“Injection molding and the plastic thermoforming process both have widespread uses in a long list of industries. Each process has some unique features and benefits that are often advantageous for a specific application. In these instances, the choice to manufacture with plastic thermoforming or injection molding may have been easily made in years past.

However, as advances in manufacturing technology continue to evolve, the area where a product’s needs and the capabilities of plastic thermoforming and injection molding overlap is increasing. Selecting the right method in these situations requires a deeper appraisal of the features, benefits, and costs associated with each process.”
PROCESS OVERVIEW

INJECTION MOLDING

Injection molding is a high-volume production process that uses thermoplastic material in a heated resin form to produce 3 dimensional parts ranging from simple to quite complex. Two sided and highly engineered injection mold tools, once constructed, are clamped together to form a 3D cavity of the desired part shape. The tool is then fed with melted plastic material, forced under high pressure and through associated machinery, into the cavity. The material is then allowed to dwell inside the tool and cool to a solid state in the shape of the intended part design. The molded part is then ejected from the tool and any secondary finishing, such as surface painting, is applied to produce the finished part.

KEY POINTS

- Ideal for small parts and large annual production volumes (3-5k / year or greater)
- Large tooling investment - A double sided 3D mold is required
- Extended lead times due to two sided mold construction and auxiliary requirements (~ 24 weeks)
- Highly detailed and consistent part repeatability
- Large capital investment
- Controlled wall thickness and two sided part geometry
PROCESS OVERVIEW

PLASTIC THERMOFORMING (Heavy Gauge)

Plastic thermoforming is a manufacturing process used to create formed plastic parts. There are multiple techniques within thermoforming. The two most common are vacuum forming and pressure forming.

The process begins by applying heat to a sheet of formulated thermoplastic. The now pliable thermoplastic is then stretched onto a temperature controlled mold to conform to a desired three-dimensional shape or part. This is accomplished through the application of either vacuum or positive pressure (vacuum forming or pressure forming).

The selection of vacuum forming or pressure forming techniques depends on the requirements and characteristics of each application. Once the part has been formed in the mold, it is then removed and any excess material is CNC trimmed to exact design specifications.

Secondary operations, if required, such as painting, silk screening, additional assembly, or attachment point bonding are accomplished to complete a finished part.

HEAVY GAUGE THERMOFORMING

Heavy gauge thermoforming is a broad term used to describe thermoforming using sheet materials ranging from .060 to .500 inches thick. This is the sheet thickness of thermoforming that is used to manufacture a wide scope of industrial applications such as medical device enclosures, transportation interior components, kiosk enclosures, and material handling equipment parts.

KEY POINTS

• Fast part processing and lead times (~ 6-12 weeks)
• Complex part geometry and large size capability with little impact on lead time and cost
• Significantly lower tooling cost than injection molding
• Able to reproduce the same level of part detail as injection molding
• Ideal for part runs from ~250 – 5,000 EAU (estimated annual usage)
• Parts are produced with less internal stress than injection molding
**Process Quick Reference - Vacuum Forming**

1. Thermoplastic sheet is secured & heated to forming temperature
2. Heated plastic sheet is placed over the mold face
3. Air is evacuated from the mold, pulling the plastic onto the mold surface
4. Part removed and CNC trimmed to specification

Click on the image for 1 min video demo of the heavy gauge vacuum thermoforming process

**Process Quick Reference - Pressure Forming**

1. Thermoplastic sheet is secured & heated to forming temperature
2. Heated plastic sheet is placed over the mold face & covered
3. Air is applied above the mold and vented below to form shape
4. Part removed and CNC trimmed to specification
COST AND LEAD TIME CONSIDERATIONS

Tooling Investment

PLASTIC THERMOFORMING

Plastic thermoforming utilizes a single sided 3 dimensional tool constructed from aluminum. Most tooling is temperature controlled for enhanced part quality and properly vented for either the pressure or vacuum forming process.

This highly engineered tool can be a significant project investment. However, with fewer tool parts, less robust design requirements, and a simple setup process, the time and cost is substantially less than injection molding.

INJECTION MOLDING

The process requires a two sided 3 dimensional mold of steel, aluminum, or copper alloy capable of withstanding the extreme pressure associated with injection molding. Depending on part size, multiple part molds can be accommodated within a single tool.

Due to their complexity and multi part construction, injection molding tools are very expensive and time consuming to produce, install, and test. The cost of the tool is also highly influenced by part size.

