Xometry

Production Guide: How to Build Custom Parts to Fit Your Needs

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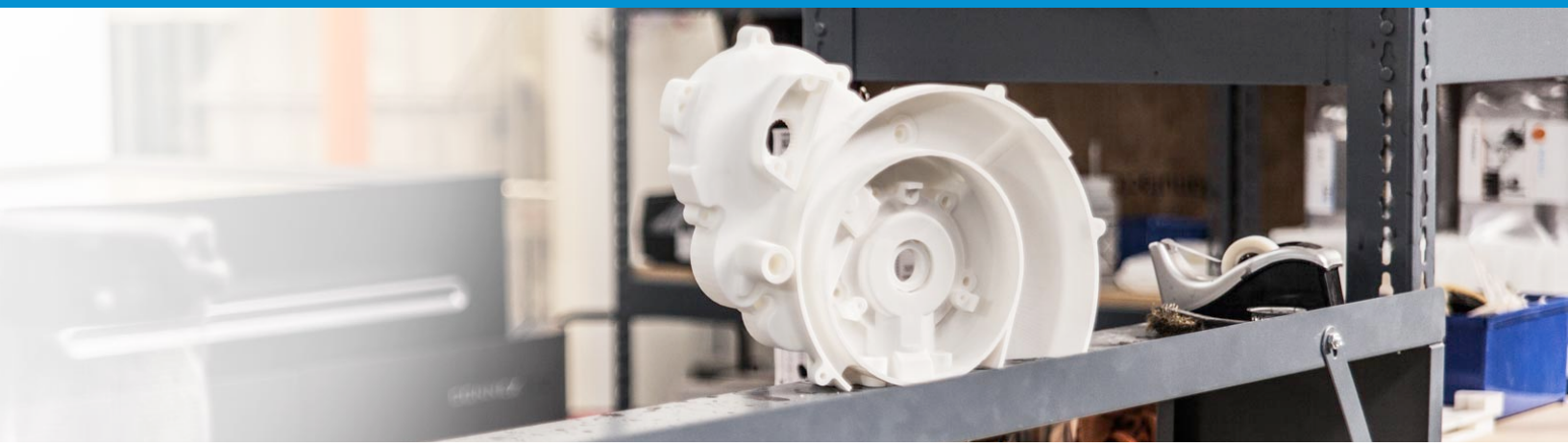
Introduction

Xometry offers a number of different means to make parts for every application and stage of the prototyping and low-volume production process.

Most of our parts are produced using the following methods:

3D Printing, CNC Machining, Urethane Casting, and Sheet Metal

Many innovative manufacturing processes can be harnessed to prototype and produce end-use parts faster and more cost-effectively than ever before. We are here to help guide you through the options and will always be available to make recommendations once you've uploaded your CAD file.



Selective Laser Sintering (SLS)

Fast and scalable, Selective Laser Sintering (SLS) is a powerful 3D printing technology that produces highly accurate and durable parts that are capable of being used directly in end-use, low-volume production.

Accuracy

We use the latest generation of SLS technologies to meet consistently tight tolerances (+/-0.005”).

Durability

Built in nylon, a durable material with great impact strength, medium flexibility, and high resistance to environmental factors.

Scalability

SLS can make a single part or component as easily as dozens of production pieces.

Complex Geometries

Geometries can be built more easily due to the 3D printing process, adding complexity without additional cost.

Rapid Turnaround

Parts can typically be shipped in 1-4 days, allowing for faster design iterations and speed to market.

Part Production

SLS is capable of producing end-use parts on-demand, increasing throughput.

Applications

Concept Models

The speed and versatility of SLS lets product developers create physical snapshots of their designs through the iterative process.

Rapid Prototyping

SLS can be used to create fully-functional prototypes, complete with moving parts, as well as all-in-one assemblies.

Direct Digital Manufacturing

The high accuracy and consistency of SLS makes it an ideal way to build large quantities of discrete or customized parts.

