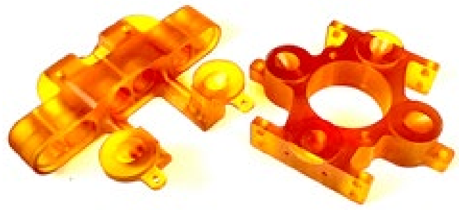
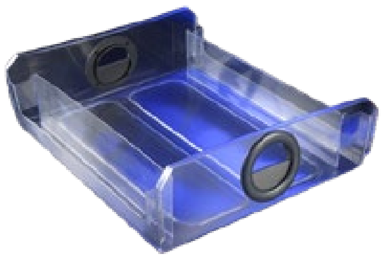




The Ultimate Guide to 3D Printing



THE TECHNOLOGY HOUSE

Your Guide to Successful 3D Printing

Our world has become a personalized, on-demand marketplace, and additive manufacturing enables us to make more things, faster and better than we could before. Materials have also advanced where we can now use all different types of engineering plastics and composites for prototype and production.

Part finish has improved with automated post-processing, updated build prep software, new additive manufacturing equipment suppliers (like Carbon and HP), and the ability to create custom finishes and textures 3D printed directly onto your parts. With these vast improvements of technology, material, and part finish, 3D-printed parts are not only strong enough to compete with the likes of machined and injection-molded parts, but they can look the part too.

In this handbook, you'll learn the ins and outs of 3D printing and the processes that will help take your idea from concept to prototype to production.

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What Is 3D Printing?

3D printing, or additive manufacturing, is the process of building parts by joining material layer by layer from a CAD file. This is unlike a traditional manufacturing process, like CNC machining, where a part is built by subtracting material from a block of material. 3D printing and additive manufacturing can be used regardless of whether the parts are fabricated in plastic, metal, or rubber.

One of the most revolutionary technologies of the 21st century, 3D printing allows designers to create complex parts for a wide range of industries—aerospace and defense, medical, consumer goods, industrial equipment—at a fraction of the cost and time of standard means like forging, molding, and sculpting.

The 3D printing process begins with a 3D CAD model. After the 3D model is created, it's exported as an STL file. If an STL file isn't available, multiple engineering programs can be used to export an STL file. The most common programs are STEP, IGES, Parasolid, Catia, SolidWorks, and Creo (ProE).

Using a 3D CAD model as the "blueprint," successive layers of material are deposited or fused by a computer-controlled "print head" into the desired 3D shape. No machining of the part is required, thus no raw material is wasted.

Benefits of 3D Printing

Today, more and more companies in a wide range of industries are embracing 3D printing technology due to the significant advantages it has over more traditional manufacturing methods, such as subtraction manufacturing and injection molding.

The main benefits of 3D printing are realized in its cost, flexibility, and speed.

COST

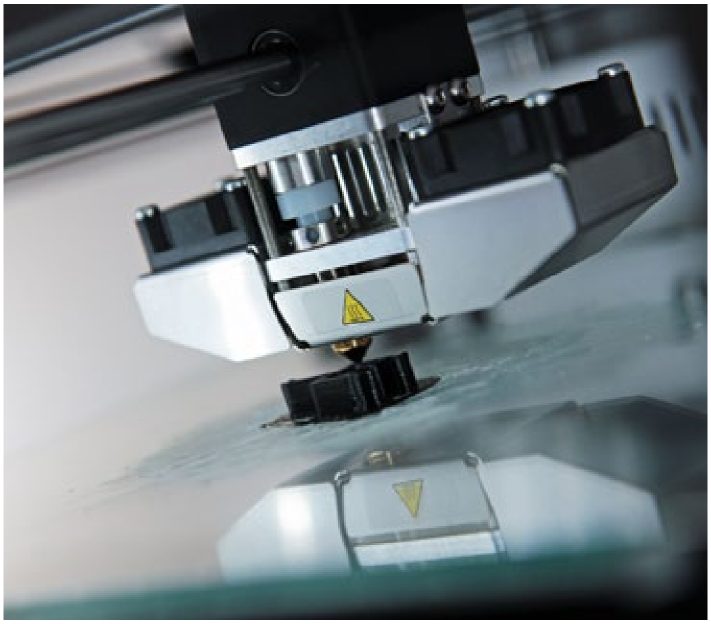
3D printing can be the most cost-effective manufacturing process for small production runs and applications. Traditional prototyping methods like CNC machining require costly machines, fixtures, and setups, while injection molding needs expensive metal tools with minimum order runs. With 3D printing, the ability to make complex shapes and parts more easily saves high costs of programming and setups. 3D printing also allows for making only what you need, minimizing material costs and minimum part orders all while running unattended.

