



forming the *future* of transportation

THERMOFORMING FOR
THE RAIL INDUSTRY



THERMOPLASTICS VS. FIBERGLASS

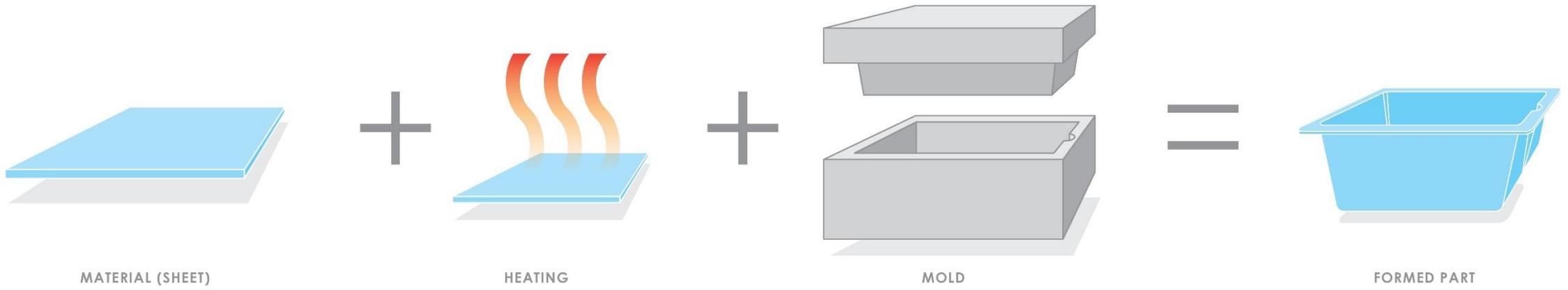
THERMOPLASTICS		FIBERGLASS
■	Lower part weight	
■	Lower part cost through process efficiency	
■	Better part definition and tolerances	
■	Environmentally friendly	
■	Enhanced interior design and enriched customer experience	
■	Low cosmetic maintenance resistant to chipping, cracking, and discoloration	
■	VOC Free	
■	Tedlar Integrity	
■	Meets SMP 800C and BSS 7239	■
	Structural contribution	■



THERMOFORMING PROCESS



WHAT IS THERMOFORMING?



HEAVY GAUGE FORMING

Heavy gauge parts are formed from material that is over .060" (1.5 mm) thick sheet stock.

Common Parts:

- Interior/exterior components for the automotive, mass transit, and aviation industries
- Equipment housing for commercial, medical, and industrial markets
- Instrument panels
- Office equipment
- Heavy-duty trays and in-process components

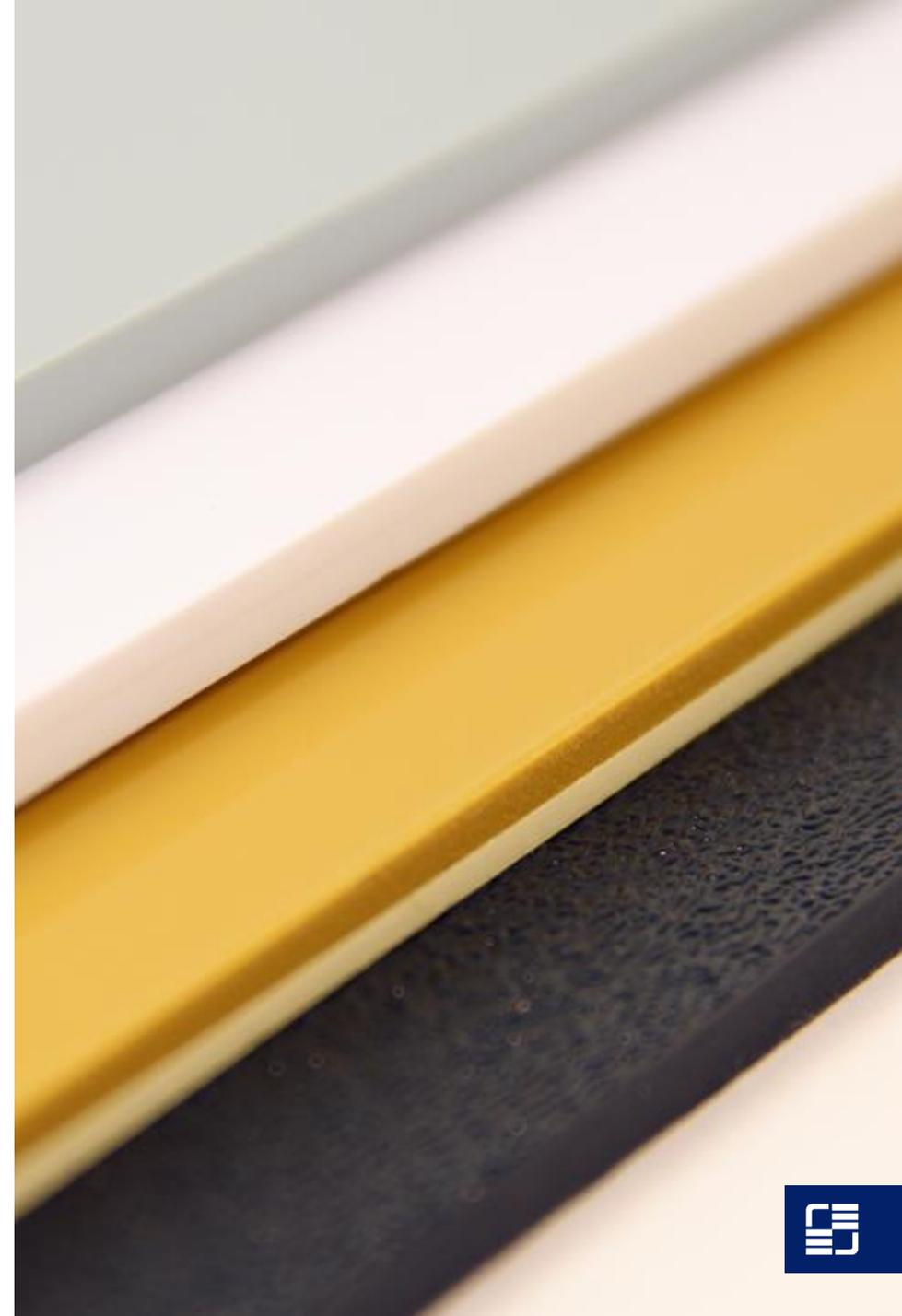


MATERIAL TYPES

Virtually all thermoplastic materials can be thermoformed. The most common materials used in heavy gauge applications are:

