



# **Injection Molding Principles**

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# Xometry for Engineering and Sourcing Professionals

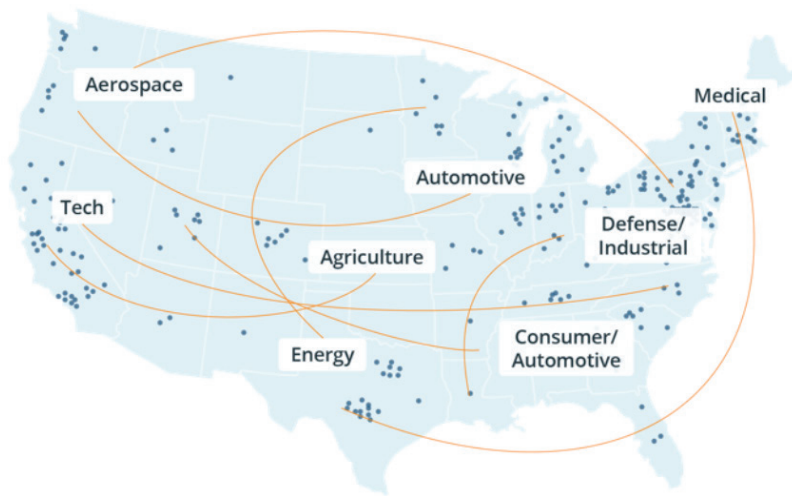
Our instant quoting platform and massive network of machine shops is transforming custom manufacturing. We make it easy for all customers — from startups to Fortune 500 companies — to access manufacturing on demand by providing the most efficient way to source high-quality parts.



- Automated RFQ
- Expert Engineering Support Team
- Best Pricing Quality and Lead Times

# Xometry Partner Network of over 3,000+ Machine Shops and 3D Printing Bureaus

Xometry's U.S.-based manufacturing partners form the backbone of our cutting-edge manufacturing on demand platform. Our production-as-a-service offering leverages an extensive network of over 3,000 highly-vetted local manufacturing shops from across the country including ITAR-qualified, AS9100D, ISO 9001:2015, ISO 13485, and NADCAP facilities, with over 13 million combined hours available.



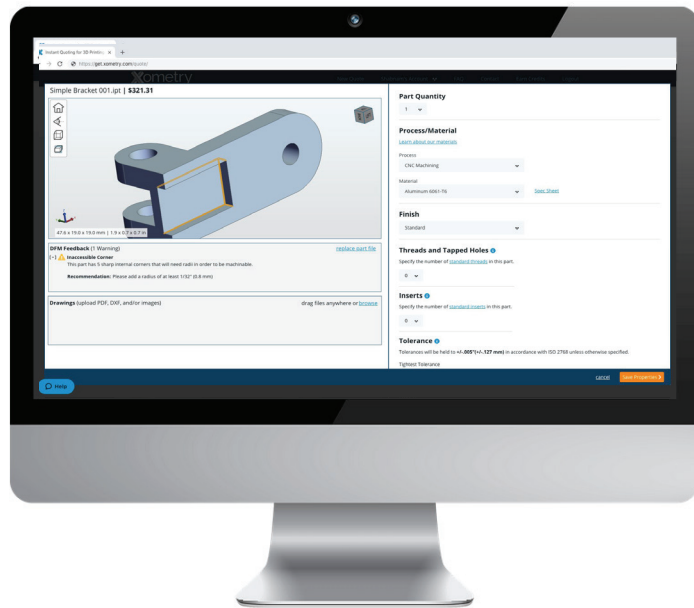


# Xometry Platform

## Xometry's Proprietary AI-Powered Manufacturing Platform

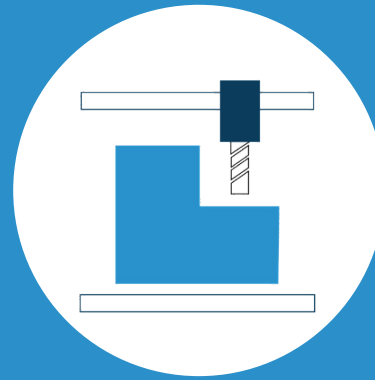
Xometry is tapping into the power of deep learning to effect a step change in how custom manufacturing gets done. We built a proprietary platform to enable engineers and product designers to instantly access the capacity of a nationwide network of world-class manufacturing facilities and receive instant DFM feedback, lead times, and pricing on their custom manufacturing jobs.

- Instant pricing and quoting
- Manufacturability analysis
- Dynamic pricing and lead times
- Guaranteed high-quality parts



# XOMETRY MANUFACTURING CAPABILITIES

Capabilities for all of your custom manufacturing applications from prototype to production



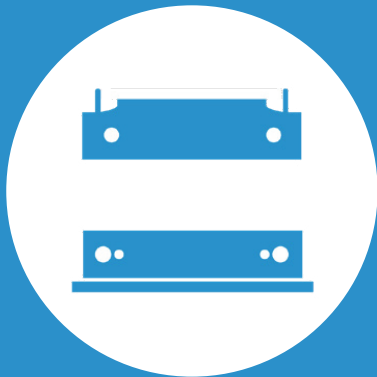
## **CNC Machining**

Combines the latest precision CNC milling and turning processes with proprietary technology



## **Sheet Metal Fabrication**

Punching, laser cutting, waterjet cutting, stamping, and bending sheet metal services



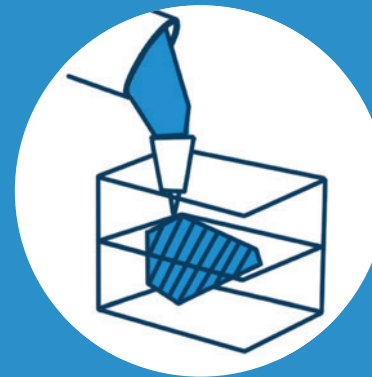
## **Injection Molding**

Combines the latest injection molding processes with proprietary technology and an experienced team to deliver end-use parts



