

An Introduction to Thermoforming

By



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Introduction

Universal Plastics is a key vacuum forming supplier to a number of major OEMs across the United States, primarily serving the medical, industrial, aerospace, and electronics industries.

Our central location in New England makes us an ideal supplier to companies in Massachusetts, Connecticut, Rhode Island, New Hampshire, Maine and Vermont. But our expertise also makes us the supplier of choice for customers all over the country.

Many people are confused when differentiating between thermoforming, vacuum forming, and pressure forming, and how these processes compare to injection molding.

We hope the following guide clearly explains each process, how they differ, and where they would be best utilized.

In a general sense, thermoforming is a forming process that converts a flat sheet of plastic into a usable 3 dimensional product.

Vacuum forming is the most common application, where the sheet is drawn over a male mold, and vacuum is applied between the hot sheet and the tool. The combination of atmospheric pressure on the non-mold side of the sheet and vacuum between the under side of the sheet and the mold, force the hot sheet to tightly conform to the tool surface. It is the lowest cost method both for tooling and product cost to form a part.

Introduction

Pressure forming is a more advanced process where a pressure box is added to the tool package to boost the force from 14.7 PSI to approx. 30 psi. The combination pushes the hot sheet very tightly into the tool, which allows for very crisp, precise detail, varying texture, and even undercuts to be formed into the part surface. The result is part virtually indistinguishable on the tool side (outside) of the part from an injection molded version of the same part. But because the tooling is just on one side and the forming pressures are considerably lower than injection molding, the tooling costs are considerably less. On larger parts, as much as 80-90% less.

For flexibility in tooling and engineering, faster set-up and production of custom plastic enclosures—especially prototypes and large parts in quantities from dozens to thousands—thermoforming is commonly selected over injection molding.

In this white paper report, we will illustrate how each process works and the advantages of each.

If you have other questions please contact Universal Plastics to discuss your particular needs and questions.

Vacuum Forming

Vacuum forming is an economical process for producing large sized, low volume parts at a reasonable price. As stated above, with vacuum forming, a heated sheet is pulled over a male mold, and vacuum is applied between the hot sheet and the tool.

The combination of atmospheric pressure on the outside of the sheet, and vacuum on the inside, forces the hot sheet to tightly conform to the tool surface. Any cut-outs, openings, etc., are made by 3 dimensional (5 –axis) trimming as a secondary operation.

The advantages of vacuum forming are the following:

1. It is a low pressure process, enabling the forming of large parts without expensive tooling or long lead-times.
2. The simplicity of the tooling reduces the capital investment for both large and small quantities of parts.
3. Mold changes and design modifications can be made easily and inexpensively, allowing for more design flexibility with less risk.
4. Since openings, holes, and cut-outs are made secondarily, changes can be implemented easily and very inexpensively. Often times similar parts can be made off of one common mold.

Therefore, vacuum forming is the clear process of choice for large parts with low volumes, and for parts where the designs need further development before hard tooling should be considered.

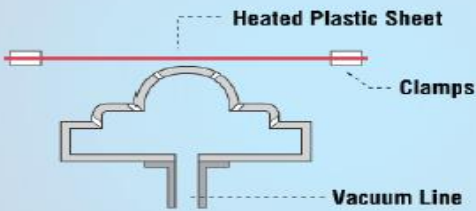
Thermoplastics most commonly specified are acrylic, ABS, PVC, HIPS, HDPE, CAB and polycarbonates. Pre-colored sheets are widely used as well as the secondary steps of painting, pad printing, hot stamping and silk screening.

For more information on the vacuum forming process or to discuss your needs, please contact us.

Vacuum Forming

Illustrating the Vacuum Forming Process

VACUUM FORMED PARTS




Heated Plastic Sheet

Clamps

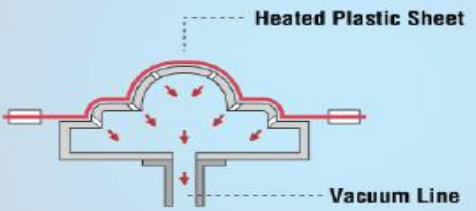
Vacuum Line

An oven heated plastic sheet is introduced to the mold.