Details

Tough yet flexible: SLS prints parts in Nylon 12. SLS is a really robust and "forgiving" process due to the toughness and flexibility of nylon. We consider it one of the most general-use forms of prototyping concept models and low volume manufacturing of end use parts.

Complex without support: SLS parts are built in a self-supporting powder bed, allowing for fine details, overhangs, and lattice structures to grow easily in all directions. This makes it a great method for complex parts.

Economical and fast: Because parts are "free floating" and can be nested together in a build, SLS is a very cost-effective process.

Chemical resistance: SLS prints in Nylon, a durable, flexible, and chemically resistant material. Nylon can also be sterilized via steam autoclave, EtO, plasma, chemical, and gamma.

Water tightness and sealing: Parts that are over 0.040" tend to be water tight and fully dense. Sealing surfaces may require manual smoothing due to the matte finish of sintered plastic.

Finishes: SLS is conducive to many types of post-processing as well! The white matte surface can be dyed black, blue, red, yellow, or green and/or media tumbled to promote a smoother surface.

Tolerances

- Standard tolerance is +/- 0.005" or +/- 0.0015" per inch, whichever is greater.
- Build area up to 13 x 13 x 20" (13" max dimension preferred). Note that thicker geometries, large broad parts, and parts with uneven wall thicknesses may deviate due to thermal shrinkage and stress. Even wall thicknesses and similar design guidelines as injection molded parts are encouraged.
- Very small gaps and holes may be tighter than designed, a 0.006" offset of small gaps and holes will help these features achieve closer to CAD results.
- SLS prints in 0.0047" (120 um) layers.

Trade-Offs

- Smoothing surface requires sanding or machining.
- Materials limited to unfilled and glass-filled nylon.
- Larger parts tend to suffer from thermal stress which causes warping or unpredictable shrink.

Resources

- **SLS Guide**
- **Video Overview**
- **SLS Finishes**

Fused Deposition Modeling (FDM)

Fused Deposition Modeling (FDM) is a 3D printing technology widely known for its speed, accuracy, and competitive cost.

Accuracy

We use the most advanced industrial FDM 3D printers designed to meet consistently tight tolerances (+/-0.005”).

Durable Materials

FDM printed parts are available in a variety of high-performance plastics for applications that require resistance to the elements.

Large Builds

Xometry can produce FDM parts with large build volumes up to 36" x 24" x 36".

Complex Geometries

Geometries can be built more easily due to the 3D printing process, adding complexity without additional cost.

Rapid Turnaround

Parts can typically be shipped within 3 days, allowing for faster design iterations and speed to market.

Part Production

FDM is capable of producing end-use parts on-demand, increasing throughput.

Applications

Concept Models
The speed and versatility of FDM lets product developers create physical snapshots of their designs through the iterative process.

Rapid Prototyping
FDM can be used to create durable prototypes that withstand thermal, chemical, and mechanical stress.

Manufacturing Tools
High-performance materials make FDM a perfect solution for producing jigs, fixtures, tool masters and production tooling.

Details

All-around MVP: FDM is widely known for its speed, accuracy, and competitive cost. These factors make it a good choice for concept models, prototypes, and end-use parts.

Trusted materials with excellent mechanical properties: FDM 3D printing builds parts layer by layer using an extruded thermoplastic filament. Its robust material options make it a great fit for applications that require proven, high-performance plastics such as ABS, Polycarbonate, PPSF, and Ultem.

Color customization: We offer an enormous amount of customization for FDM parts with 16 colors to choose from, depending on the material.

Scale & Accuracy

- With FDM, Xometry has the capability to print parts as large as 3 x 2 x 3 feet!
- We recommend the minimum feature size (including text features) to be at least 0.035”, and 0.045” is safest (check out our post with more info on small feature details **here**).
- FDM prints in 0.010” layers, 0.013” layers on parts over 16” max dimension.