A plastic thermoforming tool can cost up to 70% less than an injection molding tool.

TOOLING/MOLD COST COMPARISON

![Graph comparing tooling costs for thermoforming and injection molding](#)
COST AND LEAD TIME CONSIDERATIONS

PER PART MANUFACTURING AND VOLUME CONSIDERATIONS

PLASTIC THERMOFORMING

Significantly lower tooling cost than injection molding but a slightly higher per part manufacturing cost makes the plastic thermoforming process most beneficial at lower to mid production run volumes or estimated annual usage (EAU). The break even point for each project is different and can vary greatly with part size and other variables, but generally favors plastic thermoforming when the number of parts manufactured each year is less than 3,000 to 5,000.

INJECTION MOLDING

High tooling and startup costs tend to make this process cost prohibitive at mid to low production ranges. However the lower per part manufacturing cost, when compared to plastic thermoforming, eventually become more cost effective as part production volume increases. Again, the breakeven range can vary greatly from factors such as part size and design, but volumes in excess of 3,000-5,000 cost less with injection molding.

The breakeven cost can vary GREATLY for each project, but typically
less than 3,000 - 5,000 parts = plastic thermoforming
more than 3,000-5,000 parts = injection molding

MANUFACTURING COST COMPARISON

![Graph showing cost comparison between plastic thermoforming and injection molding.](image-url)
COST AND LEAD TIME CONSIDERATIONS

**Lead Time**

**PLASTIC THERMOFORMING**
Simple tool construction and fast manufacturing cycle times equate to a rapid lead time and reduced time to market for plastic thermoforming projects.

**INJECTION MOLDING**
Although manufacturing cycle times are relatively fast, complex tooling construction and setup cause lengthy injection molding lead times and a much greater time to market than plastic thermoforming.

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**Lead Times (Tooling and Production)**

**INJECTION MOLDING**

**PLASTIC THERMOFORMING**

Lead Time:

- **INJECTION MOLDING**
  - 22 - 24 weeks

- **PLASTIC THERMOFORMING**
  - 6 - 12 weeks
## PART SIZE - LIMITATIONS AND IMPACT

<table>
<thead>
<tr>
<th>THERMOFORMING</th>
<th>INJECTION MOLDING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOOLING INVESTMENT</strong></td>
<td><strong>TOOLING INVESTMENT</strong></td>
</tr>
<tr>
<td>$</td>
<td>$$$</td>
</tr>
<tr>
<td>As part dimensions increase there is a minimal impact on tooling costs</td>
<td>Tooling cost increase substantially as part dimensions increase</td>
</tr>
<tr>
<td><strong>LEAD TIME</strong></td>
<td><strong>LEAD TIME</strong></td>
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<tr>
<td>=</td>
<td>+</td>
</tr>
<tr>
<td>Lead time remains relatively constant regardless of part dimensions</td>
<td>Lead times can increase drastically as part dimensions increase</td>
</tr>
<tr>
<td><strong>PER PART PRODUCTION COST</strong></td>
<td><strong>PER PART PRODUCTION COST</strong></td>
</tr>
<tr>
<td>$</td>
<td>$$$</td>
</tr>
<tr>
<td>Single tool and cell based manufacturing minimize cost impact as part dimensions increase</td>
<td>Larger part dimensions decrease the # of parts produced per mold and can drive a large increase in per part cost</td>
</tr>
<tr>
<td><strong>PART SIZE LIMITATION</strong></td>
<td><strong>PART SIZE LIMITATION</strong></td>
</tr>
<tr>
<td>MAX 10' X 18'</td>
<td>MAX 4' X 4'</td>
</tr>
<tr>
<td>Plastic thermoforming can feasibly produce parts as large as 10' x 18'</td>
<td>Injection molding machinery capable of producing large dimension parts becomes cost prohibitive above approximately 4' x 4' dimensions</td>
</tr>
</tbody>
</table>

**BREAKEVEN VOLUME**

- For larger dimension parts, the cost breakeven point for annual production volume is about 5,000 parts or less
- For larger dimension parts, the cost breakeven point for annual production volume is about 5,000 parts or more
OTHER CONSIDERATIONS

Material

PLASTIC THERMOFORMING
- Thermoplastic extruded into flat sheets
- Available in various thicknesses, colors, patterns, and finishes
- Large list of available and even customizable thermoplastic material products, each with its own unique properties
- Specialty formulations available that are designed to meet requirements for industries such as aviation, automotive, rail, and mass transit
- Foam sheet can also be thermoformed

