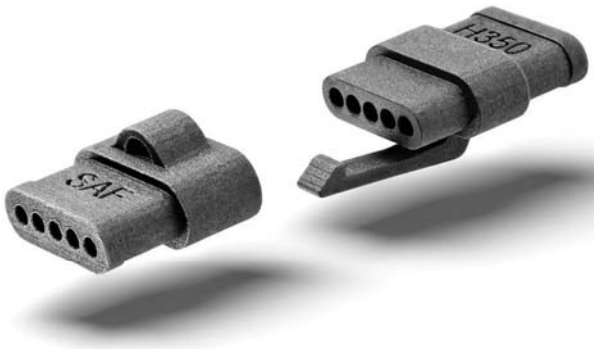
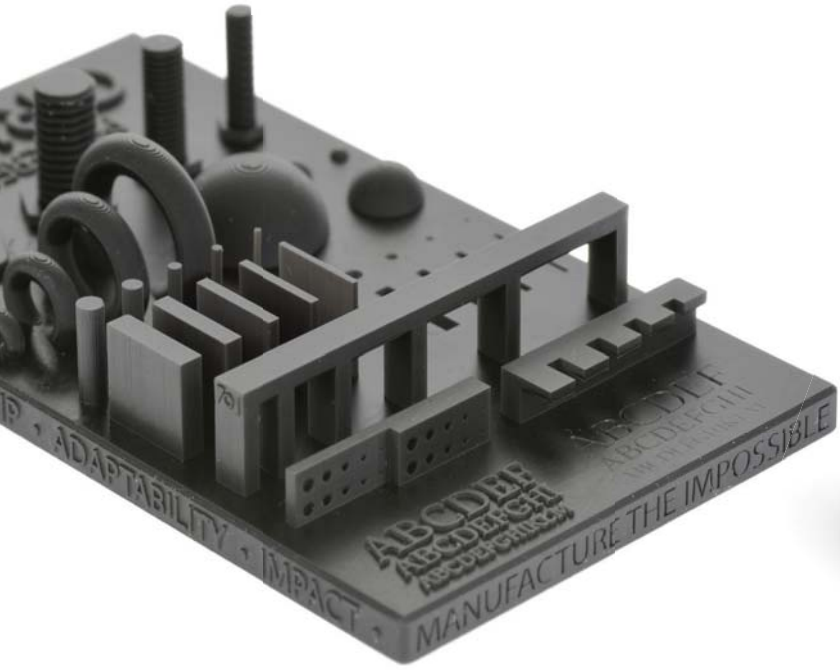
# 3D Printing
# Buyer's Guide

Find the best technology, printer
and materials for your business

stratasys




# Contents



# What is 3D printing?

3D printing is a process that creates three-dimensional objects from a digital model. It's often called additive manufacturing (AM) because the objects are built by adding successive layers of material, one on top of the next. Conventional manufacturing uses subtractive methods where the desired shape is created by cutting material away from a solid block. 3D printing is less wasteful because material is only added where it's needed to create the part.

A 3D printer is the machine that builds the part. 3D printers differ based on the type of printing technology used and the size of the parts they can build. To make the part, the printer gets its "instructions" from a CAD model and software "slices" the CAD model into virtual layers. The printer then applies material where it's needed to build each layer until the object is completed.

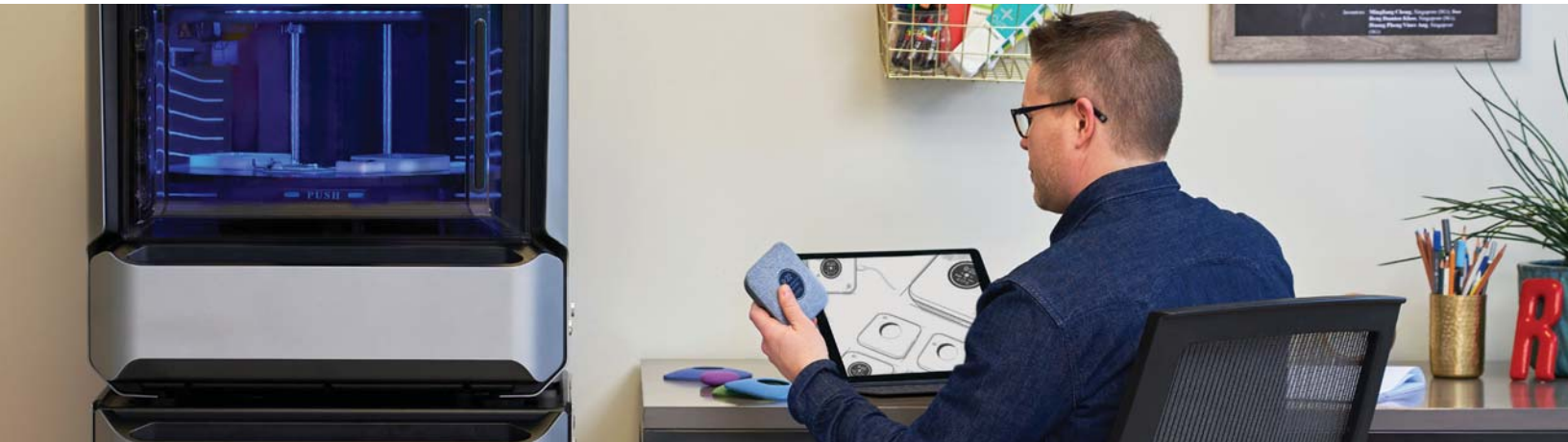
> "The adoption of 3D printing as an engine for growth and innovation is reaching levels where the potential for disruption is becoming very real."