Trade-Offs

- Bead thickness causes FDM to sweat the small details, and have noticeable layer stepping. As a result, small holes, text, very narrow pegs and lips may not resolve (for these types of features we recommend SLS or PJ3D).

Resources

- **FDM Mini-Guide**
- **Full FDM Material List**

Direct Metal Laser Sintering (DMLS)

Direct Metal Laser Sintering (DMLS) is a 3D printing technology that uses metal powders and precision lasers to quickly and accurately create complex parts from a 3D CAD file.

Speed

DMLS parts do not require tooling, reducing manufacturing lead time from months to days.

Strength

Utilizes powdered metals with strong mechanical and dynamic properties, making it perfect for end-use parts.

Complex Geometries

Produces parts that cannot be made using traditional manufacturing techniques.

Efficiency

Enables all-in-one assemblies that reduce parts count, assembly time & opportunity for failures by combining multiple parts into a single design.

Rapid Turnaround

Stainless steel part are built within 5 business days, and aluminum parts are built within 8 business days, allowing for faster innovation and speed to market.

Applications

Rapid Tooling

Because DMLS printers can print in metal, they are widely used for rapid tooling, i.e., creating injection molds.

Rapid Prototyping

DMLS printers are used to make proof of concept models and fully functional late-stage prototypes.

Direct Digital Manufacturing

High-quality finish and durable materials have made DMLS printing a favorite technology for end-use products.

Details

Speed meets durability: DMLS is a 3D printing technology that uses metal powder and precision lasers to quickly and accurately create fully-dense parts from a 3D CAD file. DMLS is great for applications that require robust and complex parts in a short lead time. Parts typically ship in 4-8 business days!

High-performance materials: Xometry offers DMLS in Aluminum, Stainless Steel (316L and 17-4), Titanium, and Copper.

Finishes: DMLS parts can be milled or welded just like any other metal part. Bead blasting, our standard finish, will give the part a fantastic bright, clean look.

Production quality: The durability and strength of DMLS parts up to 980 MPa in stainless steel makes them perfect for end-use applications. These parts are also useful for injection molds, and fully functional late-stage prototypes.

Tolerances

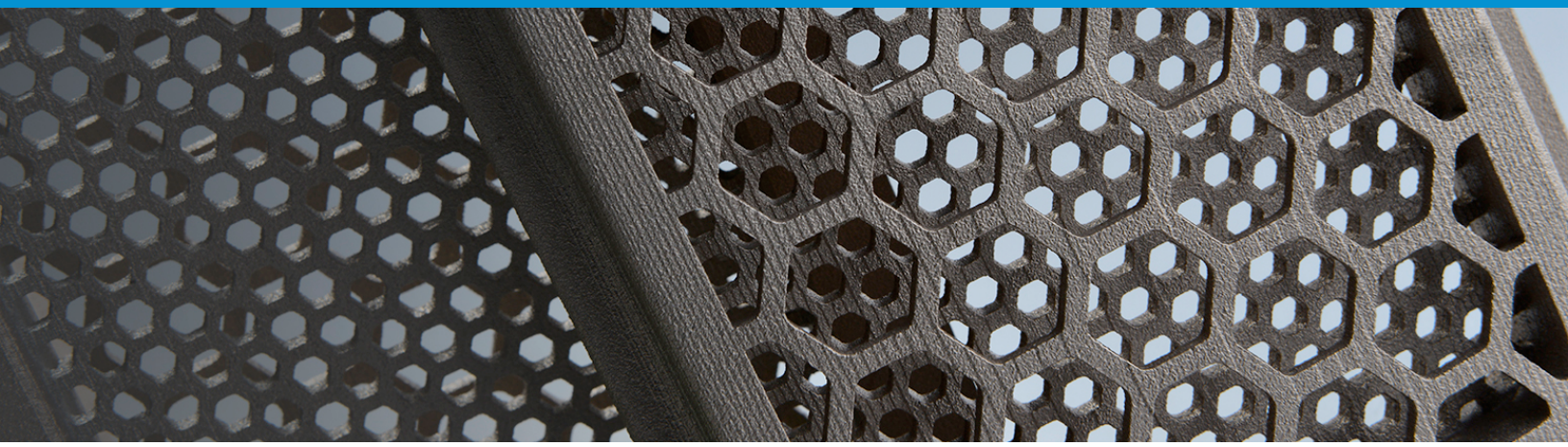
- Tight tolerance of +/-0.001”-0.006” for positive features, and +/-0.004”-0.006” for negative features such as holes.
- DMLS prints in a build volume of 9” X 6” X 6”.