NEXT 

Step 1


VACUUM FORMED PARTS



Heated Plastic Sheet


Vacuum Line

The seal is made around the entire perimeter, the vacuum is turned on, then the hot sheet conforms to the shape of the mold.


NEXT 

Step 2

VACUUM FORMED PARTS



The temperature controlled mold then starts to cool the part. The part is removed from the clamp frame and is ready for secondary trimming operations.

NEXT 

Step 3

Pressure Forming

Pressure forming is a more sophisticated version of the vacuum forming process. This process closes the appearance gap with traditional injection molding.

Pressure forming is generally done in a female mold, where a pressure box is added to the tool package to boost the force from 14.7 PSI to approx. 30 psi. The combination pushes the hot sheet very tightly into the tool, which allows for very crisp, precise detail, varying texture, and even undercuts to be formed into the part surface. The result is part virtually indistinguishable on the tool side (outside) of the part from an injection molded version of the same part. The pressure forming technique provides for forming heavier sheet from 0.093" thick up to 0.375" thick.

Typical materials are Kydex[®], ABS, FR ABS, and polycarbonate.

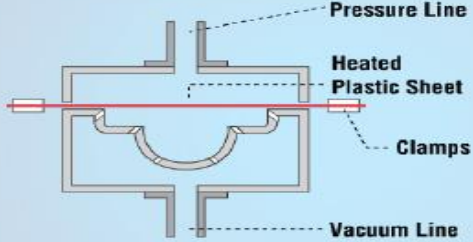
If you add in secondary 3 dimensional trimming, pressure formed parts can virtually replicate injection molded parts on one surface but with a much lower tooling cost, especially with larger parts.

Features needed on the inside of the part, such as standoffs or mounting surfaces can be bonded on secondarily. With modern structural adhesives, these bonded joints are nearly as strong as the parent material.

The other advantages of pressure forming are the same as vacuum forming; namely the ease of making changes and the potential to use one mold for similar parts.

Illustrating the Pressure Forming Process

PRESSURE FORMED PARTS



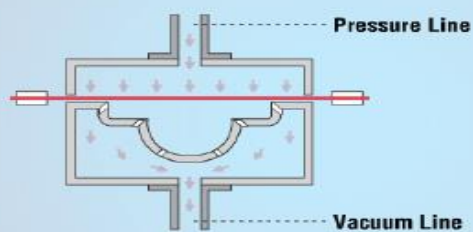
Pressure Line
Heated Plastic Sheet
Clamps
Vacuum Line

An oven heated plastic sheet is introduced to the mold. The seal is made around the entire perimeter, the vacuum is turned on, then the hot sheet conforms to the shape of the mold.

NEXT ▶

Step 1

PRESSURE FORMED PARTS



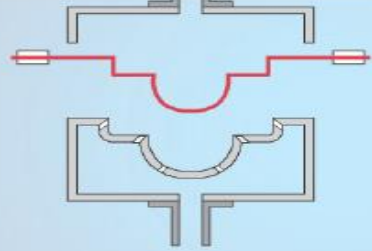
Pressure Line
Vacuum Line

Both the vacuum and the air pressure are turned on. The added air pressure (50-100lbs) from the back side of the sheet causes the hot sheet to completely press against the mold picking up additional detail not normally found during straight vacuum forming.

NEXT ▶

Step 2

PRESSURE FORMED PARTS



Details like sharp corners, logos and mold texture are examples of the features available while pressure forming.

The temperature controlled mold then starts to cool the part. The part is removed from the clamp frame and is ready for secondary trimming operations.