### Do more in less time

From rapid prototyping to manufacturing to realistic medical modeling, 3D printing opens the door to increased efficiencies and broader business opportunities. 3D printing frees you from traditional manufacturability constraints because your designs aren't limited by the restrictions of conventional machine and mold tools. You can make things that often can't be made at all with conventional tools, so you can optimize and create prototypes, tools, medical models and functional parts much more quickly and for a lower cost.

### Find your perfect 3D printer

As you begin your search for the right 3D printing solution, this guide will help you understand the questions you'll need to ask as well as provide insight into the technologies, materials and services available to you.



# Questions to guide your research

### What is your goal?

Stratasys professional 3D printing encompasses multiple technologies and capabilities along with a wide range of materials. Being clear about your goals will help you zero in on the right solution. Some objectives you might consider include:

- Shorten the design cycle
- Test more design ideas in less time
- Illustrate ideas to colleagues or investors more clearly
- Improve customization for products already produced
- Produce functional prototypes to catch and correct errors earlier
- Develop job-ready students for tomorrow's technical careers
- Improve patient outcomes using realistic surgical planning models

### What will you do with the parts you print?

Will they simply communicate an aesthetic concept (form and fit)? Or, do they need to function like traditional production materials (form, fit and function)? Will your printed parts be the final production components? Your answers to these questions will go a long way toward helping you choose the best printer fit.

### Are aesthetics more important to you than functionality?

Do your models need to look realistic? Do you need clear, multiple color or rubber-like materials? Do you need to be able to print models that have rigid and flexible elements? Do you need high fidelity for a smooth surface finish and the ability to print small features? If attaining these aesthetic characteristics with minimal post processing is most important to you, PolyJet, SL and P3 printers should be top considerations.

### Where will your printed parts be used?

Will they need to stand up to heat or pressure? Will they be used outdoors and need UV resistance? Will they be exposed to chemicals? Do they need to be able to withstand high temperatures? Do they need to be chemical-resistant? Do they need to hold tighter tolerances? If functional performance is critical for you, FDM® printers that print durable thermoplastics are an excellent choice. SAF and P3 printers also print with extremely robust materials.

### How long do you need your printed parts to last?

Will you use the parts one time, or will they need to withstand repeated use? If you need longevity from your printed parts, FDM, SAF and P3 printers will likely be the best technological fits for your organization. The robust materials these printers utilize print parts that can maintain their mechanical properties for years.

### What skills do you have in-house?

Depending on the specific 3D printing technology you choose, some orientation and training may be required. For FDM and PolyJet technologies, Stratasys offers training online or in person through instructor-led courses, webinars and e-learning modules.

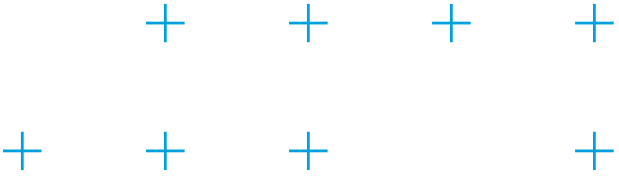
If you don't have the resources to manage a lab, or the expertise to operate or design for a certain technology, outsourcing production is a good way to minimize risk and learn more before dedicating permanent resources.

### What type of work do you have?

Some systems are more office-friendly than others, but even if you don't have the floor space or the ventilation requirements, you can still take advantage of the more demanding technologies through service bureaus like Stratasys Direct Manufacturing that can provide 3D printing services.

### What is your budget and timeline?

If you have a project with a predetermined budget and timeline, you may just be looking for the fastest solution at the lowest cost. Purchasing parts through a service bureau might be your best option.



# Stratasys technologies

Stratasys offers a range of 3D printing technologies, so you can find the right fit for your needs. Use the following sections to better understand how each Stratasys 3D printing technology works, where it excels and what materials are available.


# FDM Technology

FDM systems and related technologies are by far the most accessible and widely used form of 3D printing. 3D printers based on FDM Technology build parts layer by layer from the bottom up by heating and extruding thermoplastic filament.

Production-level systems can work with a range of thermoplastics with specialized properties like toughness, electrostatic dissipation, translucence, biocompatibility, UV resistance and high-heat deflection. This makes FDM ideal for a variety of applications ranging from basic proof-of-concept models to functional prototypes to lightweight ductwork on commercial aircraft.

**CONCEPT MODELS**

**FUNCTIONAL PROTOTYPES**

**MOLDS AND PATTERNS**

**JIGS AND FIXTURES**

**PRODUCTION PARTS**

### Compatible materials
- Standard thermoplastics
- Engineering thermoplastics
- High-performance thermoplastics

### Synonyms and similar technologies
- Filament extrusion
- Fused-deposition modeling
- Fused-filament deposition
- Fused-filament fabrication
- Material deposition
- Plastic-jet printing

### Training requirements
Knowledge of build setup, minor maintenance, machine operation and finishing.

### Facility requirements
Any air-conditioned environment and a dedicated space with ventilation and compressed air for larger 3D production systems that process engineering and high-performance plastics.

### Ancillary equipment
Support removal system and optional finishing system.

“To keep Ducati at the forefront of engine design, we sought a technology that could make accurate, durable prototypes quickly. FDM was the only solution that could meet our requirements. The machines were as easy to install as a (2D) printer and they now constitute an integral part of our design and manufacturing process.”

Piero Giusti
**R&D CAD Manager, Ducati**


# PolyJet Technology

PolyJet technology is renowned for its outstanding realism and breathtaking aesthetics. The technology works similarly to traditional inkjet printing, but instead of jetting ink onto paper, a print head jets liquid photopolymers onto a build tray where each droplet cures under ultraviolet (UV) light.