## **Metal 3D Printing**

Builds parts from ground up, allowing for the production of parts with very complex geometries



## **Urethane Casting**

Utilizes a temporary silicone mold to create end-use parts in rigid and rubber-like urethanes or silicones



## **Plastic 3D Printing**

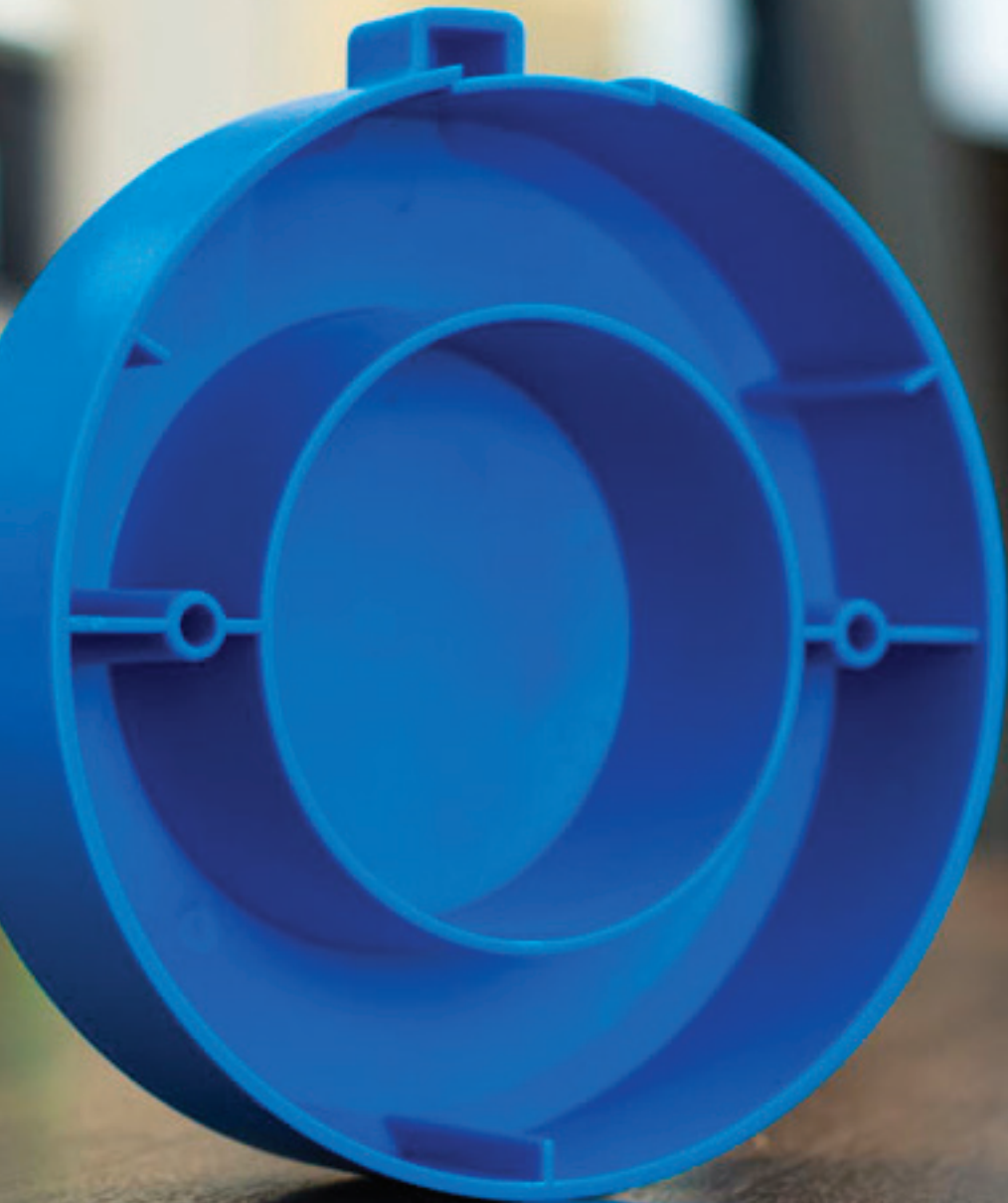
One of the fastest and most cost-efficient methods available for the iterative design, prototyping, and production of custom parts



The background of the slide is a close-up, high-angle shot of numerous blue plastic bottle caps. The caps are arranged in a grid-like pattern, with some in sharp focus and others blurred in the foreground and background, creating a sense of depth. The lighting is even, highlighting the smooth, slightly reflective surface of the plastic.

# **Molding with Xometry**

[www.xometry.com](http://www.xometry.com)



## Why Choose Molding?

- The cheapest process at scale for plastics
- Consistent, repeatable reproductions of a part
- Mid- to high-volume manufacturing
- Highest variety of materials, colors, and configurations
- Custom cosmetics from polish to texturing



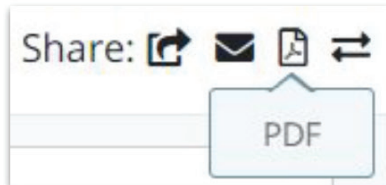
# Molding with Xometry

- “Have it Your Way” Approach
- Long term solutions, not just prototyping
- Communication -- Engineering Resources
- 24-Hour quoting. DFM feedback
- Large domestic partner network - default domestic!
- Xometry manages partners
- Only one point of contact for customer!

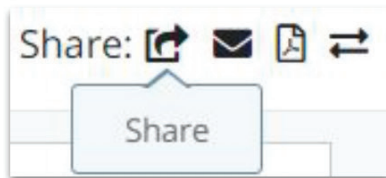
# Xometry's Tools for Engineers and Purchasers

## Sharing Quotes with Purchasers

- “PDF” sharing is the most common.