NEXT ▶

Step 3

Thermoforming Mold Making

The quality of thermoformed plastics parts depends upon the quality of tooling. At Universal Plastics, we control all facets of mold making in-house. We employ talented designers, machinists and have all the equipment necessary to produce our molds in-house. We also use several experienced outside mold makers with whom we have worked for many years. This combination provides us control over the mold design and the capacity to meet demanding delivery schedules.

Thermoforming molds can be produced from a wide variety of materials, depending on the size of the part, quantity, detail and dimensional accuracy required. For very low volume, 'one off' jobs or where there is a low cosmetic requirement, molds may be made from wood or a combination of wood and synthetic materials in a 'fabricated' assembly. These types of molds are crafted completely in our facility by experienced mold makers.

For production tooling, our mold makers use cast or machined aluminum. Aluminum tooling will last for the lifetime of the product. In most cases, we add temperature control to the molds to ensure part-to-part consistency. Aluminum molds are designed in-house by our experienced CAD designers, then translated through MasterCam to our CNC routers to produce either the master pattern for cast tools, or to direct machine the final mold.

Universal Plastics differentiates itself from most thermoforming companies by controlling the mold making process, thereby significantly reducing aluminum mold cost, risk, and lead time.

Plastic Thermoforming or Injection Molding

When deciding between plastic thermoforming and injection molding for your next project, there are several important factors to keep in mind which we have highlighted below.

Tooling costs for thermoforming are considerably lower than tooling costs for injection molding. On large parts, thermoform tooling can be dramatically less expensive than injection molding tools. For this reason, thermoforming, particularly pressure forming, is the more cost effective choice for very large, thin-walled parts. You can be assured that despite pressure forming's lower tooling cost, nothing is sacrificed in terms of quality; thermoforming can achieve highly cosmetic finishes that meet the end user's highest expectations.

In addition, Universal Plastics also offers secondary painting and assembly, so we can provide a complete service, reducing your manufacturing risks, costs, and lead-times. In the end, the best way to decide how to proceed is with the assistance of a trusted, knowledgeable plastics processor. Universal Plastics' engineering support staff can walk you through the design and manufacturing of your part to ensure it follows good design for manufacturing principals and achieves the lowest cost with the best results – the first time around itself. And if your project warrants injection molding, we can identify a Universal business partner who can offer you the same great service.

Put our plastic expertise to work for you—call us at **800-553-0120** to begin the process.

Thermoforming or Rotomolding

Rotomolding and thermoforming both offer advantages, depending on the type of project at hand.

The key advantages of thermoforming include:

- Sharp detail
- Tight tolerances
- Flexible tooling and engineering
- Efficient set-up
- The widest variety of materials, colors, and finishes

Rotational molding offers:

- The ability to mold completely enclosed parts as one unit
- Consistent wall thickness
- Strong outside corners

A well-trained, experienced plastics engineer can help you determine whether thermoforming or rotomolding is right for your particular project.

Universal's engineering support staff has the knowledge and expertise to help with these and other considerations, including:

- Material selection
- Improving geometries
- Concept development
- Final design

And, if rotational molding is the best fit, we can help you find the right rotomolder to meet your project requirements.

Thermoforming Applications

Thermoforming is widely used in industry for the manufacture of large, low volume parts. Scroll through the list below to get an idea of Universal's own specialties in this area and then call us to see how we can make the difference in your next project.

Medical:

- Equipment covers
- Sidewalls, user interface panels
- Bezels and enclosures
- Internal components
- Work-in-progress trays
- Hospital room panels

Universal has extensive knowledge in manufacturing high quality heavy and thin gauge plastic enclosures, thermoforming products and packaging for the medical industry.

