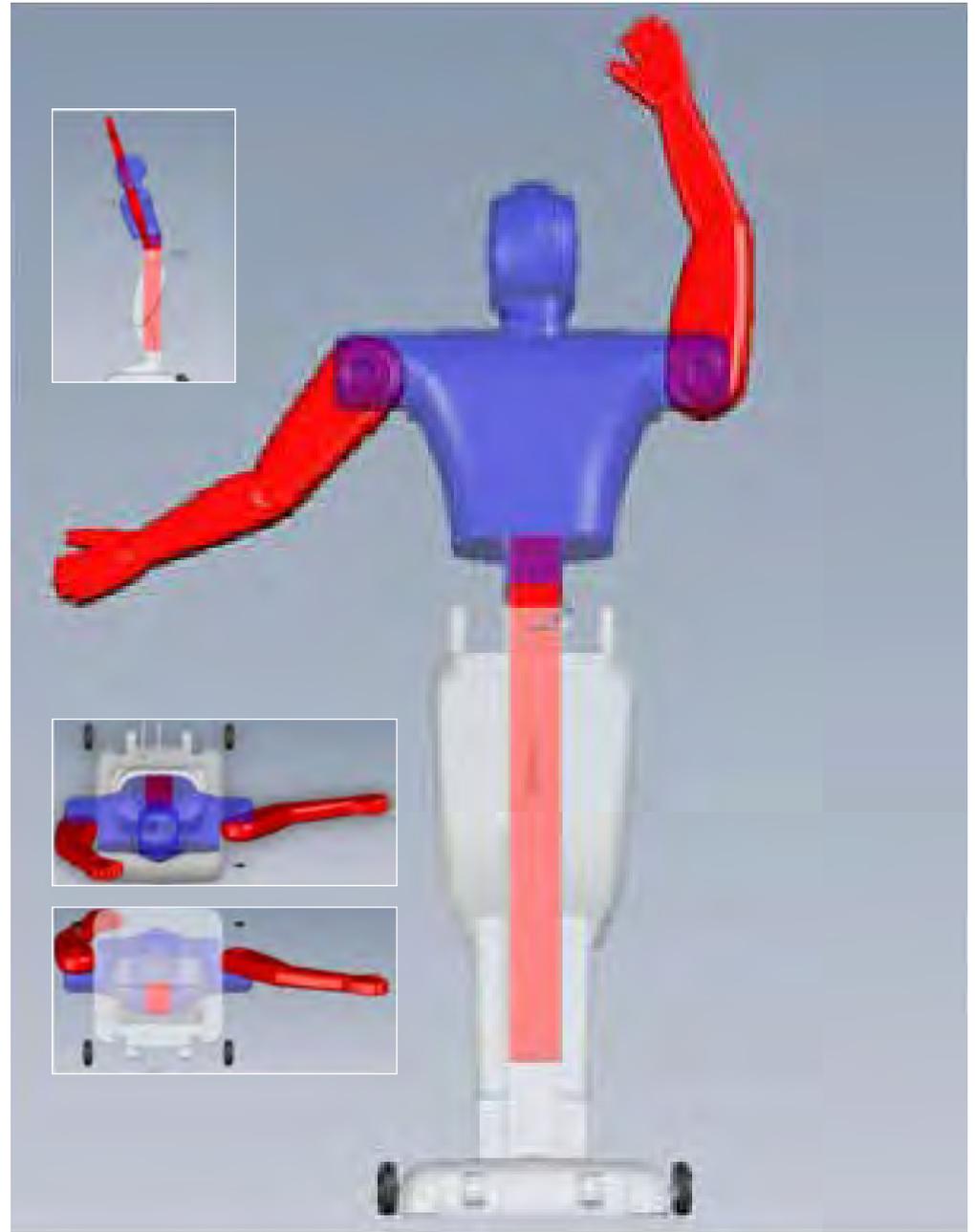
REQUIREMENTS FOR CORNER ANGLES

In addition to the space needed between parallel walls, corner angles must also be designed to ensure even wall thickness throughout an irregularly shaped part. Corners measuring 90 degrees or more require no special treatment. Anything under 90 degrees will require special attention and a closer look at the materials used for the process. Harder flow materials such as polycarbonate should not be used in a part requiring angles less than 45 degrees.