- ABS
- HIPS
- HDPE
- PC*
- PVC
- PMMA
- TPO

** Flame, smoke, toxicity (FST) compliant materials are used for rail applications*



THERMOFORMING MOLDS

Prototype Molds *(non-metallic, not temperature controlled)*

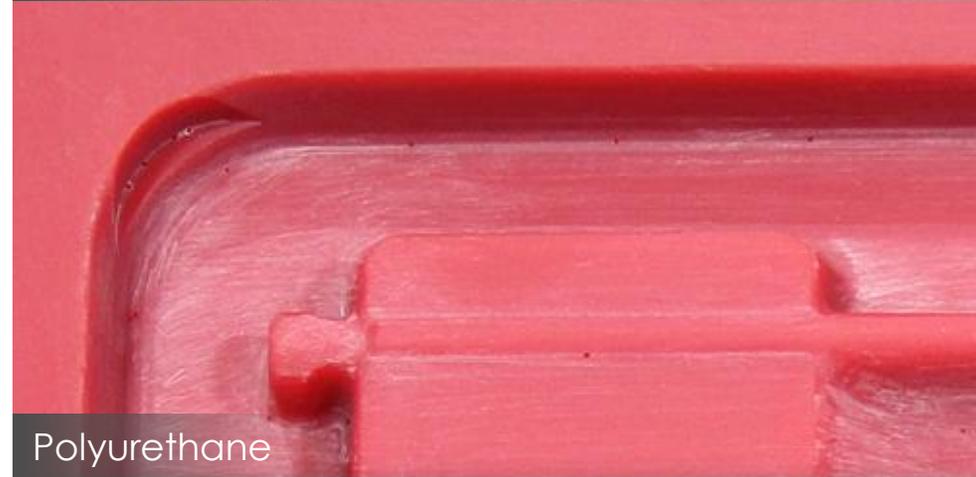
- Wood
- Plastic
- Polyurethane Modeling and Styling Board
- Fiberglass
- Ceramic