Trade-Offs

- DMLS cannot produce the smooth surface finish of a machined part. Pieces can be manually polished, but process is time-consuming and makes tolerances difficult to maintain.
- Parts require support structure for overhangs greater than 45 degrees from vertical. Fillets are great to allow surfaces to be self-supporting and grant more freedom of design.

Resources

- **DMLS Design Guide**
- **Unrivaled Production: DMLS in the NCAA!**



Metal Binder Jetting (BJ3D)

Metal Binder Jetting is a state-of-the-art technology that produces complex, fully-functional metal 3D printed parts at a fraction of the cost of traditional manufacturing methods.

Durability

Metal Binder Jetting parts achieve greater than 90% density and offer excellent wear resistance.

Lightweight

Half-open mesh and honeycomb structures can be designed to reduce part weight while maintaining strength.

Large Builds

Xometry can produce Metal Binder Jetting parts with build volumes up to 29" x 15" x 14.25".

Complex Geometries

Geometries, including internal conformal cooling and heating channels, can be built more easily due to the 3D printing process.

Part Production

Metal Binder Jetting is capable of producing end-use parts on-demand, without the need for tooling or molds.

Applications

End-Use Industrial Components

420 SS / Bronze is ideally suited for abrasive environments where parts are exposed to thermal, chemical and mechanical stress.

Rapid Prototyping

Precision, durability and a low cost per unit make Metal Binder Jetting a great option for prototyping.

Manufacturing Tools

High-performance materials make Metal Binder Jetting an excellent solution for producing jigs, fixtures, tool masters and production tooling.

Details

Cost-effective with strong material: Metal binder jetting produces complex, fully-functional 3D printed parts through a two-step process which makes a metal composite. The parts are very durable and usually the most affordable alternative to DMLS or traditional machining.

Unparalleled complexity: Binder jet offers a much higher complexity compared to traditional machining or even the DMLS process. Similar to SLS, binder jet parts are built in a self-supporting powder bed.

Finishes: We currently offer a 420 stainless steel infiltrated with bronze composite (~60% steel by volume). Media tumbling is our standard finish, giving the parts a polished and brighter bronze look. Bead blasting is also available for a more matte look that retains edges lost during tumbling.

Large volume with low cost: Binder jetting requires minimal post-processing. This allows binder jet parts to be cost-effectively printed in much larger quantities than DMLS or traditional machining.

Tolerances

- We can build binder jet parts up to 29” X 15” X 14.25”.
- Note that parts printed in this process tend to shrink. Shrinkage usually ranges from 0.8% - 2% during cooling depending on the part’s size and geometry. Internal geometries, such as holes and slots, may shrink by 3-5%.

Trade-Offs

- The matte surface can be porous.
- Shrinkage means uniformity is difficult and slightly unpredictable. We recommend scaling your part up 1.5% as a start.

Resources

- **Binder Jet Guide**
- **Selecting the Right Metal Process**

PolyJet 3D (PJ3D)

PolyJet 3D printing offers one of the most advanced industrial 3D printing solutions available, producing parts with incredible precision and speed. It also supports a wide variety of build materials.