Every PolyJet 3D printer offers sharp precision, smooth surfaces and ultra-fine details. And by combining a variety of photopolymers in specific concentrations and microstructures, the most sophisticated PolyJet systems can simulate everything from thermoplastics and rubber to human tissue, in a broad gamut of colors.

Product designers use PolyJet technology to make models and prototypes with final-product realism to quickly gain critical feedback from clients, investors and other stakeholders. PolyJet's versatility also makes it an optimal choice for specialized applications ranging from injection molding to surgical-planning models.

**CONCEPT MODELS**

**FULL-COLOR MODELS**

**MULTI-MATERIAL MODELS**

**MOLDS AND PATTERNS**

### Compatible materials

- Full-color photopolymers
- Clear photopolymers
- Flexible photopolymers
- High-impact photopolymers

### Synonyms and similar technologies

- Multijet printing
- Photopolymer jetting

### Training requirements

Knowledge of build setup, minor maintenance, machine operation and finishing.

### Facility requirements

Any air-conditioned environment and a dedicated space for larger systems.

### Ancillary equipment

Support removal system.

“With the J55, we can actually get there in just a few days, to a place that is on the edge of reality, which is something we’ve never been able to do before.”

Tony Guard
**Director Director of Innovation & Industrial Design, Kinetic Vision**

CONCEPT MODELS

FUNCTIONAL PROTOTYPES

MOLDS AND PATTERNS

# Stereolithography

Stereolithography was the world's first 3D printing technology, and it remains a great option for highly detailed prototypes that require tight tolerances and smooth surfaces. Product designers opt for Stratasys Neo® SL models when a quick build time is crucial, but they aren't willing to sacrifice resolution or accuracy. Neo 3D printers can also produce master patterns for urethane casting, sacrificial investment casting patterns that are used to produce metal parts for aerospace, automotive, power generation and medical applications.

Stereolithography, through Neo 3D printers, is great for prototyping parts that will ultimately be painted or coated because the models can be finished using the same materials and processes as the end product. Transparent and moisture-resistant materials can also be used when there's a need for flow visualization or light transmission.

### Compatible materials

- Photopolymers
- Open resin system — compatible with 355 nm stereolithography resins

### Synonyms and similar technologies

- SLA
- SL
- Vat photopolymerization

### Training requirements

Knowledge of build setup, moderate maintenance, machine operation and finishing, and proper material handling.

### Facility requirements

- Temperature range: 20 – 23°C, maximum rate change ±1°C/hour relative humidity 20 – 50% non-condensing
- 900 W typical operation, 1900 W maximum
- Integrated UPS. 10 ~ 20 mins of system up-time with Intelligent Control

### Ancillary equipment

Neo800 offload trolley / Neo UV800 post-cure and heated resin store / Neo Material Development Kit

> The superb smoothness of the parts from the Neo800 is a significant improvement over our previous machines; our high standard of finish can now be achieved more rapidly. Coupled with the extremely large build volume, we were able to complete large 3D printed parts for BAC's Mono R launch in even shorter timeframes."

Ross Nicholls
**Malcolm Nicholls Ltd**


# Selective Absorption Fusion™ SAF™ Technology

Selective Absorption Fusion™ SAF™ technology on the Stratasys H350™ delivers functional, production-grade 3D printing with unmatched consistency. Ideal for high-volume, short-run production, SAF technology achieves accuracy and repeatability by jetting single or multiple drops of highly loaded fluids with fine detail or large, fused areas without compromising throughput. It also has the ability to jet unique, high-specialty, functional fluids, process a broad range of powders and manufacture parts with selectively defined point-to-point properties.

Thanks to its unique in-line, unidirectional architecture, SAF technology prints, fuses, recoats (with Big Wave™ powder system) and heats powder in the same direction. The time-controlled manner of these processes ensures part consistency and a uniform thermal experience across the whole bed. As a result, SAF-based products will deliver a competitive cost per part, production-level throughput, part quality and consistency, and a high production yield.

**PRODUCTION LEVEL**

**CONCEPT MODELS**

**JIGS AND FIXTURES**

**FUNCTIONAL PROTOTYPES**

### Compatible materials
- Thermoplastics

### Synonyms and similar technologies
- Selective Absorption Fusion™ SAF™
- Multi-Jet Fusion (MJF)
- Selective Laser Sintering (SLS)