Production Molds *(temperature controlled)*

- Aluminum
 - Cast
 - Billet



Rapid



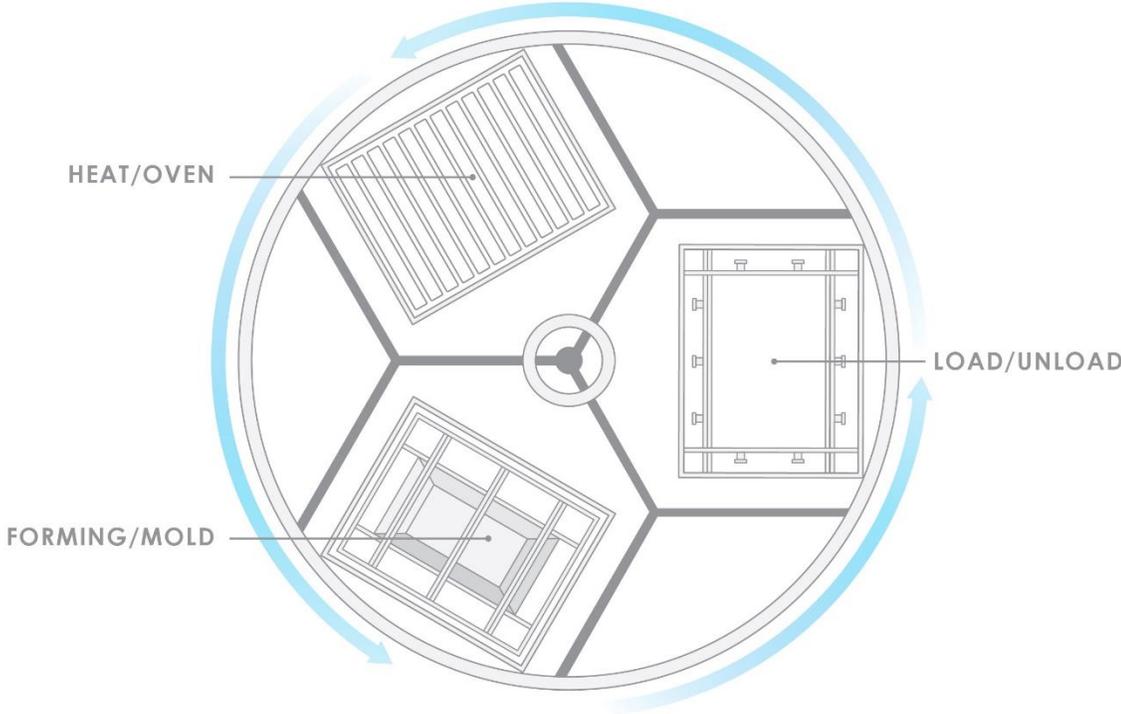
Polyurethane



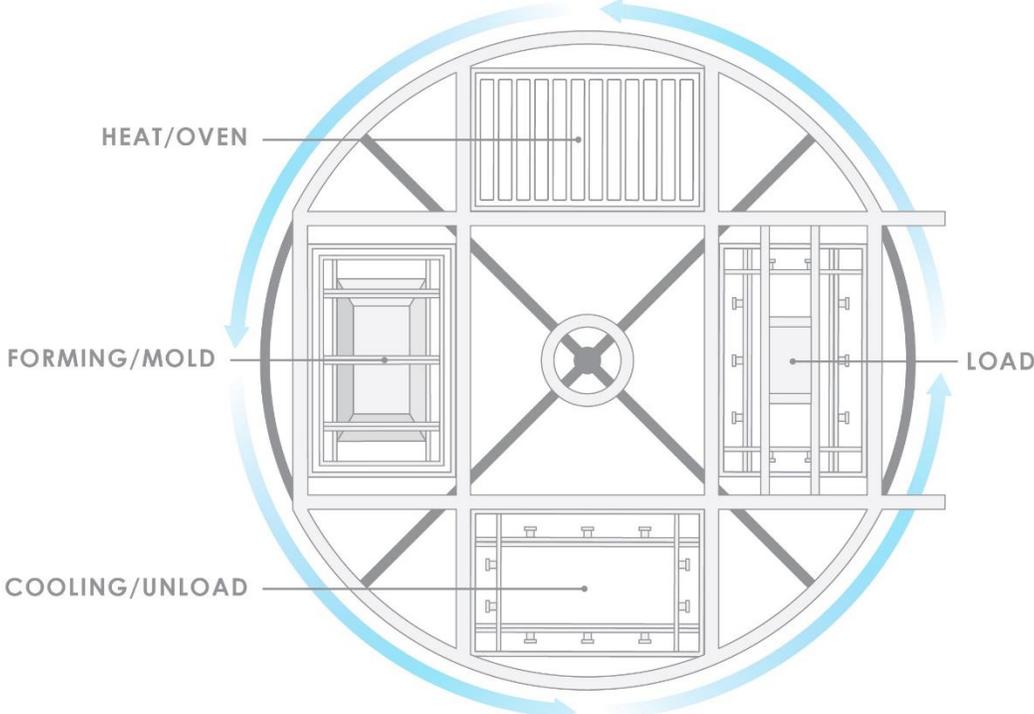
Aluminum

THERMOFORMING MACHINES

Rotary Formers



3 STATION



4 STATION



THERMOFORMING PROCESS TYPES

Vacuum Forming

Vacuum forming is the most common process of thermoforming, whereby a sheet of plastic is heated to a forming temperature, stretched onto a single-surface mold, and forced against the mold by a vacuum to form into a shape.

Pressure Forming

Plastic pressure forming is a more advanced process used to form plastic sheet into a finely detailed molded shape. It utilizes a single-surface mold to create the formed shape while using vacuum & pressure on opposing sides of the sheet.