- “Share” gives the buyer access to the checkout page.



| MANUFACTURING QUOTE                                                                                                                                 |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                 |      |                                 |                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------------------|----------------|
| <br>7951 Cessna Avenue   Gaithersburg, MD   20879   240-252-1138 |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                 |      | Quote ID:<br>03244-1511B        |                |
|                                                                                                                                                     |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                 |      | Date:<br>09/25/2019 2:32 PM EDT |                |
| Contact info:<br>Greg Paulsen                                                                                                                       |                                                                                                | Estimated delivery date with two-day shipping:<br><b>Tuesday, Oct. 22</b><br>(if you order by 11:59PM EDT Wednesday, September 25)<br>Lead time: 17 business days                                                                                                                                                                                               |      | Requirements:                   |                |
| Item                                                                                                                                                | Part ID                                                                                        | Description                                                                                                                                                                                                                                                                                                                                                     | Qty. | Unit Price                      | Extended Price |
| 1                                                                                                                                                   | <br>010A7B6 | Junction Housing.SLDPR<br><br><b>Bounding Box:</b><br>215.8mm x 172.4mm x 68.2mm<br>8.50in x 6.79in x 2.68in<br><b>Process:</b><br>Urethane Molding<br><b>Material:</b><br>Urethane, Rigid, Shore D 82-86, Black<br><b>Features:</b><br>Inserts: 12<br>Part Markings: Bag and Tag: 1<br><b>Finish:</b><br>Standard<br><b>Inspection:</b><br>Standard Inspection | 10   | \$303.58                        | \$3,035.80     |

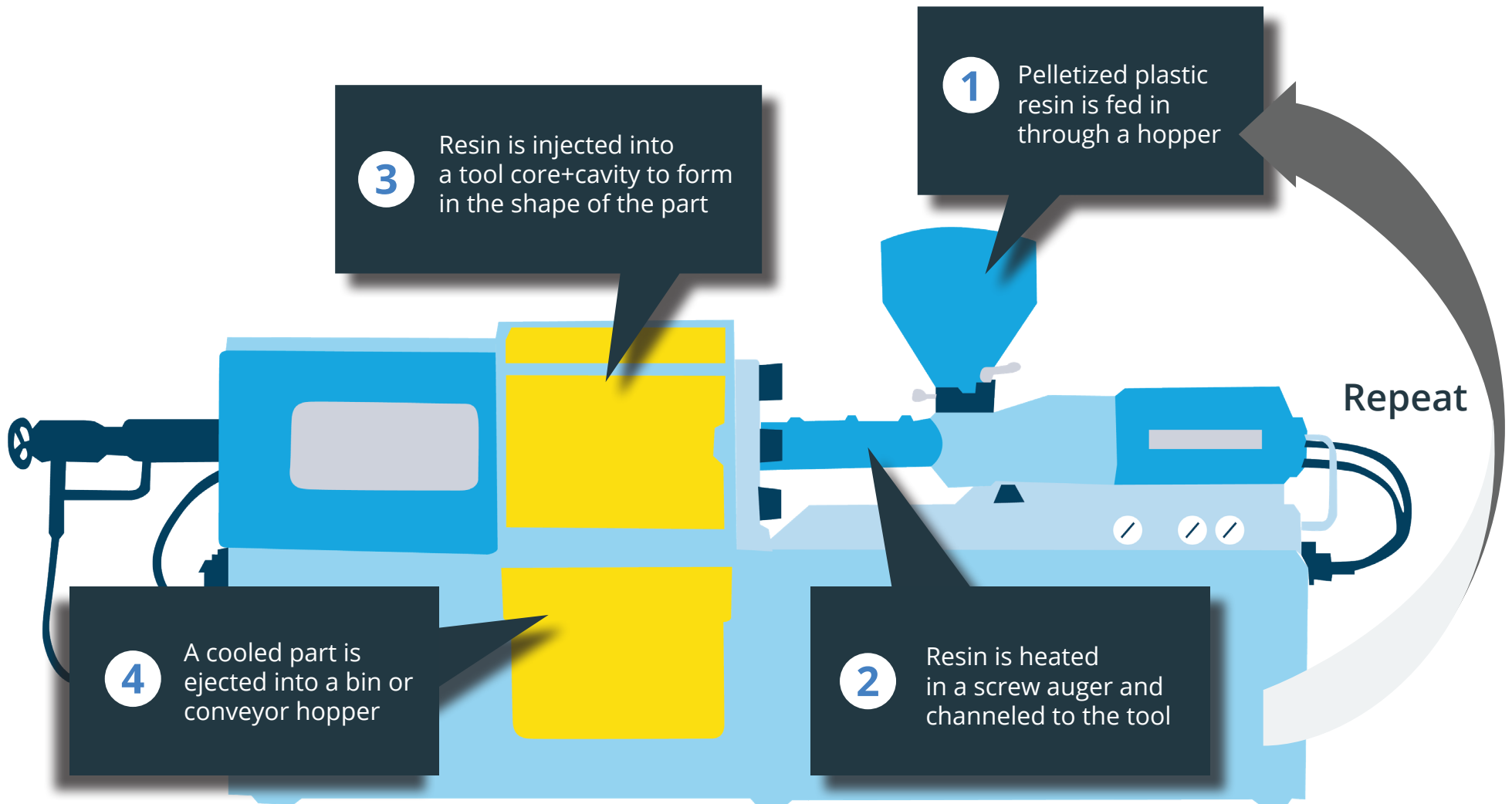




# **Injection Molding Principles**

[www.xometry.com](http://www.xometry.com)

# How Injection Molding Works





## Family Tooling

Tooling assembly designed with multiple different part cavities. These parts typically run individually using a runner shut off. (E.g., 1 + 1 + 1)

## Single Cavity Mold

Tooling assembly designed to make one part per cycle.