### Training requirements
Knowledge of build setup, minor maintenance, machine operation and finishing.

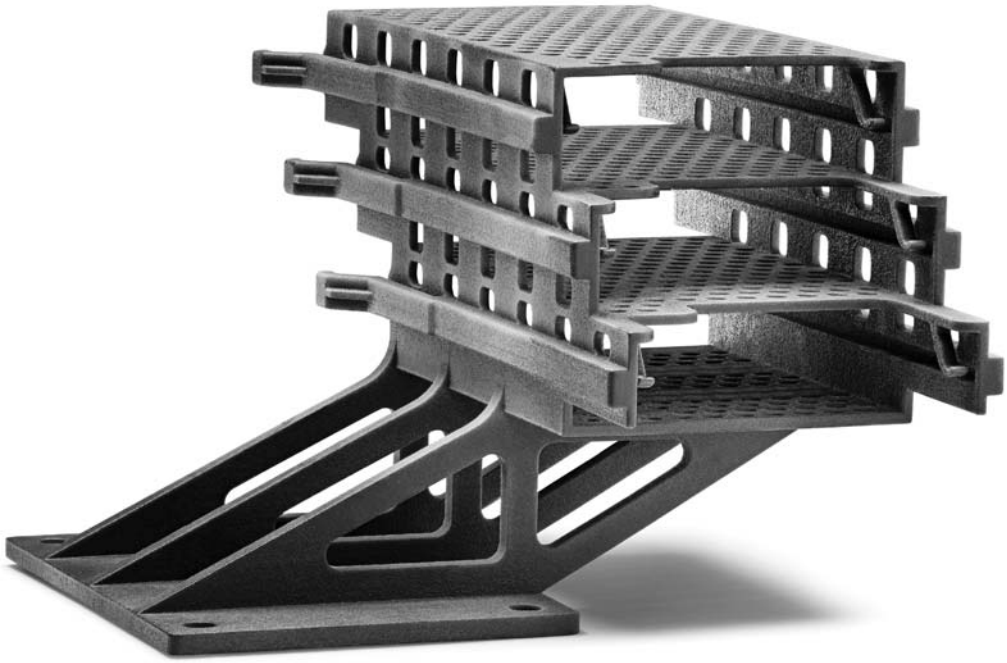
### Facility requirements
- A temperature- and humidity-controlled environment and a dedicated space for a larger system
- Power requirements: 3P+N, PE, 50 – 60 Hz, 16A
- Power consumption: 3.25 kW, 5 kw (peak), 0.15 kW (idle)
- Network requirements: RJ45 ethernet connection 35MBit
- Network with DHCP server and internet access

### Ancillary equipment
Build removal box, powder retrieval station, trolley and powder container.

“

The H350 3D printer provides us with a strong solution for volume production to manufacture cost-effectively and in short lead times.”

Philipp Goetz
**Owner of Goetz Maschinenbau**



# Programmable PhotoPolymerization (P3) Technology

Programmable PhotoPolymerization (P3) technology is all about high-performance materials, accuracy, part quality and ensuring that the last part is identical to the first. Used with a Stratasys Origin® One 3D printer, P3 technology helps you launch faster and respond flexibly to shifts in demand so you can expand production without delays — all while maintaining minimal inventory. You'll reduce part count, simplify your workflow and improve product performance.

P3 technology delivers exceptional accuracy, consistency and isotropy. You can print details less than 50 microns in size with high-accuracy materials, and you'll get smooth surface quality without secondary finishing, sanding, painting or additional processing. You'll have a lot of design flexibility, too, with a wide range of single-component, commercial-grade photopolymers to choose from.

**MOLDS AND PATTERNS**

**JIGS AND FIXTURES**

**PRODUCTION LEVELS**

**FUNCTIONAL PROTOTYPES**

### Compatible materials

- Choose from a wide range of single component production materials, including:
  - Heat-resistent
  - Tough
  - General purpose
  - Elastomers
  - Medical-grade

### Synonyms and similar technologies

- Programmable PhotoPolymerization
- P3
- Carbon Digital Light Synthesis™ (Carbon DLS™)
- Continuous Liquid Interface Production (CLIP)
- Digital Light Processing (DLP)

### Training requirements

Knowledge of build setup, minor maintenance, machine operation and finishing.

### Facility requirements

- A temperature- and humidity-controlled environment
- Operating temperature: 15 – 30 °C (59 – 86 °F)
  Operating Humidity: 30 – 70%
- 90 – 264 VAC, 50 – 60 HZ, 700 W, 1 phase
- Ethernet / WiFi with secure network configuration
- Resin storage: typically 15 – 30 °C (59 – 86 °F)

### Ancillary equipment

- Support removal: Branson Sonicator available to order from Stratasys
- Post-curing: Dymax UV flood lamps available to order from Stratasys

“

Stratasys Origin One parts are a combination of cosmetically appealing parts, with advanced material properties you don’t typically see in 3D-printed thermoset plastics. That’s a winning combination for our clients and their production needs.”

Dan Straka
**InterPRO President**

# Technology comparison

Each Stratasys 3D printing technology solves specific design and manufacturing challenges. Use the following comparisons to further understand the characteristics and differences between FDM, PolyJet, SL, SAF and P3.

# FDM Technology

| | | | | | |
|---|---|---|---|---|---|
| Layer Resolution<br>GOOD | ● | ● | | | |
| Thin Walls<br>GOOD | ● | ● | | | |
| Surface Finish<br>VERY GOOD | ● | ● | ● | | |
| Ease of Use<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Product Development Application Versatility<br>EXCEPTIONAL | ● | ● | ● | ● | ● |

**Strengths**
Durability, reliability, easy support removal, office-friendly operation, wide range of thermoplastics commonly used in production applications — some advanced materials are certified

