Making the Move to 3D Printing

A Buyer's Guide to Stratasys® 3D Printing Technology

goengineer

stratasys

Buyer's Guide

Contents

Introduction

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. In some cases, things that simply can't be made with conventional tools can be made with a 3D printer. This lets you optimize and create prototypes, tools, medical models and functional parts much more quickly and for a lower cost.

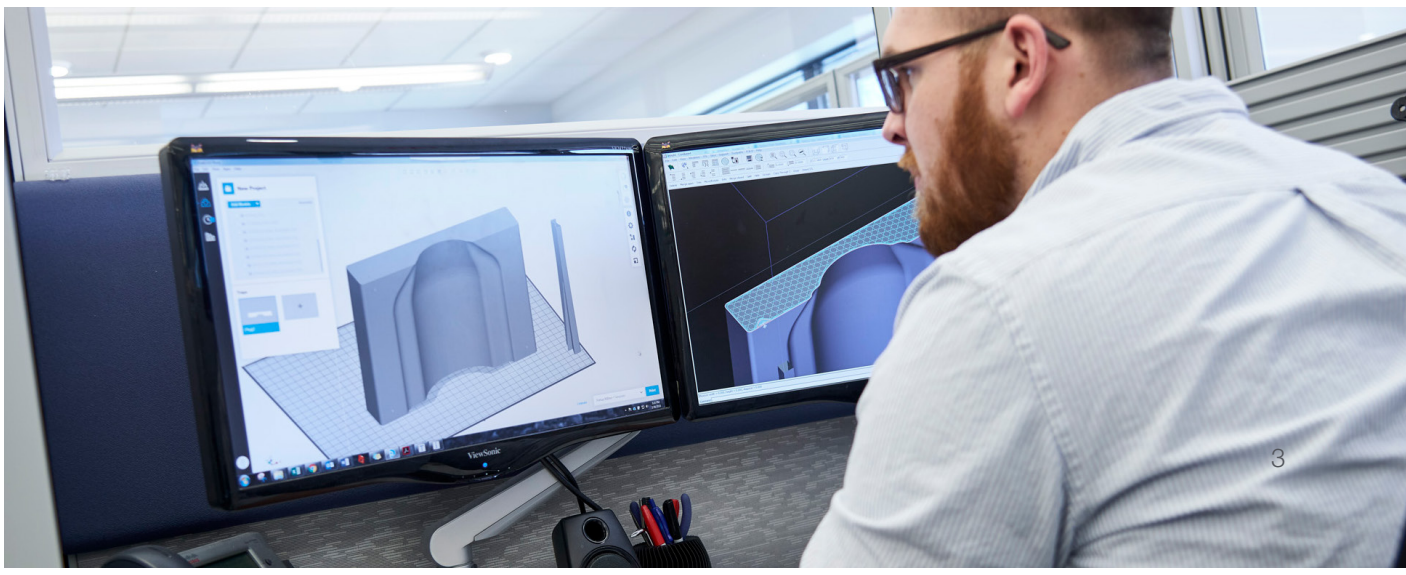
As you begin your search for the right 3D printing solution, this guide will help you understand the questions you'll need to ask as well as provide insight into the technologies, materials and services available to you.

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 an object is made by cutting material away from a solid block to create the desired shape. 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."
>
> Dr. Phil Reeves
> **Vice President, Stratasys Expert Services**



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 Does It Need to Look Like?

Does it need to be realistic? Do you need to print in multiple colors and materials? Do you need to achieve a glossy surface finish? If aesthetics are important, full-color, multimaterial PolyJet printing technology should be a top consideration. If functional performance is a priority, FDM® printers that use durable thermoplastics are an appropriate choice.

What Does It Need to Do?

Will it simply communicate an aesthetic concept, function like your finished product, or actually be the finished product? The use may dictate the need for tighter tolerances or tougher materials.

Where Will It Be Used?

Will it need to stand up to heat or pressure? Will it be used outdoors? Will it be exposed to chemicals? These are just a few factors that will determine your need for specialized material properties like UV resistance, biocompatibility, high heat deflection temperatures and chemical-resistance properties.

How Long Does It Need to Last?

Will you use the part one time, or will it need to withstand repeated use? Some 3D printing materials are very functional over a short period of time and others 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

Find out 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.