## Multi-Cavity Tool

Tooling assembly designed to make multiple of the same parts per cycle. (E.g., 2X, 4X)

**Strength:** Higher throughput, shares runner, cheaper per-part costs.  
**Consideration:** Higher upfront tool cost.

## Gating or Gate Vestige

Feature(s) on a part where materials is injected.



# Injection Molding Terms You Should Know

## Set Up Fee

A fee associated per run of a tool. Typically more expensive for larger tools.

## Ejector Pins

Typically circular features on a part which detach the new part during cycling.

## Parting Line

A visible seam line on the part where the molding cavities met.

## Shut Off

Locations where the mold tool shuts against itself to prevent plastic from flowing through.



# Common Resins

## Commodity Thermoplastics

- PS
- SAN
- PP
- HDPE
- PVC (Flexible & Rigid)

## Exotic/Speciality Resins

- PEEK (+ filled variants)
- Custom requests are welcome!
- Matching difficult-to-source resins
- Customer Supplied Resin

## Engineering Thermoplastics

- ABS
- PC
- Nylon (PA)
- PET
- PBT
- PEI (Ultem)
- PPS
- PMMA (Acrylic)
- TPE
- TPU

## Additives and Colors

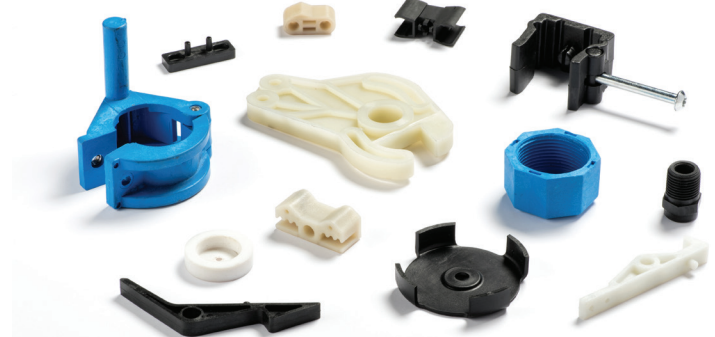
- Custom infills (Glass, Etc.)
- Color options and matching



# Resins Examples by Industry



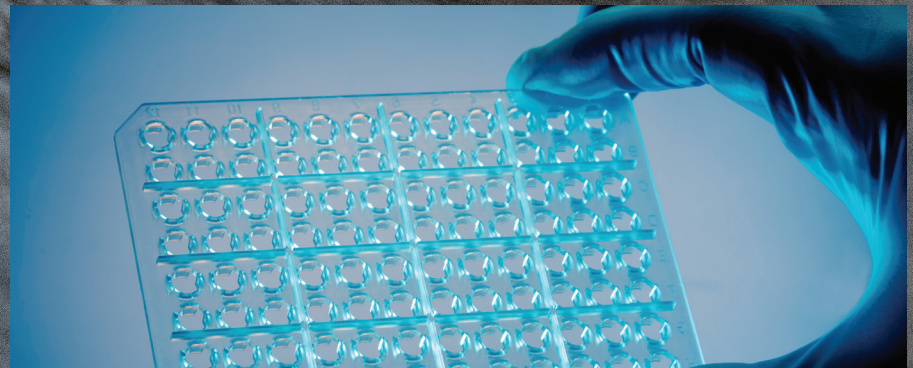
**Handheld and Wearable Electronics** | PC-ABS  
ABS



**Fixturing and Brackets** | PC-ABS  
ABS



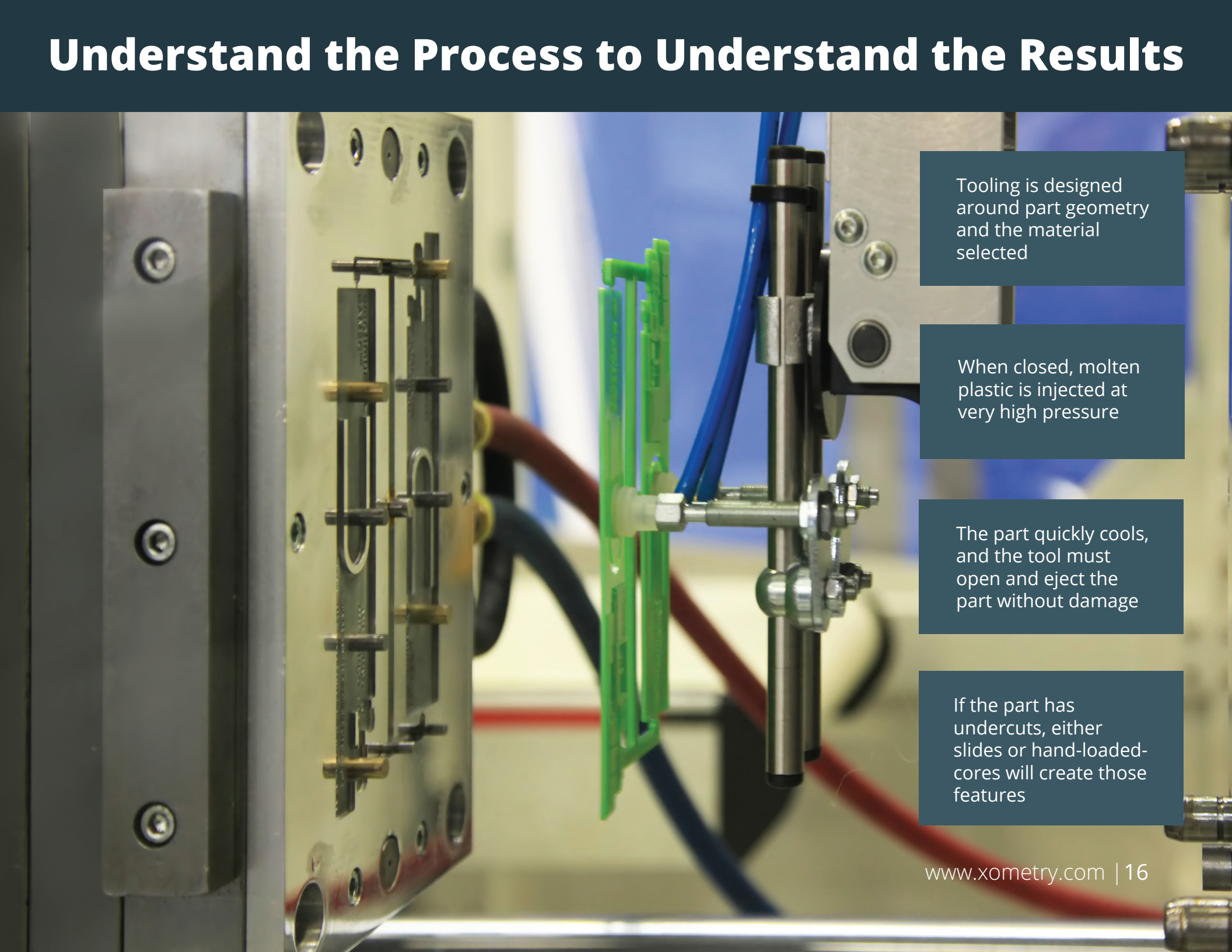
**Automotive** | PBT  
GF Nylon  
PPE-PS