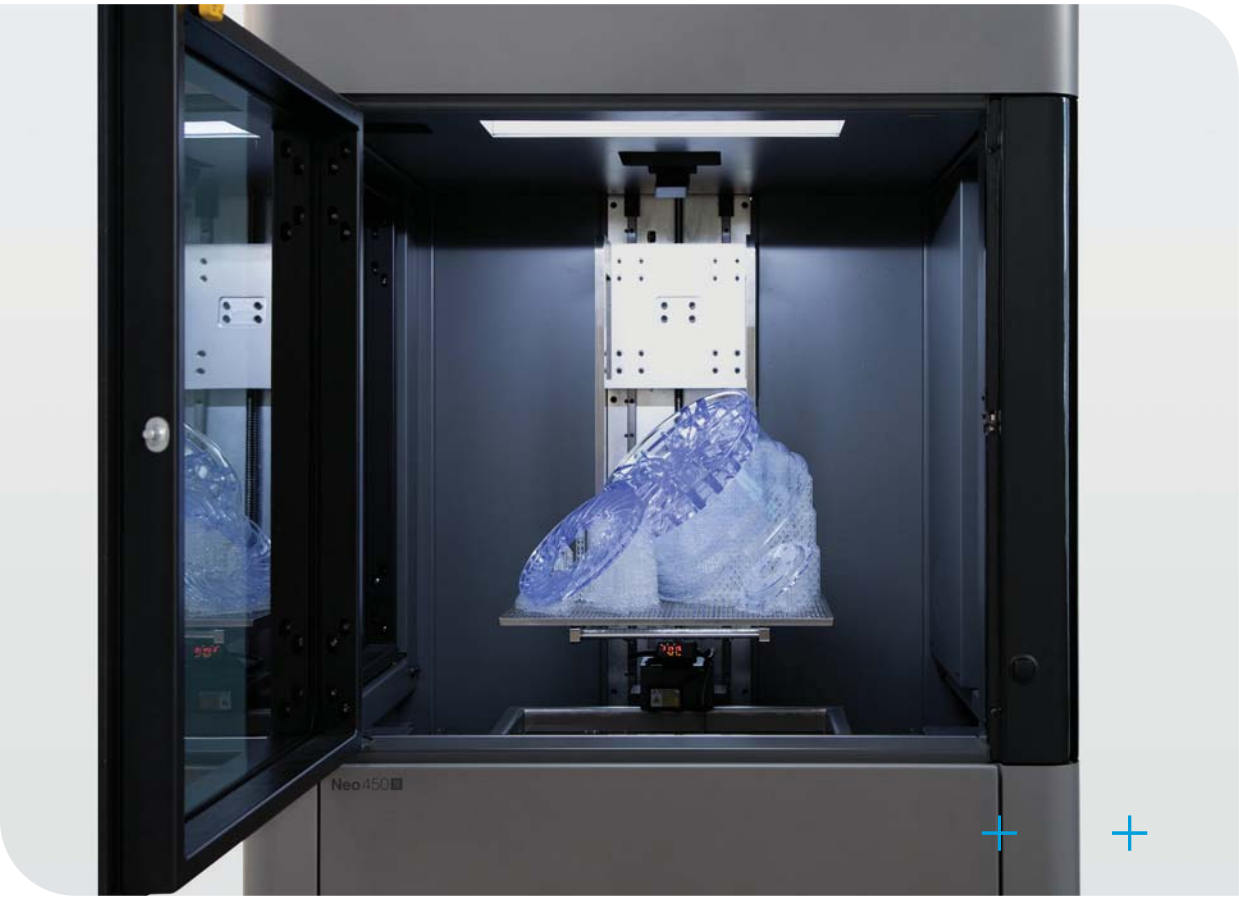
**Weaknesses**
Visible layer lines, anisotropic strength (weaker along layer lines)


# PolyJet Technology

| | | | | | |
|---|---|---|---|---|---|
| Layer Resolution<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Thin Walls<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Surface Finish<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Ease of Use<br>EXCELLENT | ● | ● | ● | ● | |
| Product Development Application Versatility<br>VERY GOOD | ● | ● | ● | | |

**Strengths**
Part realism, surface finish and feature resolution, easy support removal, office-friendly operation, multi-color printing, clear materials, multi-material printing (overmold printing — flexible and rigid materials in one continuous part print)

**Weaknesses**
Temperature sensitive, limited functional material properties



# Stereolithography

| | | | | | |
|---|---|---|---|---|---|
| Layer Resolution<br>EXCELLENT | ● | ● | ● | ● | |
| Thin Walls<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Surface Finish<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Ease of Use<br>GOOD | ● | ● | | | |
| Product Development Application Versatility<br>GOOD | ● | ● | | | |

**Strengths**
Precision, surface smoothness

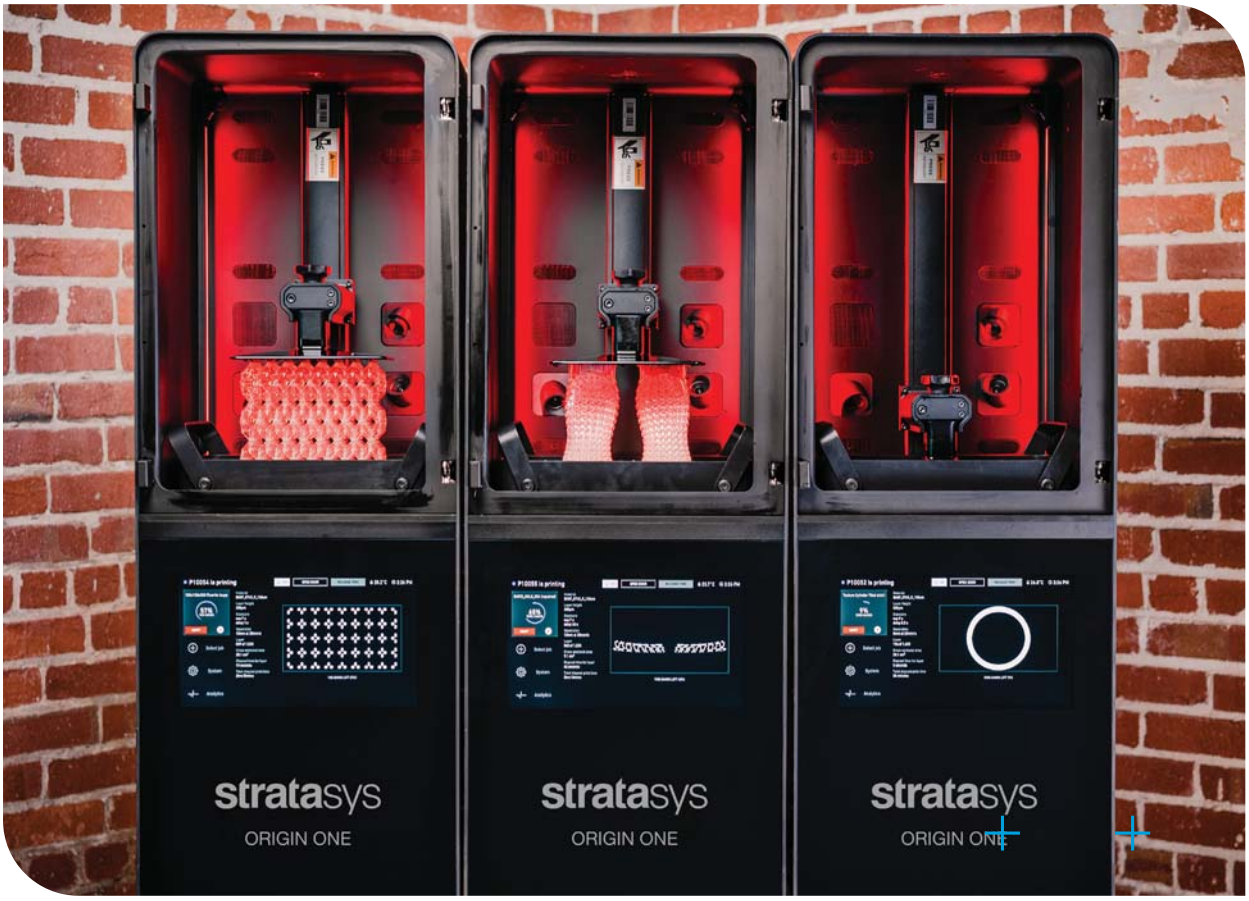
**Weaknesses**
UV-sensitive, extra post-curing steps, not as office-friendly as FDM and PolyJet, not optimal for functional prototyping