Telecom – radomes for:

- RVs
- Yachts
- Military aircraft
- Commercial aircraft
- Ground-based operations

Industrial:

- User interfaces
- Bezels
- Enclosures
- Plastic housings
- Panels

Thermoforming Applications

Diversified:

- Bins, totes and bases
- Office furniture and interior panels
- Plastic enclosures for fitness equipment
- Underground pipe supports and housings
- Domes and panels for a variety of industries
- Marine vehicle parts
- Transportation components, plastic covers and enclosures

Thin-gauge:

- Retail packaging
- Medical shipping and kitting trays
- Work-in-progress trays
- Food containers

Plastic Fabrication in Thermoforming

Fabrication is the simplest process of all, where the sheet itself is simply bent and or bonded into a new shape, very similar to sheet metal, but with the many benefits plastics bring to product design.

There is virtually no tooling cost with this process, and the variety of shapes that can be created are only limited by the designers imagination.

Common uses include machine guards, tanks, retail displays, and back end enclosures that match up to pressure formed bezels.

Vacuum Forming FAQs

Vacuum forming, a low-cost thermoforming process, offers an economical method of creating large-size, low-volume plastic parts.

As a custom thermoforming specialist, Universal Plastics has all the answers to your vacuum forming questions.

Read through the most frequently asked questions below, or call us at **800-553-0120** for more information.

What size of parts can be vacuum formed?

Universal has the capabilities to vacuum form parts as small as an ice cube to dimensions as large as 8 feet by 5 feet. Any thermoplastics with the appropriate melt strength can be vacuum formed, and Universal Plastics' dedicated staff has the expertise and technical know-how to help you select the best material for your part.

Is design and engineering assistance available for my vacuum-forming project?

Yes. We have an experienced design team on premises who can guide you through the design process, from concept to final design. Our engineers have decades of experience in product design - not just for plastics, but for virtually all commonly used materials. We can not only validate thermoformed products, but also evaluate how those products will work within the overall product design. In fact, our customers tell us it is the high level of design and engineering assistance available from Universal sets us apart.

Vacuum Forming FAQs

What tolerances are required for radii & draft angles?

The project's specifics & geometries will determine this. Universal's experienced engineering support staff is available to help each customer work through the design process to make sure the final vacuum formed part is the right part for your project.

Does Universal Plastics build tooling?

Universal has the ability to make, maintain and store all tooling in-house. Consistently good parts only come from well made tools. The experience we apply to control all facets of the tool making process enables us to ship consistently good parts on time and at a competitive price. This is how we 'Form Customers for Life'.

Does Universal provide secondary assembly?

Yes, we provide a wide array of assembly procedures, including mechanical, chemical and sonic welding which allows for the production of large, complex final plastic parts.

Does Universal offer any other secondary services?

Besides complex assembly as detailed above, Universal Plastics also offers in-house wet painting, drape forming services, and part decorating (silk screening and pad printing).

Vacuum Forming FAQs

What file formats are accepted?

Universal largely works with SolidWorks, and Mastercam, although we have the ability to import just about any type of file.

How can I trust you will make a quality part that meets my requirements?

This is a great question that should be asked more often. Many companies state that they are ISO9000 and offer assurances that they can meet your specifications. It's important though to look beyond the website to the actual Quality Plan and supporting documentation. At Universal Plastics, we make no assumptions. Our engineering team validates every manufacturing plan. Our Quality Plan is rigorous, highly detailed, and designed to insure any deviations are successfully addressed. Please see our website for more information. Or better yet, feel free to ask for a referral. Many of the largest OEM's in this country trust us to make their products and would be happy to attest to the success of our partnership.

Can I arrange a tour of Universal's manufacturing facility?

Universal Plastics is pleased to welcome all customers, both new and existing, to tour our state of the art 95,000-square-foot facility. Please call us at **800-553-0120** to arrange an on-site visit.

Summary

We hope you found this guide informative and helpful in choosing the right process for your plastics needs.

Please call or email us for additional information or to discuss your particular design or production challenges.

Universal Plastics' engineering support staff can walk you through the details of your design to ensure you end up with the right product and the right price to meet your bottom line requirements. And if your project requires another manufacturing process, we can identify a Universal business partner to meet your needs.

Put our plastic expertise to work for you — call us at **800-553-0120** to begin the process.

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