**Handheld and Wearable Electronics** | PEEK  
PC  
PS



# Understand the Process to Understand the Results



Tooling is designed around part geometry and the material selected

When closed, molten plastic is injected at very high pressure

The part quickly cools, and the tool must open and eject the part without damage

If the part has undercuts, either slides or hand-loaded-cores will create those features



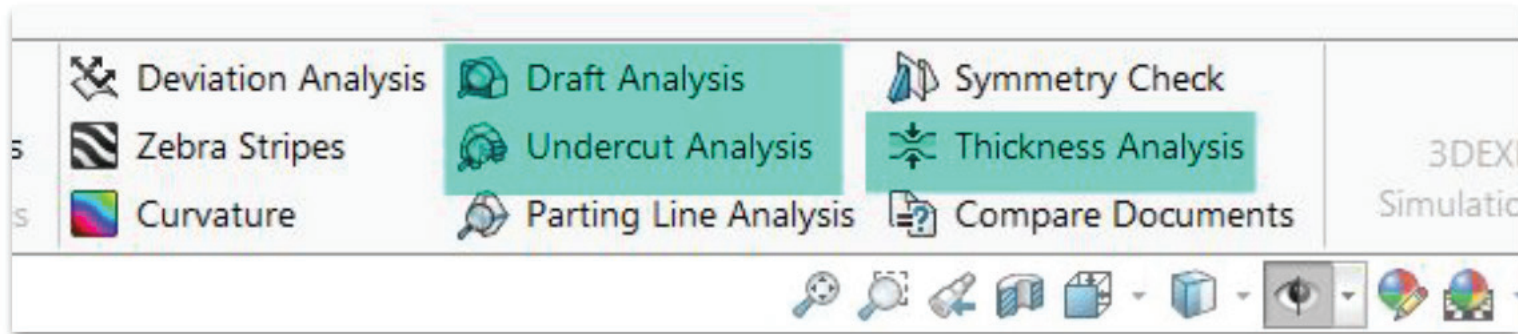
The background of the slide is a close-up, slightly blurred image of numerous blue plastic bottle caps. The caps are arranged in a grid-like pattern, with their circular tops and raised rims visible. The lighting creates soft highlights and shadows, emphasizing the texture and color of the plastic.

# **The Molding Trinity: Undercuts, Uniformity, Drafts**

[www.xometry.com](http://www.xometry.com)



# Common in Most CAD: “Evaluate” Tools



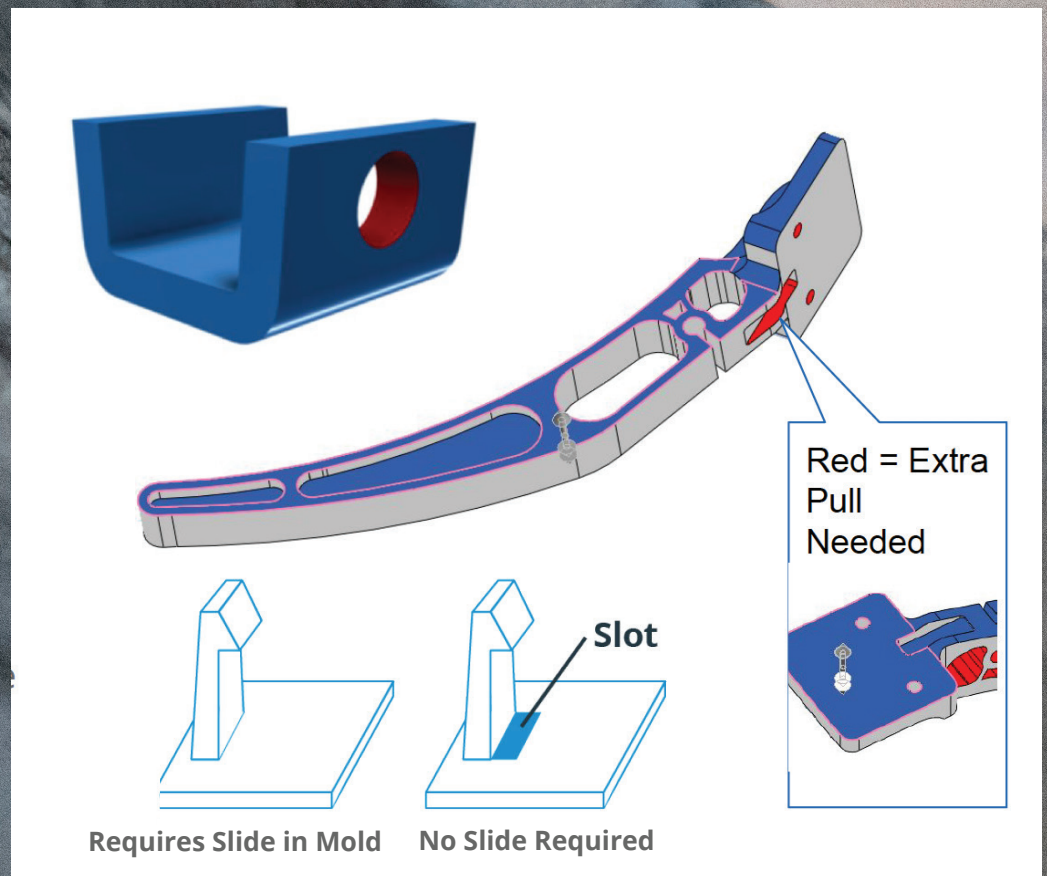
|                     | Acceptable | Needs Improvement | Critical Change Required |
|---------------------|------------|-------------------|--------------------------|
| Thickness Analysis  |            | X                 |                          |
| Undercut Analysis   | X          |                   |                          |
| Draft Analysis      |            | X                 |                          |
| Overall Moldability |            | X                 |                          |