FLEXIBLE DESIGN

One of the biggest advantages of 3D printing is design flexibility. 3D printing allows for the design and print of more complex geometries, which often can't be achieved with traditional manufacturing methods, either as a single part or at all without high costs and long lead times. Designing without restriction allows for the creation of new designs to potentially increase performance, reduce material and weight, and consolidate part counts of assemblies into single parts.

SPEED

You can save a lot of product development time and cost by using 3D printing to quickly iterate prototypes or go directly into printing production parts. 3D printing is faster than traditional manufacturing methods because, unlike injection molding, there is no tooling required to make parts. With 3D printing, you can design a part, manufacture it, and test it, all within 24 hours.



Types of 3D Printing Technology

There are several types of 3D printing, which include:

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

In order to select the right 3D printing process for your application, it's important to understand the strengths of each process and map those attributes to your product development needs.

Carbon Digital Light Synthesis (DLS)

Carbon DLS with Carbon CLIP technology allows for true 3D digital manufacturing.

Carbon DLS is the photochemical process using both light and oxygen to build parts. DLS works by projecting UV images generated by a digital light projector through an oxygen-permeable window in a reservoir of UV-curable resin. After parts are built continuously in 25 to 100 micron layers, they go through a wash or rinse process. After all excess material is rinsed away, supports are removed and parts go into ovens for final curing, which gives the parts their mechanical properties and strengths.

Benefits of DLS

- Wide range of elastomeric and rigid engineering-grade materials
- Biocompatible and sterilizable materials
- Reduced time to market
- Isotropic parts, air-tight and leak-proof
- Outstanding surface finish
- Smart equipment for industry 4.0

Carbon DLS parts are best used for:

- End-use production parts
- Digital inventory for on-demand production
- Part consolidation
- Complex, organic, generative designs
- Foam replacement parts

Stereolithography (SLA)

High-precision prototypes for your next development cycle

SLA is the process of converting a liquid plastic into solid 3D objects using a stereolithograph apparatus, or SLA machine. SLA was the first additive manufacturing process and was introduced over 30 years ago. SLA works by building a 3D model of a component using a vat of liquid UV-curable photopolymer resin and an ultraviolet laser to form one thin layer at a time, usually 0.002"–0.006" or 50–150 microns.

Benefits of SLA

- Highly Accurate
- Smooth surface finish
- Easy to finish and paint
- Heat and moisture resistant
- Quick turnaround
- Low costs with economies of scale

SLA is best used for:

- Fit and function samples
- Master patterns
- Painted sales & marketing samples
- Clear sample parts
- Quickcast for casting masters

HP Multi Jet Fusion (MJF)

Print production-quality parts with accurate and detailed part finish

HP MJF is a new powder-based 3D printing process created by HP for scaling industrial printing volumes from prototype to production. MJF is a digital manufacturing platform for additive manufacturing that 3D prints layers on top of molten layers, which allows the printed layers to fuse together to form strong and detailed parts quickly. This allows MJF to produce production-quality parts with different materials faster than other similar technologies.

Benefits of MJF

- Strong, tough, durable parts
- Fine feature resolution and surface finish
- Thermoplastic materials: Nylon, GF Nylon, PP, TPU
- Economies of scale with fast, nested prints
- Isotropic mechanical properties
- Print complex organic shapes and working assemblies with no supports

MJF is best used for:

- Replacement parts
- Snap fits and living hinges
- End-use production of all volumes
- Air-tight and leak-proof
- Color printing

Fused Deposition Modeling (FDM)

The most common and one of the most affordable 3D printing processes

FDM is the most widely used 3D printing process because of its ease of use and ability to run real engineered plastics. Also known as fused filament fabrication (FFF), FDM is a popular method for additive manufacturing but has its own specific benefits. FDM is more widely known and affordable than HP MJF or Carbon DLS due to the availability and low cost of entry with desktop 3D printers.