DRAFT ANGLES FOR EASY REMOVAL

Draft angles are tapers applied to the part making removal from the cavity easier. Draft angles reduce the force placed on a part during the removal and, therefore, minimizing cooling time, cost, induced stress, and part warpage. One advantage that rotational molding has over other molding forms is that many parts can be manufactured successfully without using draft angles. As the part cools, it shrinks away from the mold, making it easy to remove.

There are no specific rules for determining the use of draft angles. Certain materials such as polyethylene are used for softer pieces and can be removed without difficulty. However, the designer must take in consideration the materials used, shape of the part, and inside shrinking of the piece during the cooling process. When it does not interfere with the design, draft angles should be used liberally to ensure easy removal.



DESIGNS USING INTERNAL & EXTERNAL UNDERCUTS

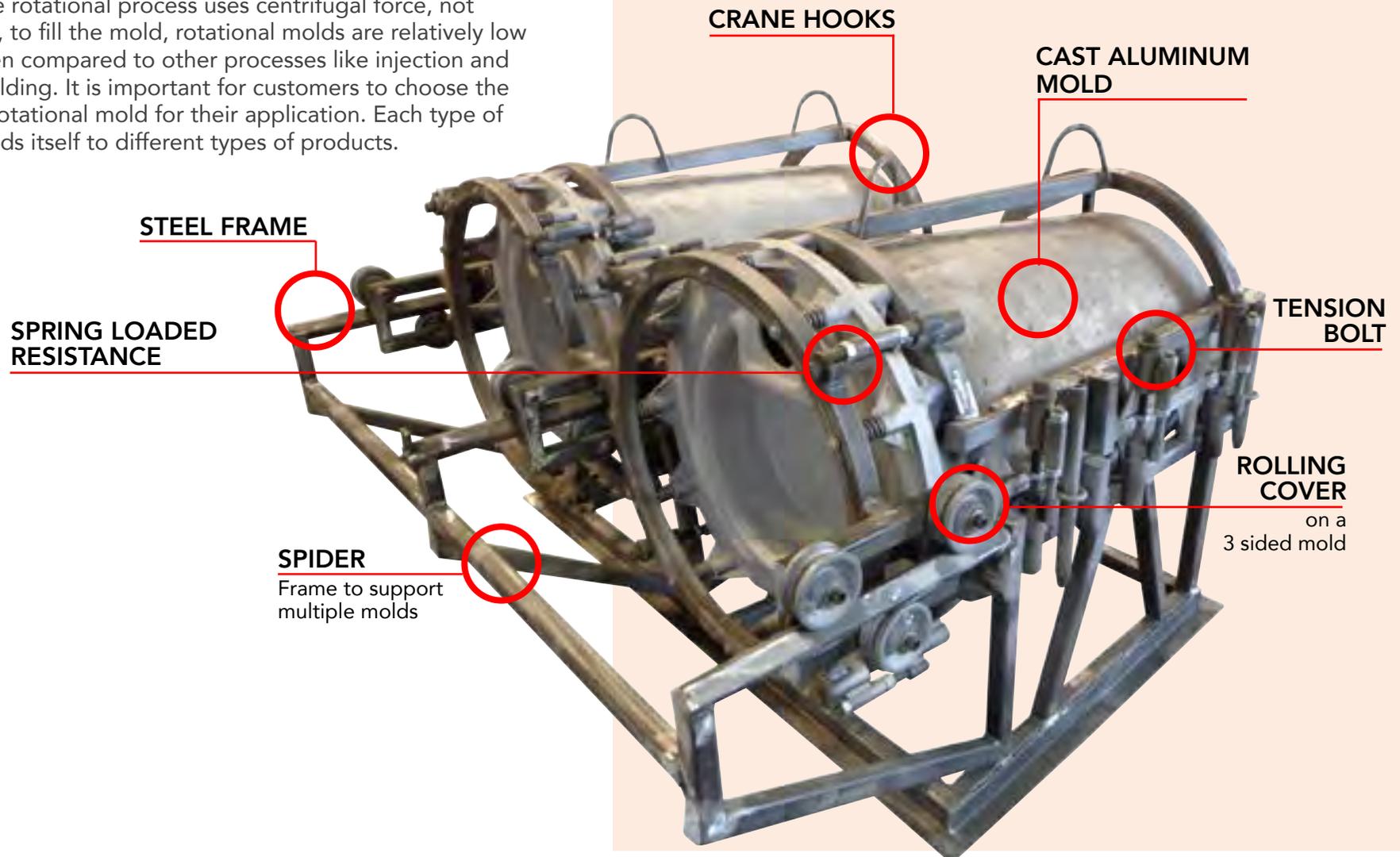
An undercut on a rotationally molded part is any projecting wall that is parallel to the parting of the mold that must be deformed in order to be removed from the mold. Because of the rotational molding process there are design limitations and material requirements in order to produce an effective piece. Many times parts are constructed of two or more pieces to accommodate internal and external undercuts that are necessary for a product. These extra components, however, do add to overall maintenance and design costs.