You can analyze your molding part designs in most CAD tools like SOLIDWORKS, Inventor, or Fusion360

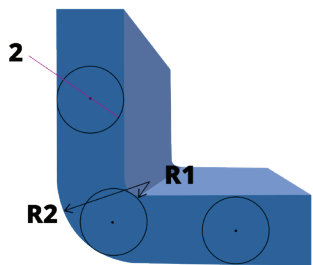


# First Check: Undercuts

- Undercuts typically indicate the need for slides or hand loaded cores
- Die lock is where an undercut is unachievable with standard actions
- Parting lines and shutoffs often “show themselves” with this check
- Best practice is to minimize the pull directions needed to as close to two as possible while maintaining your design intent
- Pass-thru cores are your friend

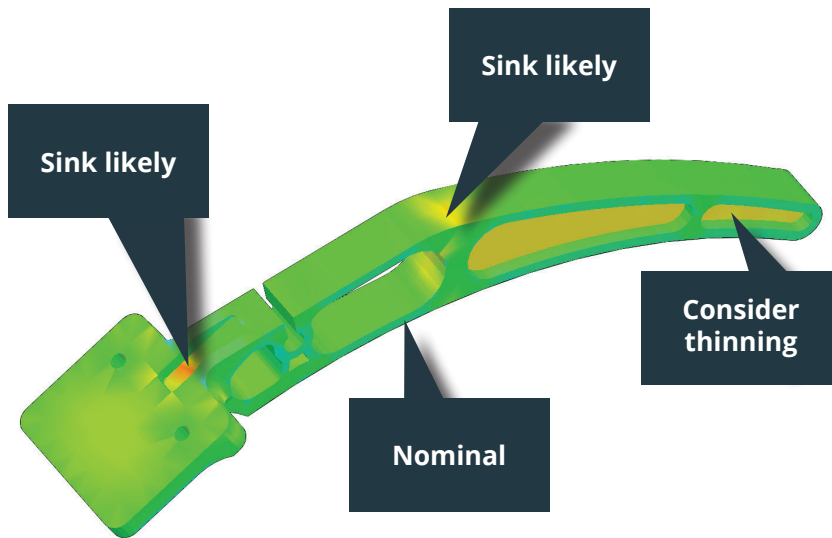






$$R2 = R1 + \text{Thickness}$$

Improved design



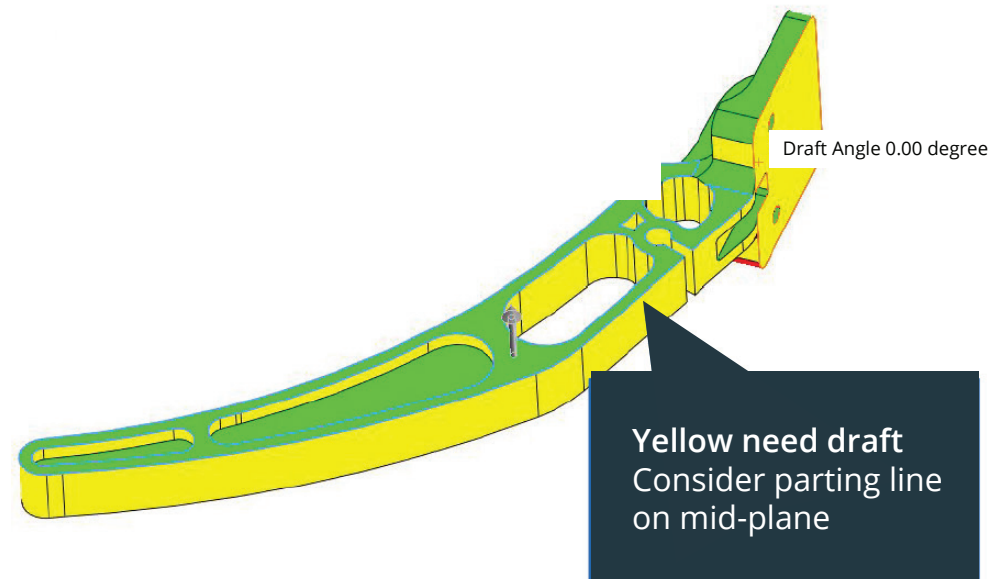
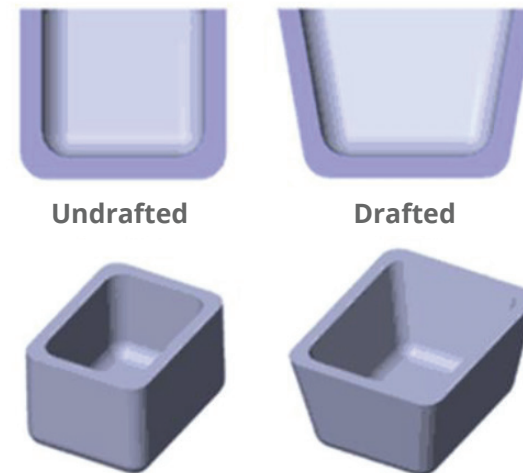
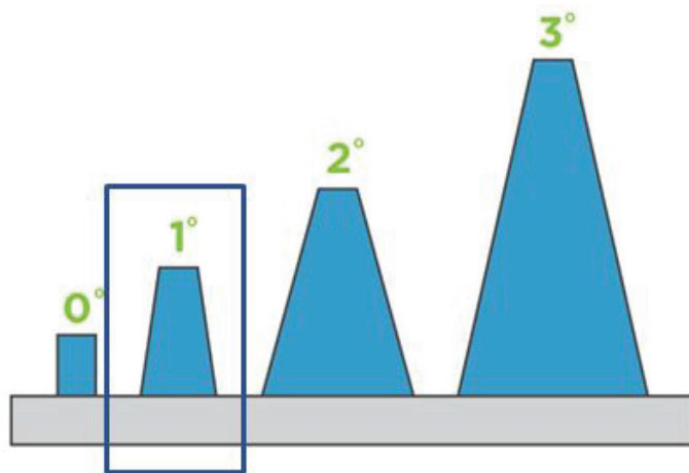
## Second Check: Uniform Wall Thickness