# SAF Technology

| | | | | |
|---|---|---|---|---|
| Layer Resolution<br>VERY GOOD | ● | ● | ● | |
| Thin Walls<br>VERY GOOD | ● | ● | ● | |
| Surface Finish<br>VERY GOOD | ● | ● | ● | |
| Ease of Use<br>GOOD | ● | ● | | |
| Product Development Application Versatility<br>EXCELLENT | ● | ● | ● | ● |

**Strengths**
Part durability, accuracy and consistency, cost effective in higher volumes

**Weaknesses**
Limited materials, lower volumes not as cost effective, not optimal for conceptual prototyping




# P3 Technology

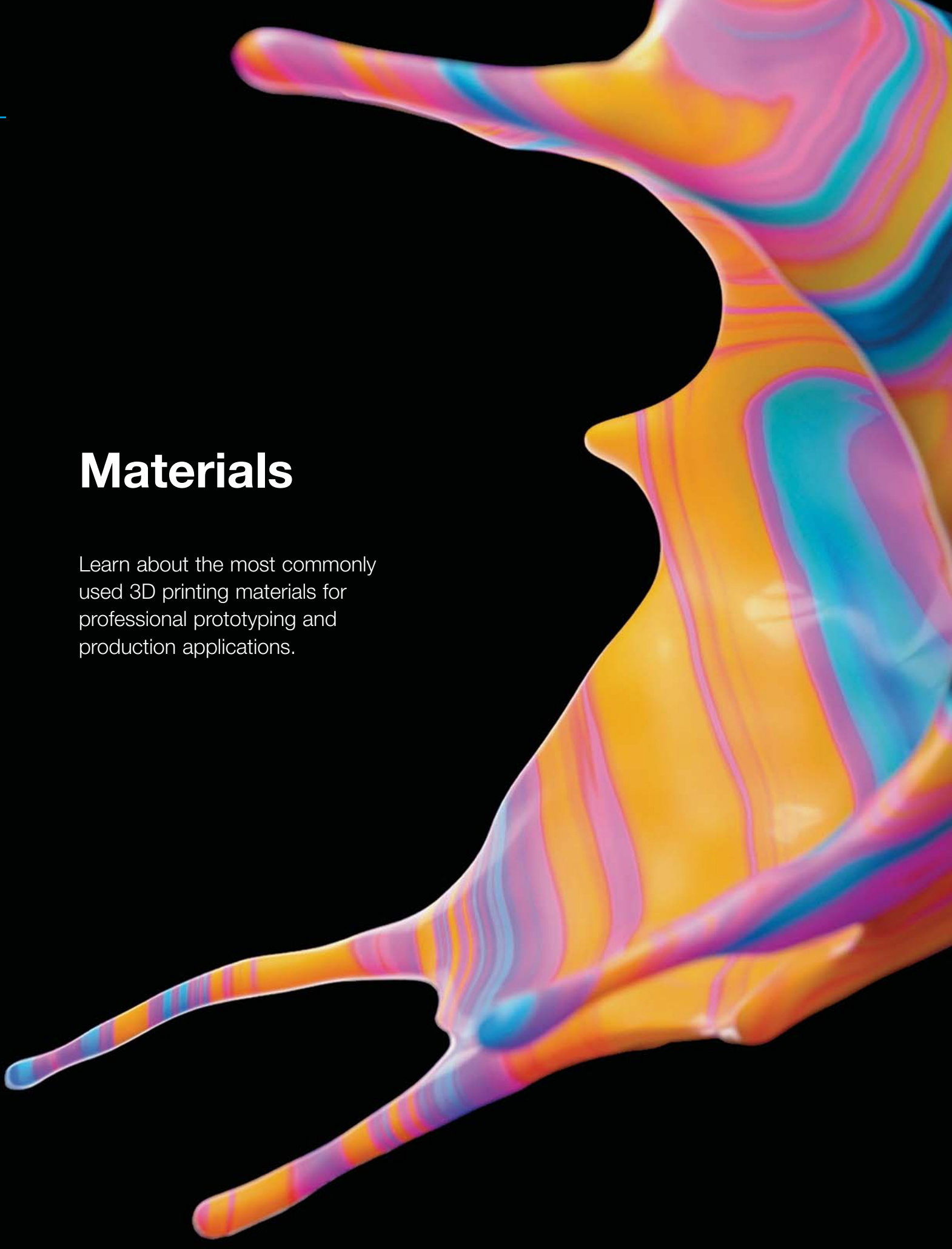
| | | | | | |
|---|---|---|---|---|---|
| Layer Resolution<br>EXCELLENT | ● | ● | ● | ● | |
| Thin Walls<br>EXCEPTIONAL | ● | ● | ● | ● | ● |
| Surface Finish<br>EXCELLENT | ● | ● | ● | ● | |
| Ease of Use<br>EXCELLENT | ● | ● | ● | ● | |
| Product Development Application Versatility<br>EXCEPTIONAL | ● | ● | ● | ● | ● |