INJECTION MOLDING
- Thermoplastic in pellet form
- Available in a wide variety of colors
- Large list of available and even customizable thermoplastic material products, each with its own unique properties
- Specialty formulations available that are designed to meet requirements for industries such as aviation, automotive, rail, and mass transit

The sheet form of thermoplastic used in thermoforming can be extruded in a wide spectrum of patterns, textures, and finishing. It can also be co-extruded with materials such as carbon fiber and other composites to enhance its mechanical or aesthetic properties. This is the main material advantage that thermoforming has over the thermoplastic pellets used in injection molding as the material for both processes start as essentially the same chemical formulations.

Click for additional info on thermoplastic materials and selection
OTHER CONSIDERATIONS

Surface Finishing

PLASTIC THERMOFORMING
- Excellent aesthetic appearance without post production painting
- High or low gloss
  - Effected by material selection
- Textured
- Painted or silk screened
- Distortion printing
- In mold branding, graphics, or design

INJECTION MOLDING
- Most parts often require post production painting to obtain aesthetic appearance
- High or low gloss
  - Effected by many variables
- Textured
- Painted or silk screened

Unpainted colored material thermoformed plastic part

Unpainted colored material injection molded plastic parts

High gloss thermoformed plastic part
OTHER CONSIDERATIONS

**Design and Technical**

**PLASTIC THERMOFORMING**
- .030” minimum wall thickness for sheet fed thermoforming
- Finished part wall thickness can vary depending on depth of draw
- Attachment points - thermoforming requires bonded in blocks and hardware
- Additional rigidity obtained by twin sheet thermoforming or bonding with other rigid materials and shapes
- Hollow parts can be produced by twin sheet thermoforming
- Pressure forming produces sharp features and details similar to injection molding
- Able to form multilayer sheet material for varied engineering and aesthetic results

**INJECTION MOLDING**
- .040” minimum wall thickness
- Uniform wall thickness attainable
- Attachment points - injection molding uses webbing and molded in features
- Desired rigidity achieved with molded in ribs and features
- Not capable of molding hollow parts
- Process produces sharp features and details
## PLASTIC THERMOFORMING & INJECTION MOLDING

### COMPARISON AT A GLANCE

<table>
<thead>
<tr>
<th></th>
<th>THERMOFORMING</th>
<th>INJECTION MOLDING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Effective</strong></td>
<td><strong>Part Volume</strong></td>
<td><strong>Part Volume</strong></td>
</tr>
<tr>
<td>Production Range</td>
<td>Small to Mid 3,000 - 5,000 or less</td>
<td>Mid to Large 3,000 - 5,000 or more</td>
</tr>
<tr>
<td><strong>Tooling Cost</strong></td>
<td>$$</td>
<td>$$$$</td>
</tr>
<tr>
<td><strong>Manufacturing Cost Per Part</strong></td>
<td>$$$</td>
<td>$</td>
</tr>
<tr>
<td><strong>Part Size</strong></td>
<td>Larger Parts Dimensions Up to 10’ x 18’</td>
<td>Smaller Parts Dimensions Up to 4’ x 4’</td>
</tr>
<tr>
<td><strong>Lead Time</strong></td>
<td>6 - 12 Weeks</td>
<td>22 - 24 Weeks</td>
</tr>
<tr>
<td><strong>Surface Finishing and Branding Capabilities</strong></td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐ ⭐⭐</td>
</tr>
<tr>
<td><strong>Industry Compliant Material Options</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Part Rigidity</strong></td>
<td>⭐⭐⭐ ⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td><strong>Part Detail</strong></td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐</td>
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</tbody>
</table>
The team at Productive Plastics hopes that you have found the information in this comparison and selection guide useful.

Your project is unique and while this guide serves as a general overview, the details of your part’s design may have a big impact on the ideal manufacturing process beyond what we could fit into these pages.

We invite you to contact us at Productive Plastics for any additional information on selecting the right process for your application and to discuss high quality solutions for your project’s design, manufacturing, and time to market challenges.

Over 60 years of thermoforming, design, and manufacturing expertise

ISO 9001:2008 certified

On site painting facility

Secondary assembly capabilities

Lean manufacturing enterprise

Looking for more information on process selection?
Please contact us.

For more technical information on designing and manufacturing with heavy gauge plastic thermoforming download our design guide.