- Sink happens when a thicker area of a part cools at a different rate, pulling faces towards its center
- Warp and distortion may occur if sink is significant
- Use coring and ribs to mitigate thick areas while maintaining even walls
- Be mindful of long drafts making thick bases

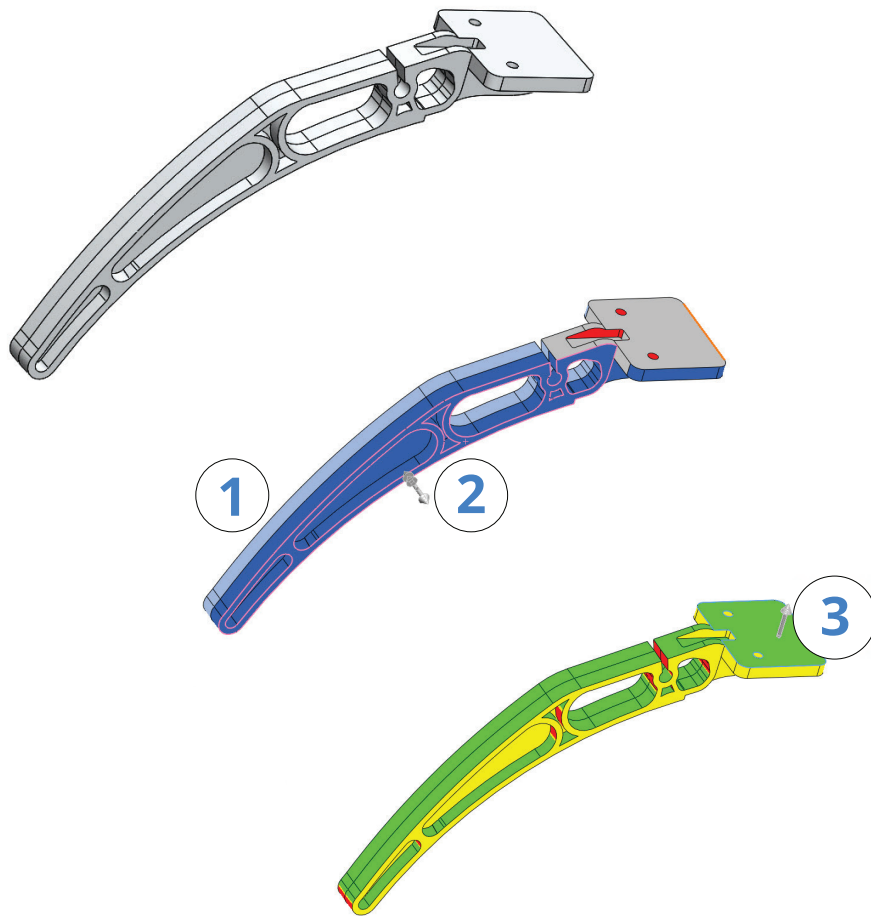


# Last Check: Draft Angles

- **Needed** for part release
- 1 degree draft per inch pull is a general rule
- Textured features require 2 degree minimum
- Lack of draft will result in drag marks or scratches on sides of parts







## Putting it All Together

1. The part was redesigned with a mid-plane parting line.
2. Thick areas were cored to produce even walls and mitigate sink.
3. The main body was drafted in the parting direction. The flat feature will be produced with an additional slide.



The background of the slide is a close-up, high-angle shot of numerous blue plastic bottle caps. The caps are arranged in a grid-like pattern, with some in sharp focus and others blurred in the foreground and background, creating a sense of depth. The lighting is even, highlighting the texture and slight imperfections of the plastic.