**Strengths**
Rigid and flexible materials, surface finish, part strength, biocompatible materials, high throughput, low cost per part, UV stability

**Weaknesses**
Extra post-curing steps, limited build envelope size, not optimal for office settings

# Materials

Learn about the most commonly used 3D printing materials for professional prototyping and production applications.



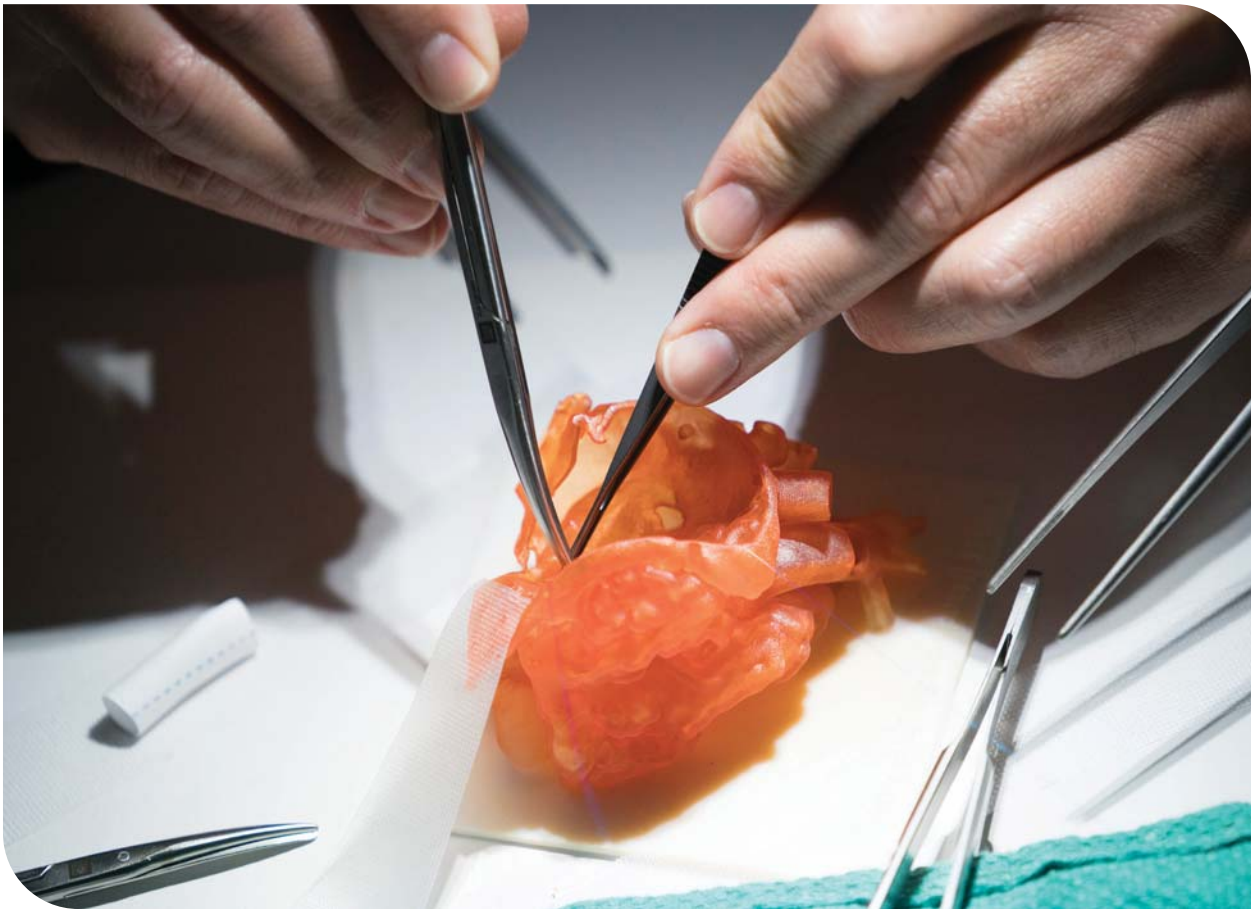
# Thermoplastics

### Standard plastics
The most widely used category of 3D printing materials includes some of the same general-purpose plastics found in mass-production processes like injection molding. And since 3D printed parts bear many similarities to their injection-molded counterparts, you can accurately test form, fit and function before investing in expensive tooling.

### Engineering plastics
For applications that require higher heat resistance, chemical resistance, impact strength, fire retardancy or mechanical strength, production-level 3D printers work with specialized plastics that meet stringent engineering requirements.