Benefits of FDM

- Tough and durable parts
- Real thermoplastic materials: ABS, PC, Nylon, Ultem
- Sustainable
- Ease of use
- Low cost

FDM is best used for:

- Jigs and fixtures
- Strong prototypes
- Low-volume production
- Material and durability testing
- Part replacements

Selective Laser Sintering (SLS)

Tough and durable prototype and production parts from thermoplastic material

SLS is the 3D printing process of creating 3D objects with an expensive laser and plastic powders. SLS is very similar to the SLA process in that it uses a laser to make a 3D object except that it uses powder material instead of liquid material. Also, similar to HP MJF, SLS can build a whole chamber of parts at the same time without support.

Benefits of SLS

- Tough and durable parts
- Thermoplastic materials (Nylon, GF Nylon)
- Economy of scale prints
- Print working assemblies
- Heat resistant
- UL94 rated
- Biocompatible

SLS is best used for:

- Material testing
- End-use production parts
- Durable housings
- Snap fits
- Living hinges

PolyJet

The ideal process for 3D printing multi-material prototypes and highly complex parts with lots of fine details

PolyJet is an inkjet process for 3D printing that creates smooth and accurate parts. Movie effects, medical models, consumer goods, and automotive and electronic components are industries that typically use PolyJet parts. PolyJet works by simultaneously jetting drops of photopolymer materials that solidify when exposed to UV light. This is repeated in microscopic layers over and over until the part and build are complete. Multiple materials and/or colors can be jetted at the same time to create multi-material or multi-colored printed parts. The end result is a solid 3D model.

Benefits of PolyJet

- Highly accurate with fine details
- Smooth finish
- Ease of use
- Multi-materials (e.g., over-mold samples)
- Multi-colored
- Economy of scale

PolyJet is best used for:

- Design checks
- Rapid tooling
- Full-color marketing models
- Full-color figurines
- Medical models
- Over-molded samples

Metal 3D Printing

Create complex and intricate geometries in a short timeframe with 3D metal printing technology

Also known as direct metal laser sintering (DMLS) or direct metal deposition, 3D metal printing is a printing/additive manufacturing technology that produces 3D printed metal parts and prototypes. 3D metal printing technology prints metal parts by sintering various metal and alloy particles together. 3D metal printing technology produces parts with high accuracy and detail resolution, good surface quality, and excellent mechanical properties.

Benefits of Metal 3D Printing

- Wide range of materials
- Complex geometries
- Reduced time to market
- Similar material properties
- Medical and aerospace
- Consistent per cost price

Metal 3D printing is best used for:

- Prototypes
- Material testing
- Replacement parts
- Low-volume production parts
- Injection mold inserts
- Conformal cooling

3D Printing FAQs

Q: How large can parts be made?

A: Technically, you can build a part of any size. This is due to 3D printing's ability to make parts in sections.

Q: Can you glue 3D printed parts?

A: Yes. It is very common to section and bond parts in 3D printing to make large parts or fix those prototypes that may get chipped over time.

Q: What is the minimum thickness required?

A: The minimum thickness can vary based on the material, machine, and process, but most processes require a minimum thickness of .025" to .030". Softer materials will require a thickness of at least .040". Smaller features, walls, and geometries can be built but are geometry or build orientation dependent. Keep in mind that most 3D printing processes require some finishing and small, thin features are more delicate and take a lot of care to survive printing, processing, and shipping.

Q: In what ways can I reduce 3D printing costs?

A: There are multiple ways to save on 3D printing and additive manufacturing costs. Here are the most common:

- Hollow out or use sparse build files to reduce material and build times
- Consolidate parts when possible to reduce material and part counts
- Tall parts can be cut and run in sections to be bonded in finishing
- Use larger build layers to decrease build times (this will reduce part quality finish)
- Nest or group parts together to reduce overall costs through economies of scale

Post-Processing Options

Depending on your application's requirements, there is a range of different finishes and coatings for plastic and metal prototype and production parts. Most 3D printed parts require a level of finishing.

Plastic Part Finishes

- Tumbling
- Vapor smoothing
- Media blasting
- Inserts & assembly
- Drill, ream, & machine
- Painting (flat to gloss)
- Color-match paints
- Clear (frost, tint, dye)
- Dyeing
- Textures (printed & post-print)
- Vacuum metalize
- Plating
- EMI shielding
- Soft-touch coatings
- PTFE coatings
- Part decorations (e.g., labels, decals)

Metal Part Finishes

- Heat treat
- Media blasting
- Shot peening
- Tumbling
- Polishing
- Etching
- Machining
- Plating

Ready to find the right 3D printing technology for your project? Whether you're putting together a fit and function test model, small production run, or mass 3D printed parts for production, we can help.

Contact Us

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