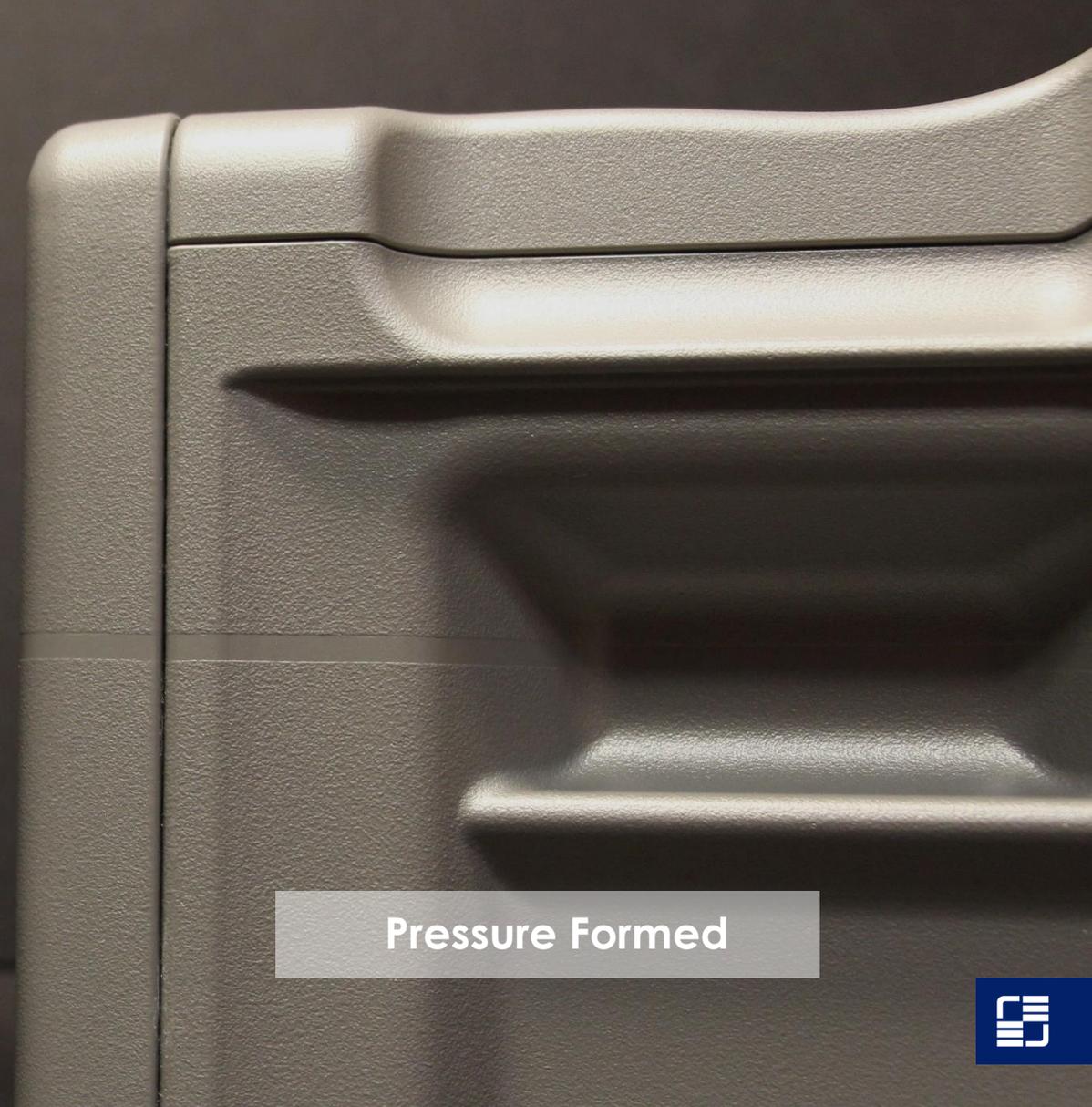




THERMOFORMING PROCESSES



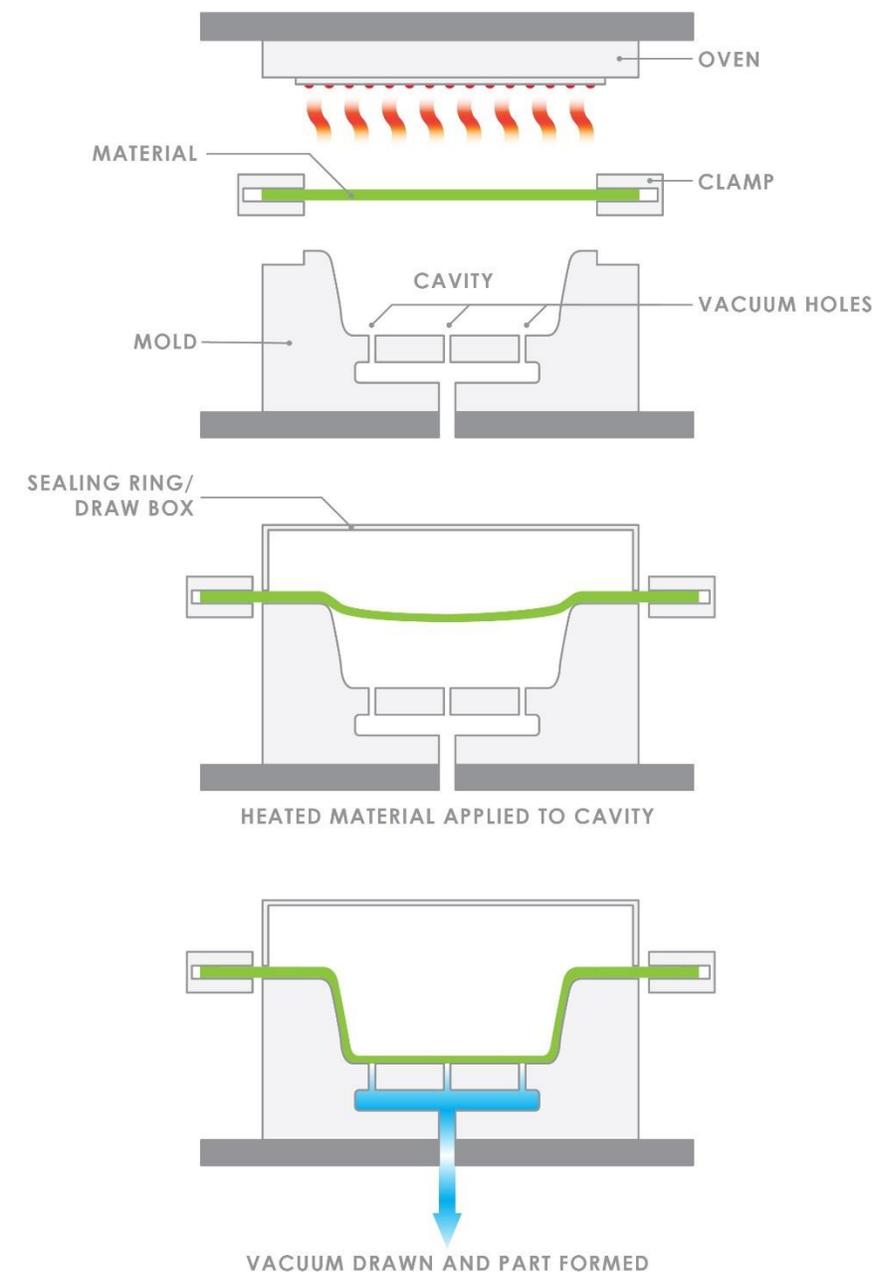
Vacuum Formed



Pressure Formed

VACUUM FORMING PROCESS

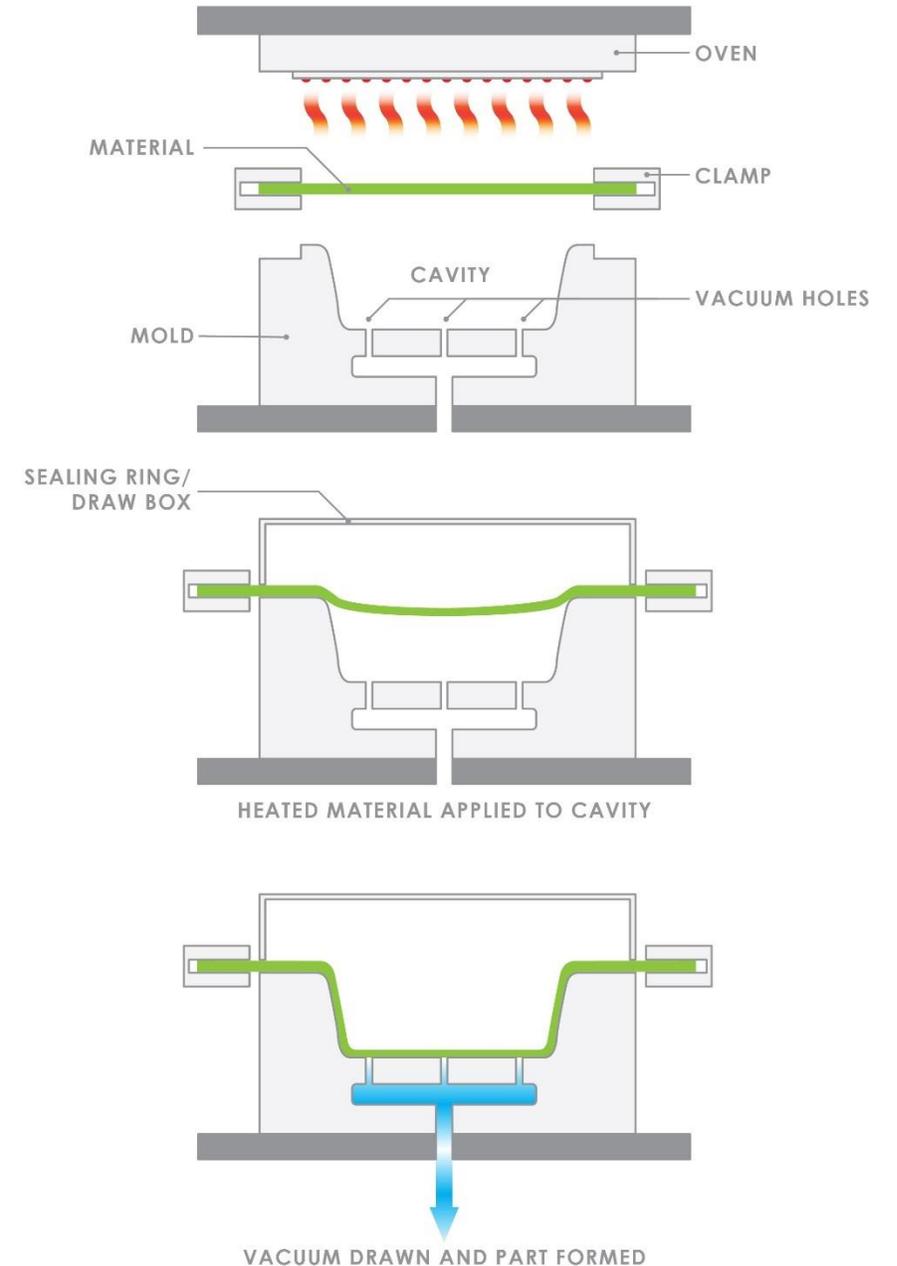
- Material is stretched over mold
- Forming under atmospheric pressure
- Capable of providing high gloss parts, approaching class A surface quality