ROTATIONAL MOLDING TOOLING

ROTO MOLDING USES LOW COST TOOLING

Since the rotational process uses centrifugal force, not pressure, to fill the mold, rotational molds are relatively low cost when compared to other processes like injection and blow molding. It is important for customers to choose the correct rotational mold for their application. Each type of mold lends itself to different types of products.



MOLDS AVAILABLE FOR THE PLASTIC ROTATIONAL MOLDING PROCESS INCLUDE:

Fabricated Molds are used mainly for large parts with simple shape fabricated from steel, aluminum or stainless steel these molds are lightweight, have a consistently thin cavity wall and are the lowest cost approach when dealing with large molds.

Cast Molds are the most common type of rotational molds to produce parts varying from very small to large. Cast molds produce parts that require considerable detail or elaborate shapes and they can be modified to integrate design changes.

CNC Molds are used when extreme precision or extended production runs are required. Because of a higher cost, they are used only in special cases.

Epoxy Molds use a liquid thermosetting polyester and epoxy material that is formed and cured at room temperature.

The most important thing to consider with all types of molding is the quality of the mold. There is no substitute for an excellent mold. A Production rotational molder can advise you on the type of mold best for your application, and the plastic material most suitable for your product. Sterling Technologies can help you make the right decisions to make your product stand out from the rest.