# **Specific Design Tips**

[www.xometry.com](http://www.xometry.com)

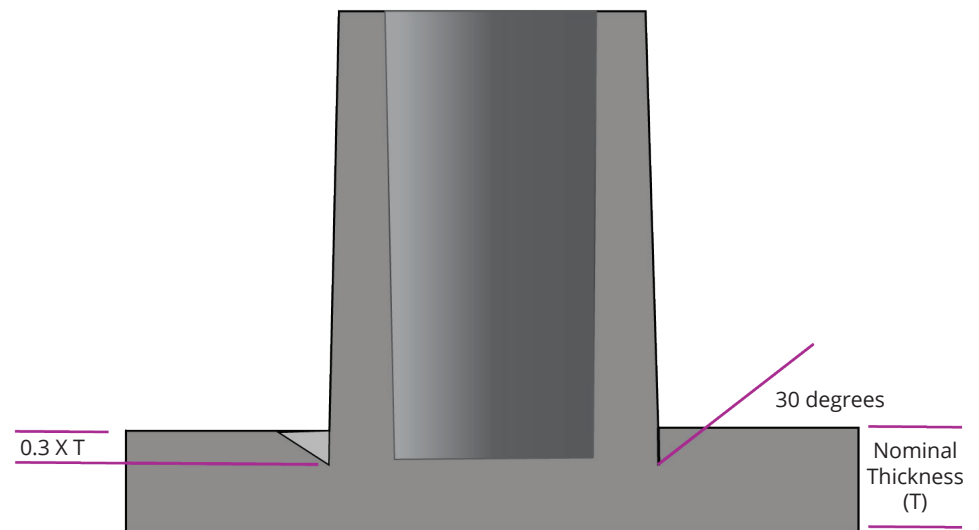
# How to Mitigate Sink or See-thru on Ribs and Bosses

## Internal Rib Thickness

- Target 40-60% of outer walls (nominal)
- Draft still applies

## The Boss Trick

- Cut a groove at 30% deep wall thickness around the exterior
- Make boss depth 30% wall thickness deeper





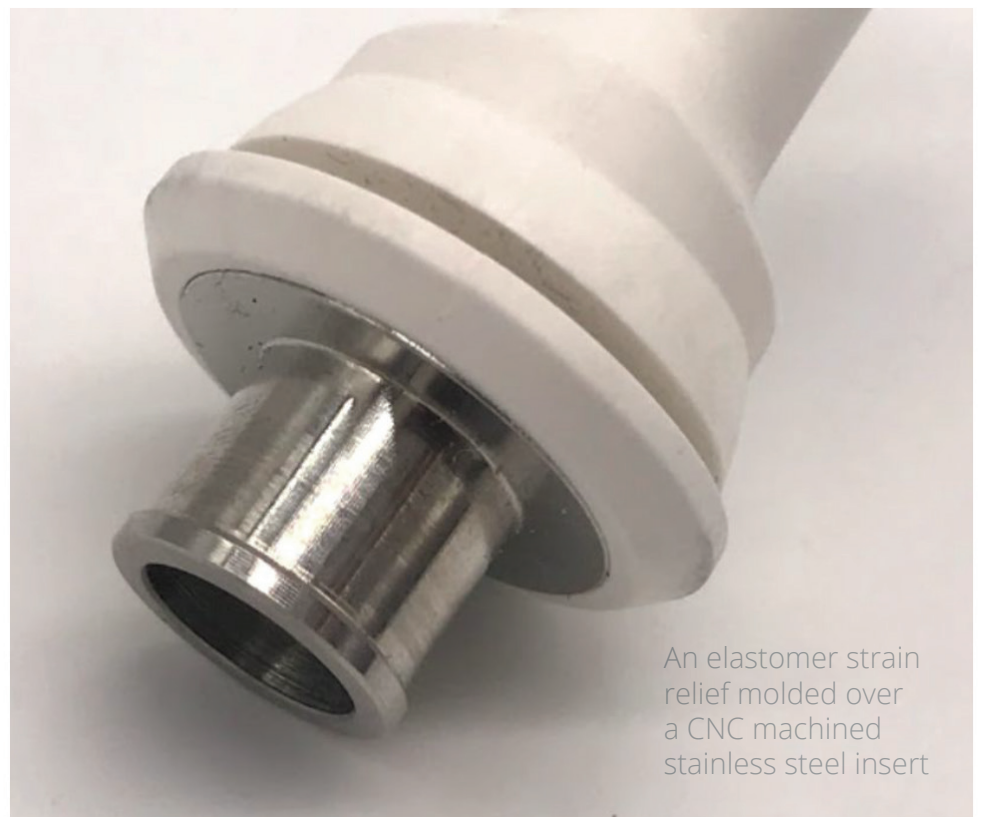
# Mold Inserts and Overmolds

## Inserts

- Can be COTS, or custom manufactured
- Require mechanical features for bonding
- Design mechanical features like ring grooves, through holes, and dovetails

## Overmold

- Materials should be compatible (e.g. ABS+TPE)
- Mechanical features preferred, especially if high use



An elastomer strain relief molded over a CNC machined stainless steel insert

# Considerations for Threads

## Molded-in

- External threads can be molded with part down the vertical
- Suggested to make “flats” where parting line is to avoid interfering fits
- Internal threads can be hand-loads, or automated

## Inserts

- COTS inserts can be installed and are preferred over tapping.
- Ultrasonic, heat-stake, and mold-in are common.



Injection molded cap for a toddler cup



## FAQ/Live Engineering Support

**Live support hours: M-F 8:00 AM - 9:00 PM EDT**



**Email**

support@xometry.com



**Phone**

240-252-1138



**Live Chat**

Talk to an Expert

**After Hours/Anytime: Browse our FAQ at [xometry.com/support](https://www.xometry.com/support)**

# Our Capabilities

## CNC

CNC Machining  
CNC Milling  
CNC Turning

## Sheet Metal

Sheet Metal Fabrication  
Waterjet Cutting  
Laser Cutting  
Plasma Cutting

## 3D Printing

3D Printing Service  
Digital Light Synthesis (Carbon DLS)  
Direct Metal Laser Sintering (DMLS)  
Fused Deposition Modeling (FDM)  
HP Multi Jet Fusion (MJF)  
Polyjet  
Selective Laser Sintering (SLS)  
Stereolithography (SLA)

## Injection Molding

Injection Molding  
Insert Molding  
Overmolding

## Other

Urethane Casting  
Finishing Services