- Tightest outside radii are at least 1.5x thickness of the material
- Distorted texture
- Inconsistent gloss



VACUUM FORMING TOOLING

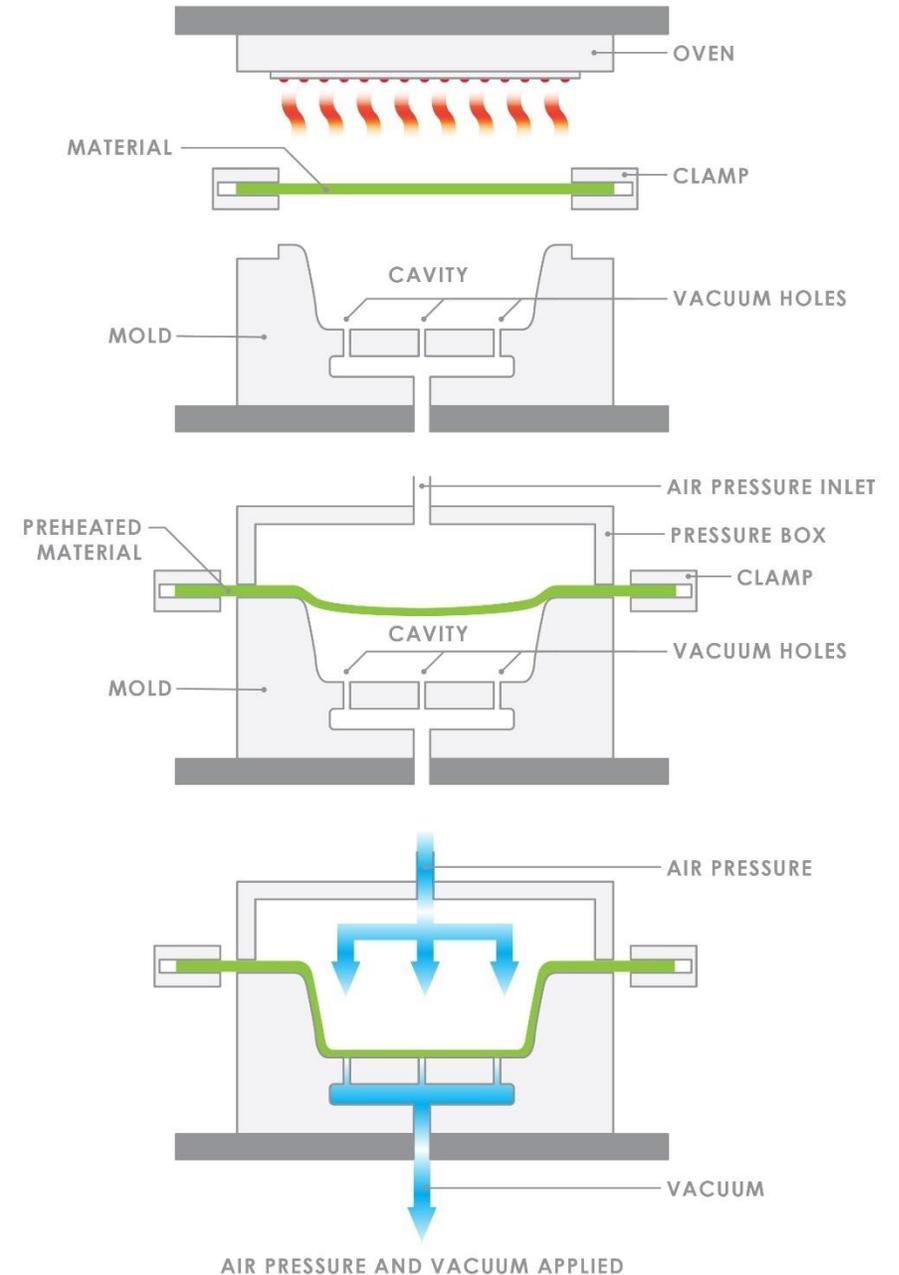
Positive or Negative Molds

- Aluminum
 - Cast
 - Billet
- Bead blast or sand blast texture to evacuate air
- Coupled with:
 - Sealing Ring
 - Draw Box