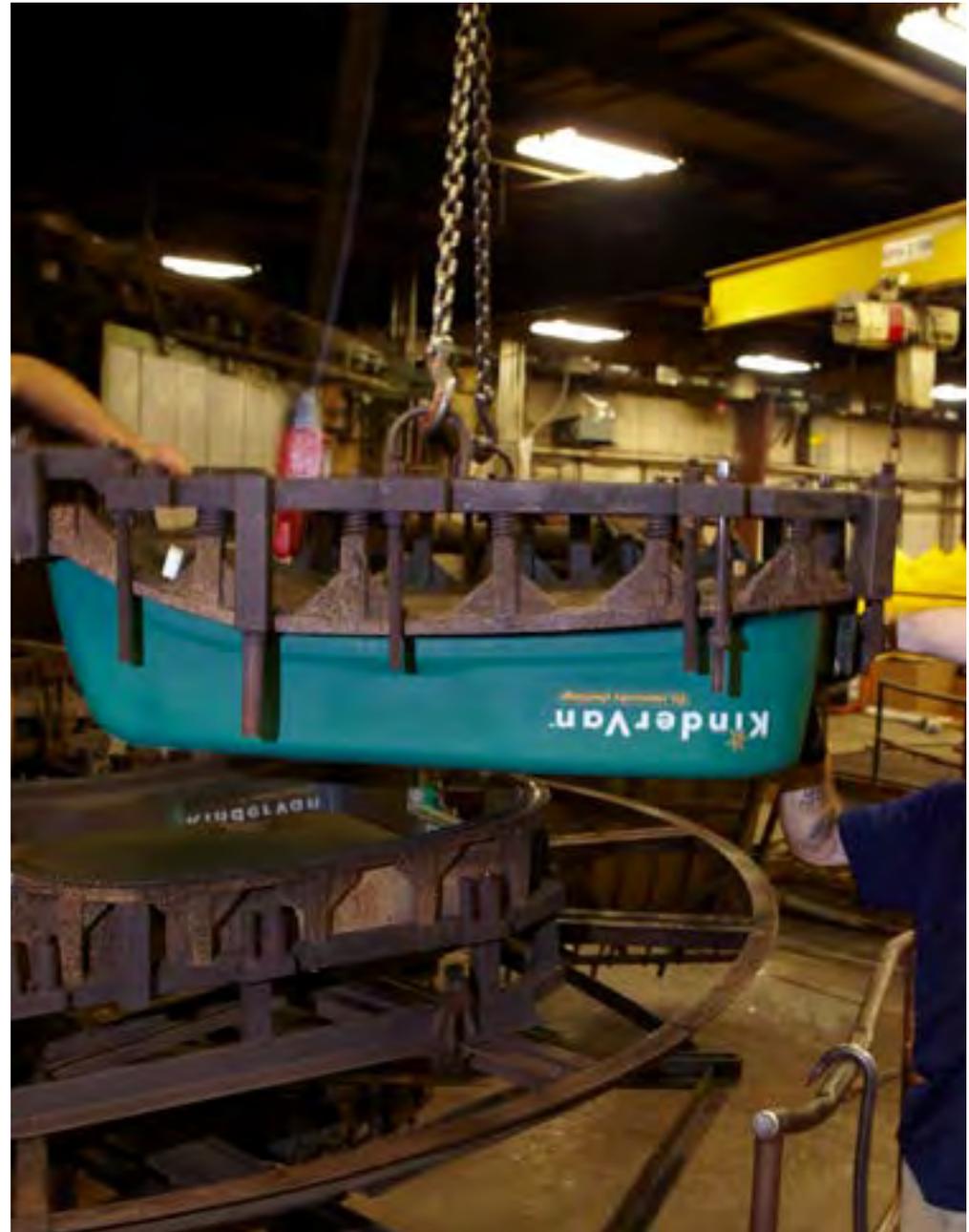


MOLD-IN GRAPHICS ON PARTS

Removed from the rotational mold, parts are quickly transferred to finishing where the warm flash is trimmed, assembly holes are drilled and the part is staged for further operation or is wrapped for shipping. If desired, Sterling will “flame” the surface to create a smoother more glossy finish without affecting the quality of your rotationally molded part. Additional graphic details can be added before or after the molding process. Mold-in-Graphics can be placed inside the mold’s cavity prior to molding. These graphics can be large, colorful and will withstand continued use. Sterling Technologies also provides a range of other graphic enhances including hand painting!

Sterling provides:

- Custom trim and cutting operations
- In-mold and post-mold graphics
- Post-mold flaming
- Foam fill and air pressurization
- Air tight pressure testing
- Leak testing



Typical Projects

- A) The hunter's package includes a dog kennel, a high-impact case and gun cases.
- B) Large enclosures to protect snowmobiles.
- C) Fuel cell with molded in threaded fasteners and graphics.
- D) Typical case or footlocker. These are common rotationally molded products.
- E) Two piece hand washing station with complete assembly.
- F) Grocery shopping cart for children. Two peice with molded in graphics.
- G) Golf club demo carts with drawers and wheels.
- H) Spine boards with foam reinforcement for stiffness.
- I) Impact resistant carrying case with handles and wheels.





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