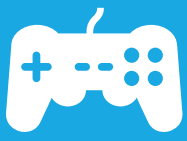
Production-level systems can work with a range of thermoplastics with specialized properties like toughness, electrostatic dissipation, translucence, biocompatibility, UV resistance and high-heat deflection. This makes FDM ideal for a variety of applications ranging from basic proof-of-concept models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

CONCEPT MODELS

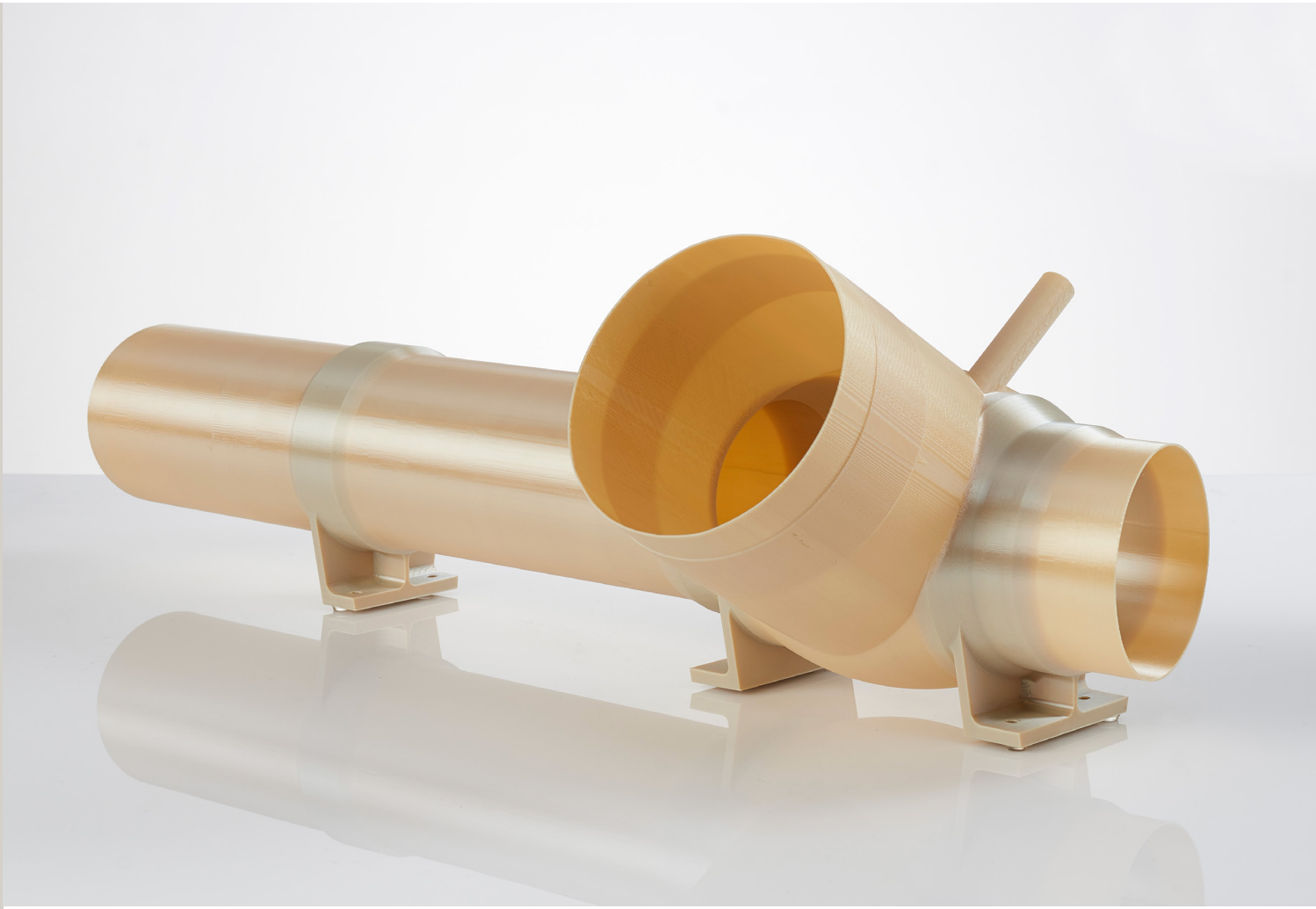
FUNCTIONAL PROTOTYPES

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

JIGS AND FIXTURES

COMPATIBLE MATERIALS

- 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.

> "We use 3D printing technology and materials to create a lifelike vascular environment that isn't achievable any other way."
>
> Mike Springer
> **Director of Operations and Entrepreneurship, Jacobs Institute**

Stereolithography

Stereolithography (SL) 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 SL models when a quick build time is crucial, and they can invest time and resources into additional finishing processes. SL can also produce master patterns for urethane casting, as well as investment casting patterns that are used to produce metal parts for aerospace, automotive, power generation and medical applications.

SL 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, heat-resistant and moisture-resistant materials can also be used when there's a need for flow visualization, light transmittance or thermostability.

CONCEPT MODELS

FUNCTIONAL PROTOTYPES

MOLDS AND PATTERNS

COMPATIBLE MATERIALS

- Photopolymers

SYNONYMS AND SIMILAR TECHNOLOGIES

- SLA
- SL
- Vat photopolymerization

TRAINING REQUIREMENTS

Knowledge of build setup, moderate maintenance, machine operation and finishing, optical delivery systems, and proper hazardous material handling.