PRESSURE FORMING PROCESS

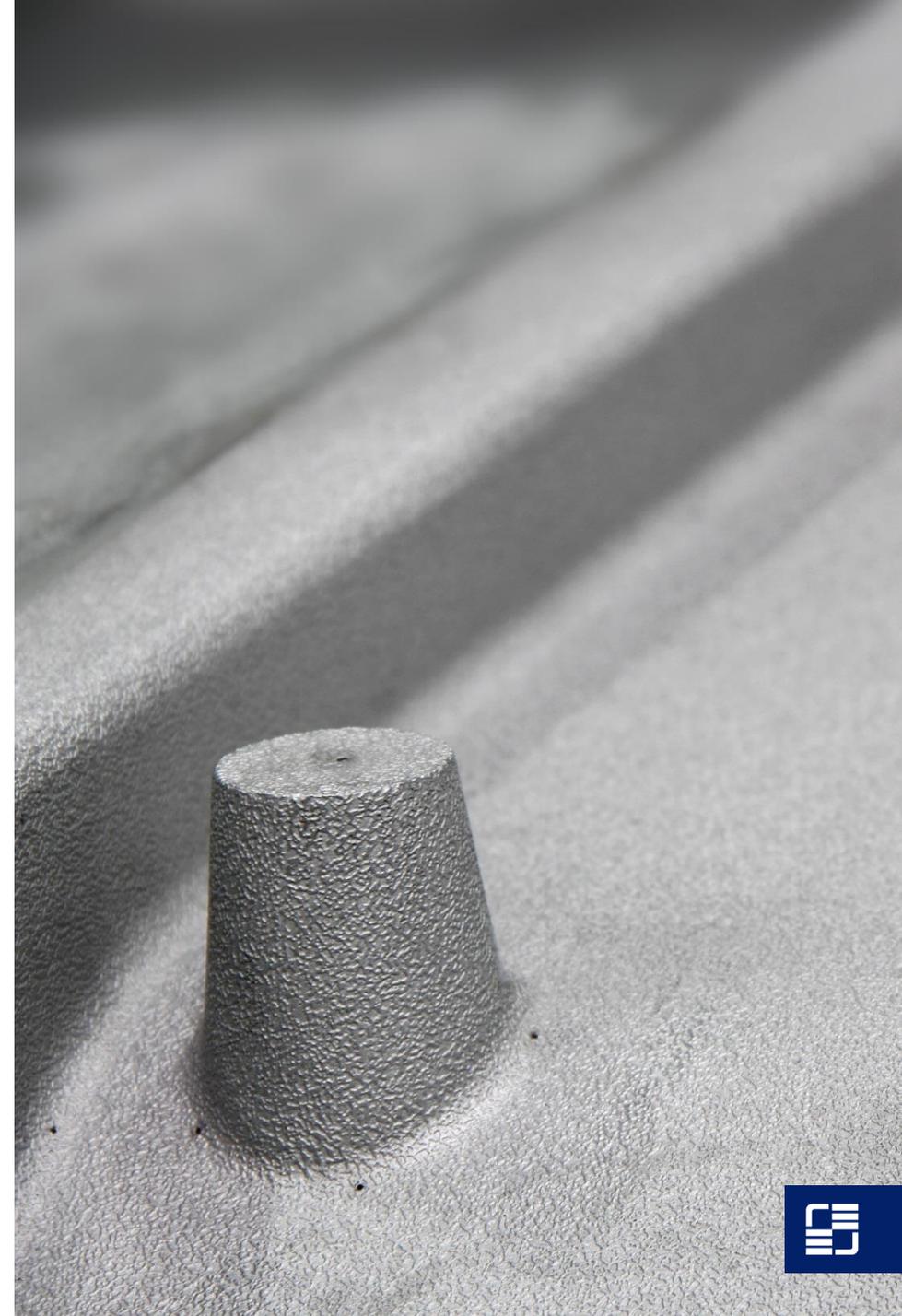
- Material stretched and pressed into mold
- Forming under pressurized air – 241 kPa (35 PSI) to 414 kPa (60 PSI)
- Uniform texture
- Consistent gloss
- Undercuts possible
- Small protrusion present from vacuum hole