Efficiency

Eliminates the multi-stage processes of traditional manufacturing, such as tooling, milling, and creating molds.

Speed

Because PolyJet 3D can create complex and multi-material parts in a single operation, significantly less build time is needed vs. traditional manufacturing.

Flexibility

PolyJet 3D can build vastly different part geometries, unlike traditional processes that would require complete retooling of an assembly line to produce a different part.

Material Selection

Offers a vast material selection with a range of properties, as well as the ability to print multiple materials and simulate overmolds.

Complex Geometries

Creates complex shapes with a high degree of precision that would otherwise be impossible to build via traditional manufacturing processes.

Increased Innovation

Produces prototypes for a fraction of the time and cost of traditional manufacturing, enabling rapid design iterations and increased innovation.

Applications

Concept Models

The speed, efficiency, and range of build materials make PolyJet 3D perfect for creating concept models.

Rapid Prototyping

PolyJet 3D can be used to create fully-functional prototypes, complete with moving parts.

Rapid Tooling

PolyJet 3D is ideal for making tools and molds that can be used in production settings.

Details

Incredibly fast and precise: PolyJet 3D printing builds parts layer by layer using UV light to cure a jetted resin. It offers one of the most advanced industrial 3D printing solutions available, growing parts in a wide variety of materials with precision and speed.

Finishes: This process is known for resolving very fine details and producing a smooth surface finish. Polyjet builds parts in fine layers using a UV-cured photopolymer deposited through jetting print heads. It is widely used for models, prototypes, and (low-heat) molds.

Largest variety of properties: Parts in PJ3D can be printed in materials with many different properties from rigid to rubber-like, and even translucent. PolyJet machines can also run multiple materials simultaneously or blend materials together! This drastically increases the variety and characteristics a part can come in.

Immediate: Polyjet allows for quick lead times due to simple pre- and post-processing procedures. PJ3D can be delivered in as little as 1 business day!

Tolerances

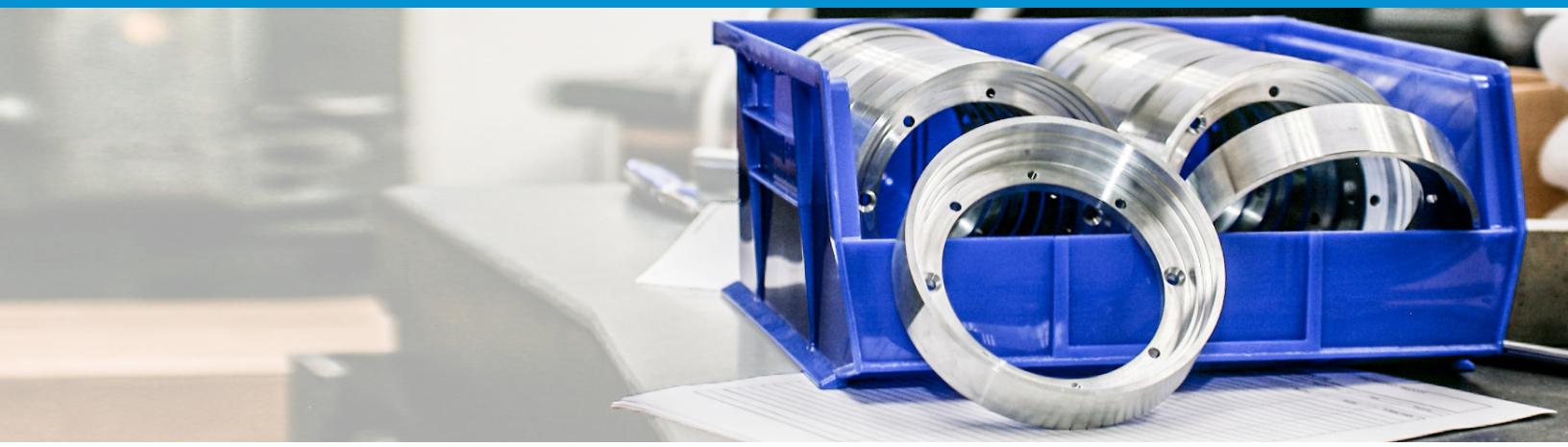
- PJ3D can be expected with a precision of +/- 0.0035” or +/- 0.0005” per inch, whichever is greater.
- The max build area is 19” X 15” X 7”.
- PJ3D prints in 0.0012” (30 um) layers.