### High-performance plastics
High-performance plastics offer the greatest temperature stability, chemical stability and mechanical strength for the most demanding applications.

### Printing methods
FDM
SAF



# Photopolymers

Photopolymers are liquid resins that cure with exposure to UV light. Most photopolymer technologies print single, opaque colors like grey, white and black. Many of them also have translucent or clear materials. PolyJet is even more advanced and is capable of printing models with full and gradient color. Generally speaking, photopolymer technologies produce models with outstanding feature definition and a smooth, beautiful surface finish. Some, like SL, have a specially formulated material for investment casting patterns. However, photopolymers are UV-sensitive and generally not as durable as production-grade thermoplastics.

**Printing methods**
PolyJet
Stereolithography
P3

# Cost of ownership

If you're considering bringing 3D printing in-house, learn about the factors that contribute to the total cost of ownership.

# The six cost factors

### 3D printer
Stratasys professional 3D printers range in price depending on capability. Consider your current and future 3D printing goals to determine an appropriate printer choice.

### Materials
The cost of materials and the amount you'll consume will be a big contributor to your total cost of ownership. If you don't need high-performance thermoplastics or full-color multimaterial capability, lower-priced printers will be your best option.

### Equipment and facilities
FDM, PolyJet and P3 3D printers can be installed in any office environment, while SL and SAF printers have special requirements.

### Labor
All FDM and PolyJet printers are easy to use and don't require extensive training. SL, SAF and P3 printers may require more training and/or the need for personnel trained in this type of 3D printing technology.

### Support and maintenance
An annual service contract can help minimize downtime, maintain production schedules, and keep costs stable and predictable.

### The cost of doing nothing
Show decision-makers the cost of inaction — whether that's slow design and decision processes, too many change orders, a stagnated product line or excess inventory with fewer turns.

> "For our first FDM machine purchase, we projected ROI in 4 years, but it took only 18 months. For our second FDM machine purchase, we saw ROI in only 9 months."
>
> Mitchell Weatherly
> **Sheppard Air Force Base**


# Cost comparison

| | Under $10K | $10 – 50K | $50 – 200K | $200 – 500K |
|---|---|---|---|---|
| FDM Printer | ● | ● | ● | ● |
| PolyJet Printer | | ● | ● | ● |
| SL Printer | | | | ● |
| SAF Printer | | | | ● |
| P3 Printer | | | ● | |

| | Material Costs | | | Time and Labor Requirements | | | Facilities and Equipment | | | Printed Part Cost* (economy of sale for mass-production) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FDM Printer | $ | $$ | | $ | | | $ | | | $ | $$ | $$$ |
| PolyJet Printer | $ | $$ | $$$ | $ | $$ | | $ | $$ | | $ | $$ | $$$ |
| SL Printer | $ | $$ | | $ | $$ | $$$ | $ | $$ | $$$ | $ | $$ | $$$ |
| SAF Printer | $ | $$ | | $ | $$ | | $ | $$ | $$$ | $ | | |
| P3 Printer | $ | $$ | $$$ | $ | $$ | $$$ | $ | $$ | | $ | $$ | |

*Excludes capital expenditure hardware investment costs

# Support and services

When you make the decision to add a 3D printer to your factory or office, consider all factors when deciding which company to partner with. Look for companies with the ability to provide the full range of printing services you will need.

Look for companies that offer design and DFAM consulting as well as a 3D-printed, parts-on-demand service.

If your printer is down for scheduled maintenance, is busy printing another part for your project or you need a part to be printed in a different material, a parts-on-demand service could be the difference between you hitting or missing your deadlines.

Stratasys offers the comprehensive suite of 3D printing services to help you with any printing challenge you encounter.

# Stratasys
# Direct Manufacturing

If you don't have budget for a 3D printer now or you need to demonstrate an ROI model or vet the various options to determine what's best for your organization, Stratasys Direct Manufacturing is the optimal solution for you. Every technology in this guide, and more, is available to you directly from Stratasys Direct Manufacturing.

Stratasys Direct Manufacturing makes it easy for you to "try before you buy." To receive an instant quote and to have Stratasys Direct Manufacturing print your parts, simply upload your CAD file to our intuitive website. We'll print and deliver your parts quickly using your technology and material selections.

If you're not sure which technology and material combinations to try, you can leverage our extensive expertise with 3D printing technologies to help you choose the optimal processes for your application. Using Stratasys Direct Manufacturing is a great way to characterize different solutions and learn more before you buy. Stratasys Direct Manufacturing also specializes in traditional manufacturing technologies. Those traditional manufacturing methods include:

**Urethane casting**
Achieve quality, consistent parts using our low- to mid-volume urethane casting process and get fast turnarounds and consistent delivery with our innovative master pattern production.

**CNC machining**
Get CNC-machined parts quickly with the help of our experienced CNC machinists and streamlined operations.

**Injection molding**
Get large or small quantities of injection-molded parts using our fast tooling methods and near-unlimited material choices.

**Design services**
Achieve designs that leverage the power of the additive manufacturing process. We'll help you modify CAD files for optimized results and an expedited time to market.

Learn more or request a quote at:
**stratasysdirect.com.**

# Expert help is always available

Our network of authorized resellers is extremely knowledgeable and responsive. They are ready to help you find the ideal 3D printing solution for you organization based on your applications, budget and timeline.

Find a reseller at:
**stratasys.com/contact-us/find-a-local-reseller**

Call us at:
**1-800-801-6491**

# Notes

**Stratasys Headquarters**

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)


BG_DU_2021BuyersGuide_0721b