PRESSURE FORMING TOOLING

Positive or Negative Molds

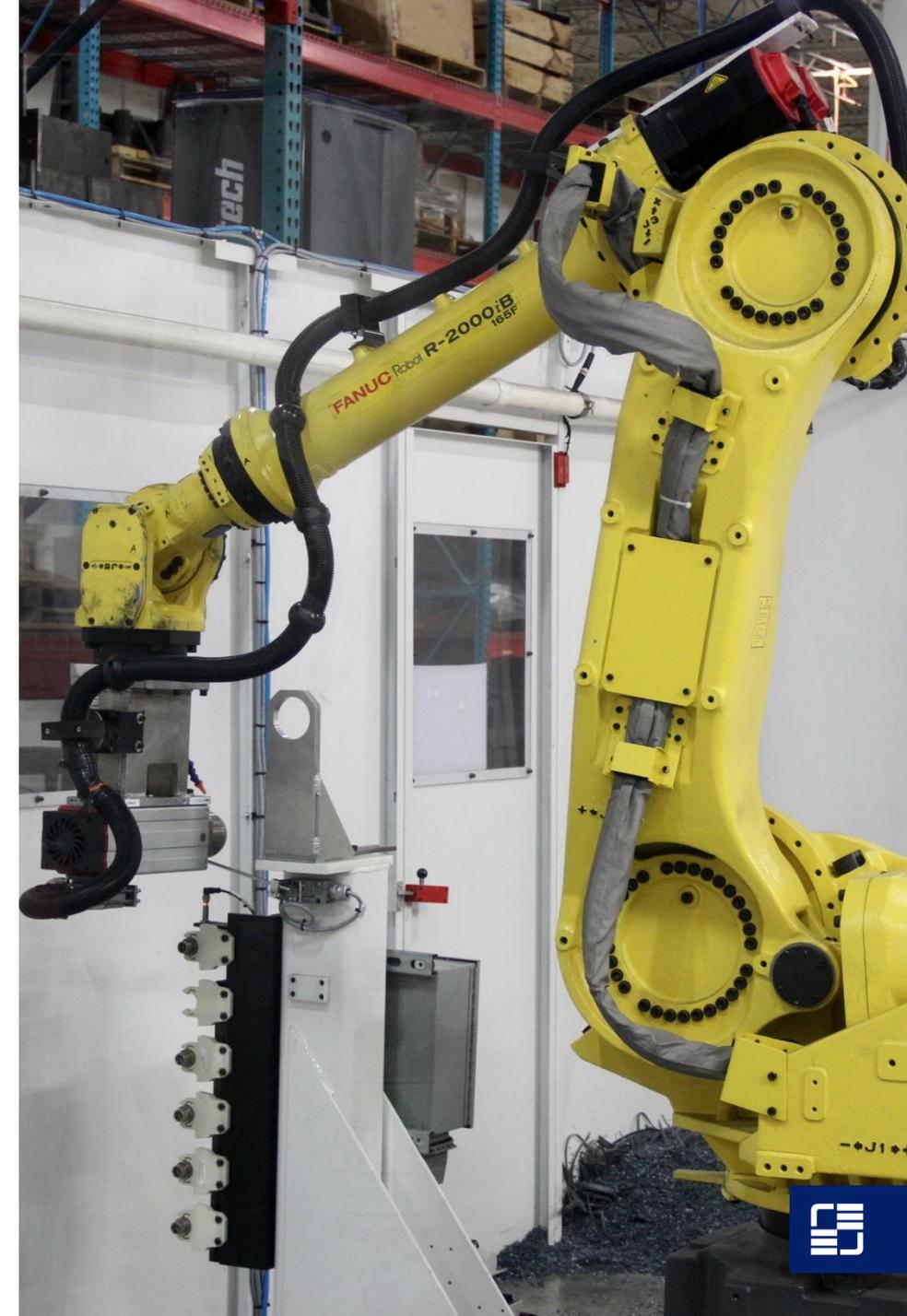
- Aluminum
 - Cast
 - Billet
- Structure to withstand pressure
- Tool is textured
 - Acid Etch
 - Bead blast
- Tool is engraved
- Coupled with:
 - Pressure Box – Shallow Draw
 - Pressure Box with Plug Assist – Deep Draw



PRODUCTION: TRIMMING

Methods

- Hand Trimming
 - Band Saw
 - Shaper
 - Router
- Punch and Die Sets
- Cutting Die
 - Steel Rule
 - Forged
- Laser
- Water Jet
- Routing (Machining)
- CNC (5 axis)
- Robotic (7 axis)