Trade-Offs

- Polyjet materials tend to be more fragile than FDM or SLS parts. We recommend using it for fit-checks, “feel” checks, trade-show models, and other uses that do not involve harsh environments or impact.
- Small features on PolyJet parts pose a high risk of breaking off during post-processing. We recommend adding drafts, fillets, and ribs to strengthen the part. Thin and narrow sections of a part are most vulnerable to break.
- Support material is needed for certain features, which could reduce the freedom of design because removal of support may risk breaking fragile features.

Resources

- **PJ3D Mini-Guide**
- **3D Printing Process Comparison**



Computer Numerical Controlled (CNC)

CNC machining offers unparalleled precision
for producing metal and plastic parts.

Speed

Using the latest CNC machines, Xometry produces highly accurate parts in as little as 6 business days.

Scalability

CNC Machining is perfect for production of 1-10,000 parts.

Precision

Offers high-precision tolerances ranging from 0.005" – 0.001", depending on customer specs.

Material Selection

Choose from over 50 metal and plastic materials. CNC Machining offers a wide variety of certified materials.

Custom Finishes

Select from a variety of finishes on solid metal or plastic parts, built to precise design specifications.

Applications

Rapid Tooling

Because CNC machining services can be applied to virtually any material, it is perfect for rapid tooling, i.e., creating injection molds.

Rapid Prototyping

The range of materials available, low cost per unit, and speed of production makes CNC a great option for prototyping.

Rapid Manufacturing

High-quality finish, vast material options and precise tolerances have made CNC machining a favorable technology for end-use parts.

Details

Extreme precision and high quality: CNC machining is one of the fastest, most accurate methods of building market-quality parts for almost any application. CNC removes material using high speed, precision machines that are programmed to use a wide variety of cutting tools to create the final design.

Fast Delivery: Xometry can machine parts in most common metals and plastics in as little as 6 business days. Our standard lead time for most orders is 10 business days.

Economical with minimum setup: We offer 5-axis CNC machining to produce parts quickly, and with minimal setups. However, designing parts efficiently is crucial to avoid increasing cost due to additional setups.

Finishes: Machined parts have a large option of features and finishes to select from. This includes surface finishing like powder coating, anodizing, plating, part marking, as well as embedded features like inserts.

Tolerances

- Standard tolerances are +/-0.005” for metal parts and +/-0.010” for plastic parts. Tighter tolerances are available if required.

Trade-Offs

- Given the cost of material and setup, CNC machining can be more expensive for smaller quantities of parts.
- CNC Machining can be limited. Certain features, such as those that cannot be reached by the milling tool, cannot be produced.
- Sharp interior corners must have a radius of at least 0.0156”, and square interior corners will have a corner radius of ⅛ times the depth of the pocket applied.

Resources

- **CNC Design Guide**
- **Top 10 Ways to Save on CNC**
- **Standard Inserts**
- **Standard Threads**

Urethane Casting

Urethane casting provides end-use, rigid or flexible plastic parts with production-level quality.

Durability

Polyurethane cast materials are available in either rigid or flexible end-use plastics. Urethane cast parts are generally as tough or tougher than injection molded pieces, and are significantly stronger than 3D printed counterparts.

Scalability

Our casting process is optimal for low-volume production for quantities of one to several hundred. On average, a silicone mold can accurately cast about 20-50 parts. The maximum quantity varies based on part design and material cast.