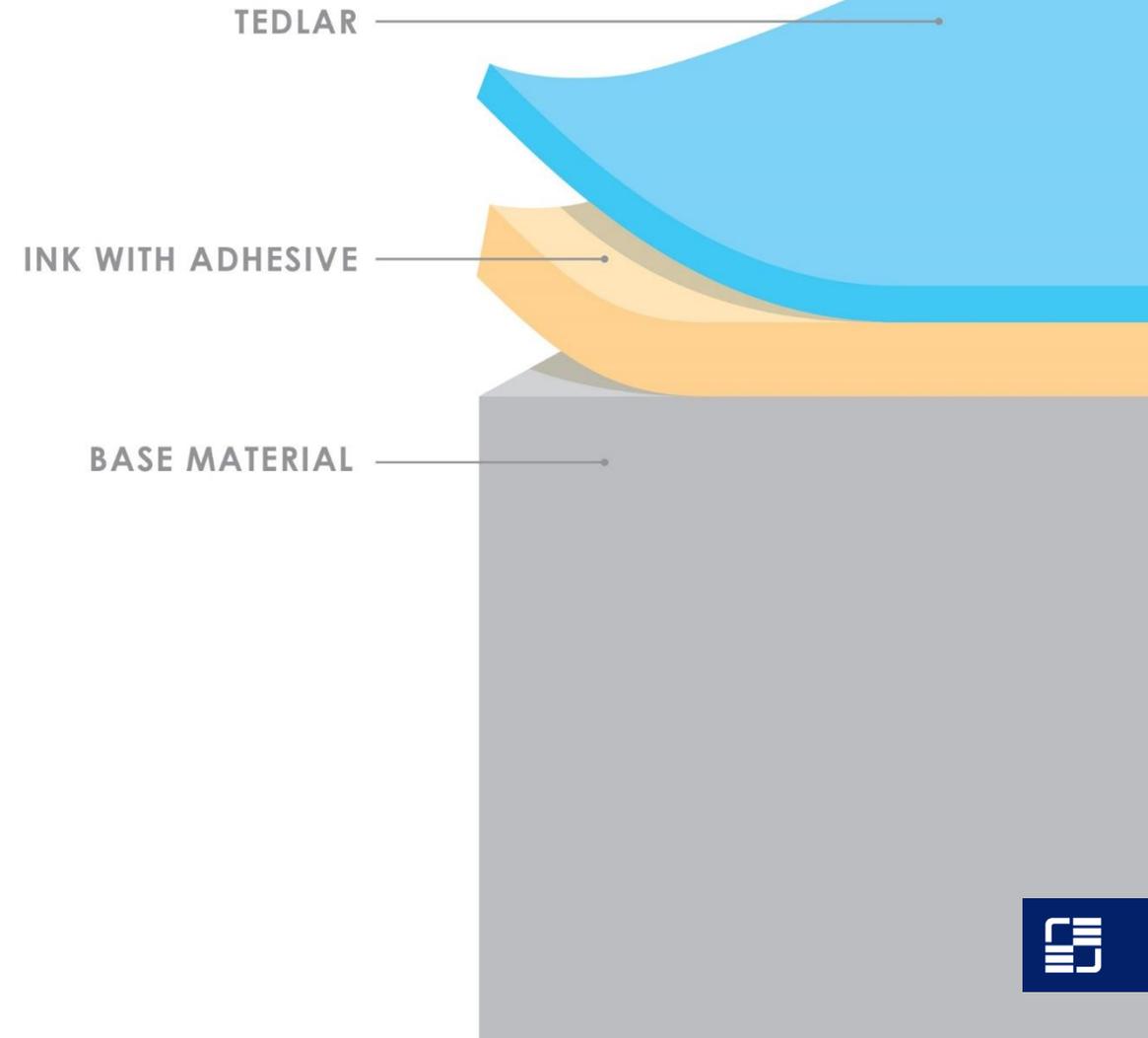
MATERIAL SELECTION

- Thermoplastic material to replace fiberglass (FRP)
- Low smoke
 - 49CFR238.103 & NFPA 130
- Low toxicity
 - SMP800C & BSS 7239
- Base material
 - Polycarbonate blend



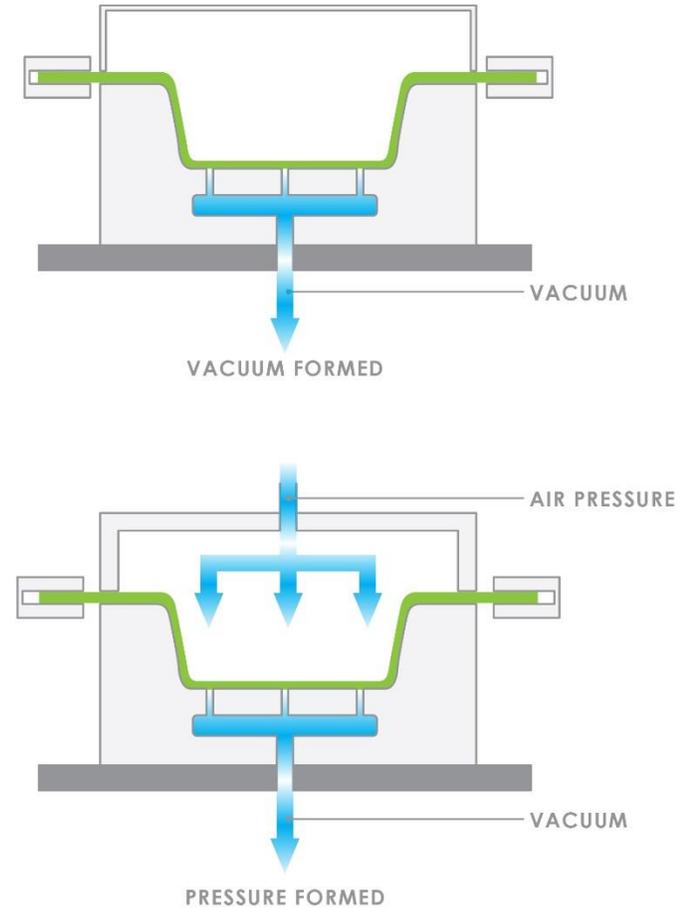
MATERIAL SELECTION

- No film
 - No protection on base material
 - Lowest cost
- Films
 - Applied at time of extrusion ensure long lasting durability and performance
 - PVDF
 - Clear (base material provides color)
 - Varying gloss levels
 - Graffiti resistant
 - Chemical resistant
 - UV resistant
 - Mid-level cost
 - PVF*
 - Printed Color and Pattern
 - Graffiti resistant
 - Chemical resistant
 - UV resistant
 - Highest cost



PROCESS SELECTION

- Pressure Forming or Vacuum Forming?
- Review of Requirements
 - Texture
 - Gloss
 - Detail: Logo/Engraving
 - Tool Cost



TOOLING SELECTION

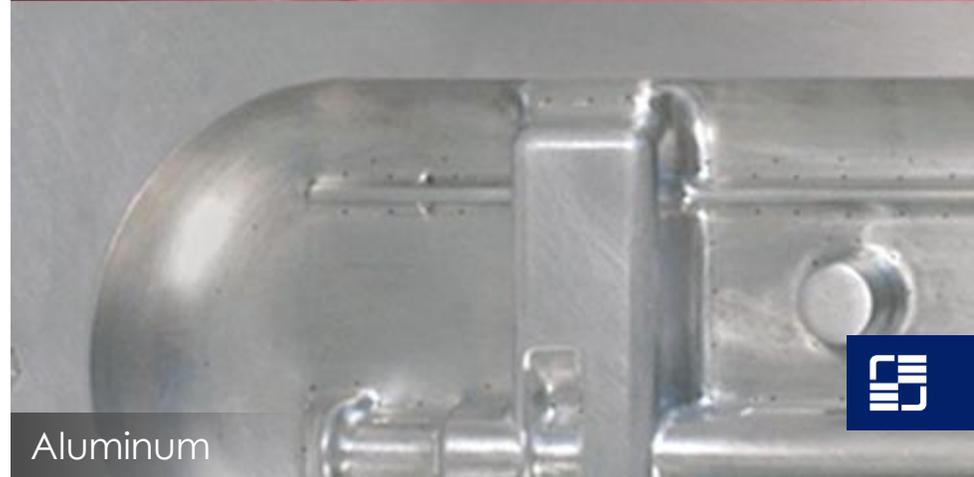
- Production or Prototype
- Negative or Positive
- Pressure Forming or Vacuum Forming
- Part Volume
- Number of Cavities



Rapid



Polyurethane



Aluminum

QUESTIONS?





THANK YOU