Material Selection

We offer a wide range of rigid and flexible urethane cast materials, from very soft and flexible (Shore A) to extremely rigid and impact resistant (Shore D). Parts are cast in a color that is blended to your specifications.

Professional Finish

The urethane casting process is capable of reproducing small details. Little to no finishing is required, because the desired textures and finish levels are applied to the master pattern.

Rapid Turnaround

Urethane cast parts are shipped within 15 business days, depending on order specifications and volume. By contrast, injection molded parts can take months to build.

Applications

Low-Volume Production

Urethane cast parts are perfect for low-quantity production — when volumes do not justify investment in injection mold tooling — as well as for first run production parts, which can be completed weeks before production tooling is ready.

Advanced Prototyping

The urethane casting process and relatively inexpensive tooling involved makes it easy and economical to make any necessary design changes. Additionally, different materials can be used with the same mold, making it possible to test designs with a variety of materials.

Market Testing

End-user functionality and a high-quality finish makes urethane cast parts ideal for consumer testing, user evaluation and concept models. Using the cast urethane process means that changes can be incorporated quickly for either further testing or market launch.

Details

End-use durability: Parts made with urethane casting are great for applications such as automotive and aircraft parts due to their ability to be produced quickly and at a low price, while being durable enough for end-use.

Mechanical property range: Depending on the mixture, urethane casted parts can be either rigid, flexible, or rubber-like and are even sufficient for end-use applications due to this method's high impact strength, abrasion resistance, and resistance to heat.

Faster than injection molding: Urethane casted parts are known for "bridge tooling" or "soft tooling" when compared to injection molded parts because of the faster rate of production and lower fixed cost.

Finishes: We currently offer many different colors and finishes for urethane casted parts. Colors include transparent (standard), black, blue, red, green, and yellow. Finishes include standard, smooth finish, or custom (this may include hardware installations and painting).

Tolerances

- We can offer urethane casted parts as large as 30" long.
- Our typical tolerance on urethanes is +/- 0.010" + 0.002" per inch. Irregular or overly-thick geometries may cause deviances to normal tolerances due to shrinkage.
- A shrinkage rate of +0.15% can be expected due to thermal expansion of the liquid, and the response of the flexible mold.

Trade-Offs

- Quantities are limited by both time and durability of the silicone molds, due to the fact that parts need to solidify and can only manufactured one at a time.
- Shrinkage may be unpredictable depending on the geometry of the part.

Resources

- **Urethane Casting Services**

Sheet Metal Fabrication

Sheet metal produces durable, end-use metal parts that are fabricated to your specifications.

Durability

Similar to CNC machining, sheet metal processes produce highly durable parts well-suited for both functional prototypes and end-use production.

Scalability

All sheet metal parts are built on-demand and with no set-up costs. Depending on your needs, order as little as a single prototype up to 10,000 production parts.

Rapid Turnaround

Combining the latest cutting, bending and punching with automated technologies, Xometry provides instant sheet quotes and completed parts within 12 business days.

Material Selection

Choose from a variety of sheet metals across a wide range of strength, conductivity, weight, and corrosion-resistance.

Custom Finishes

Select from a variety of finishes, including anodizing, plating, powder coating, and painting.

Applications

Enclosures

Sheet metal offers a cost-effective way to fabricate product device panels, boxes and cases for a variety of applications. We build enclosures of all styles, including rackmounts, “U” and “L” shapes, as well as consoles and consolets.

Chassis

The chassis we fabricate are typically used to house electromechanical controls, from small handheld devices to large industrial testing equipment. All chassis are built to critical dimensions to ensure whole pattern alignment between different parts.

Brackets

Xometry builds custom brackets and miscellaneous sheet metal components, well-suited for either lightweight applications or when a high degree of corrosion-resistance is needed. All hardware and fasteners that is needed can be fully built in.

Details

Production quality: We currently offer sheet metal fabrication services including bending, punching, and cutting many different metals to form your part for either low to high volume production runs. Parts are well known for their durability and precision, which makes them perfect for end-use.

Durable, uniform thickness: Sheet metal fabrication produces thin-walled, metal parts that can’t be produced with CNC machining. Chassis, enclosures, and brackets are perfect for sheet metal fabrication because they maintain a uniform thickness and need to be rigid and durable.

Quantity discounts: As quantity increases, price per part drastically decreases due to the fact that parts are able to be patterned on the same stock of material.

Materials: Common materials include aluminum, mild and stainless steel, copper, brass, and even exotic alloys.

Finishes: Depending on the metal, we provide bead blasting, powder coating, plating, anodizing, welding, and custom finishes.

Tolerances

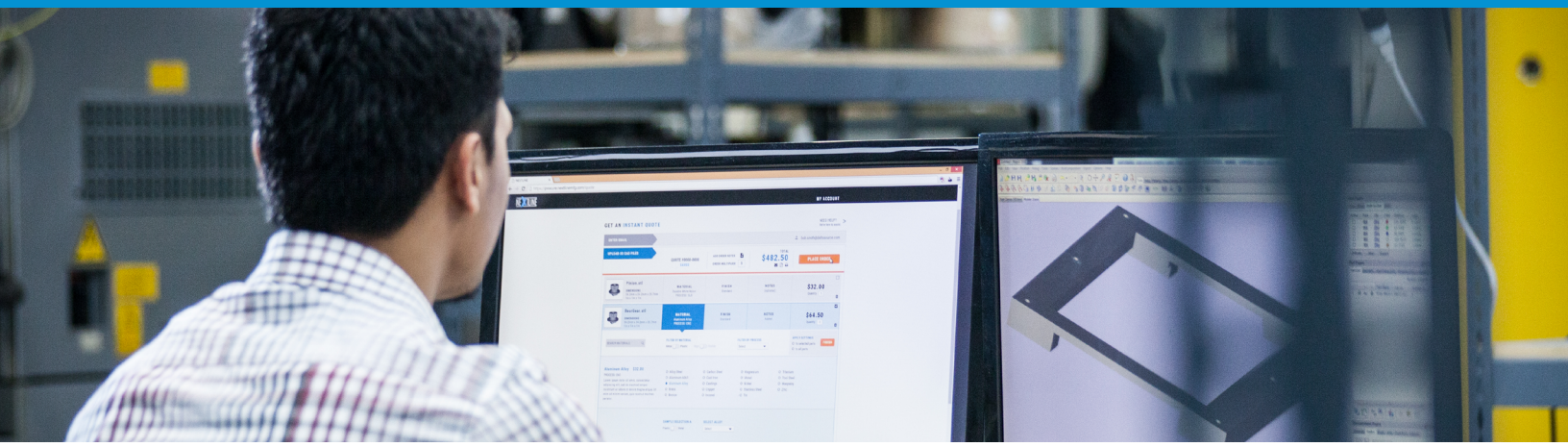
- Tolerances for sheet metal features fall within +/- 0.010” / inch.
- Holes can be punched with a maximum of 2” diameter. Laser cutting can provide more complex punches and patterns.

Trade-Offs

- Sheet metal may be expensive for lower quantities of parts due to tooling, setup and material costs.
- Sheet metal fabrication cannot be used for parts with non-uniform or large wall thicknesses.
- Sharp interior corners are incompatible with this method, as the sheets are bent with machinery that has rounded corners.

Resources

- **Sheet Metal Fabrication Services**



Resources at Xometry

Instant Quoting

You can also upload your CAD file to our online quoting engine at **get.xometry.com/quote**.

Support Team

Contact our support team to speak directly with Xometry's engineers:

Email: **support@xometry.com**
Phone: (240) 252-1138

Live Engineering Support

Click the Help button anywhere on **xometry.com** for FAQs and other helpful articles, or to chat live with our engineers.