FACILITY REQUIREMENTS

A dedicated manufacturing space for machine(s), ventilation and a specialty multi-stage alcohol treatment bath station with containment.

ANCILLARY EQUIPMENT

Post-cure oven, wash stations, hazardous waste disposal and containment, hand finishing tools and equipment, and isopropyl alcohol recycling system.

> “The great thing about SL plastics is that they are strong enough to endure vibration testing to a certain point. We used the SL [camera housing] prototype for water, precision of alignment and vibration testing.”
>
> Marcel Tremblay
> **Director of Mechanical Engineering, FLIR**

Technology Comparison

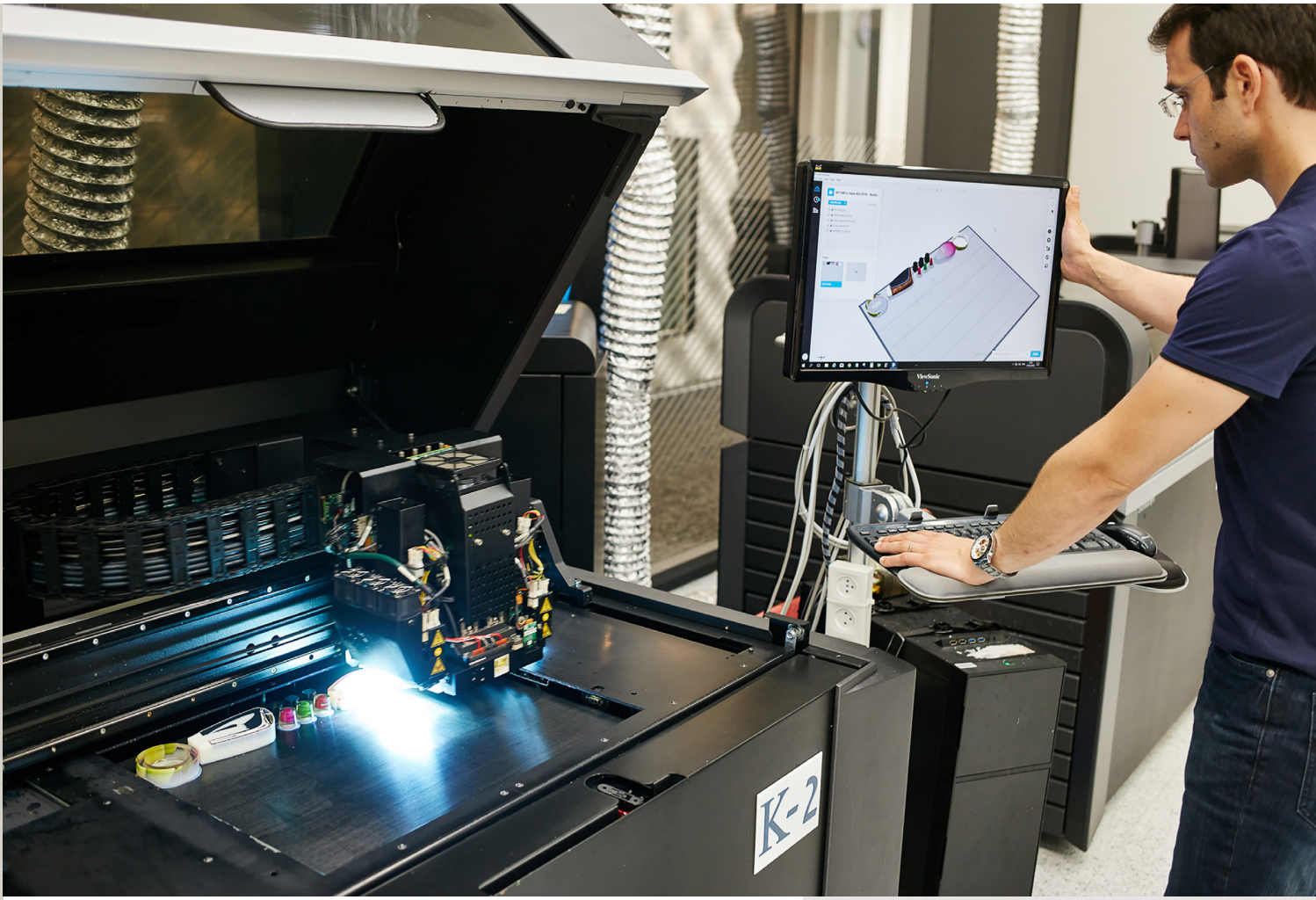
Whether it's FDM, PolyJet or SL, Stratasys 3D printing solves specific design and manufacturing challenges. Compare the optimal characteristics of each technology.

FDM Technology

Layer Resolution OK	●	●			
Thin Walls OK	●	●			
Surface Finish GOOD	●	●	●		
Ease of Use OUTSTANDING	●	●	●	●	●

Strengths
Durability, reliability, familiar materials, easy support removal, office-friendly operation

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

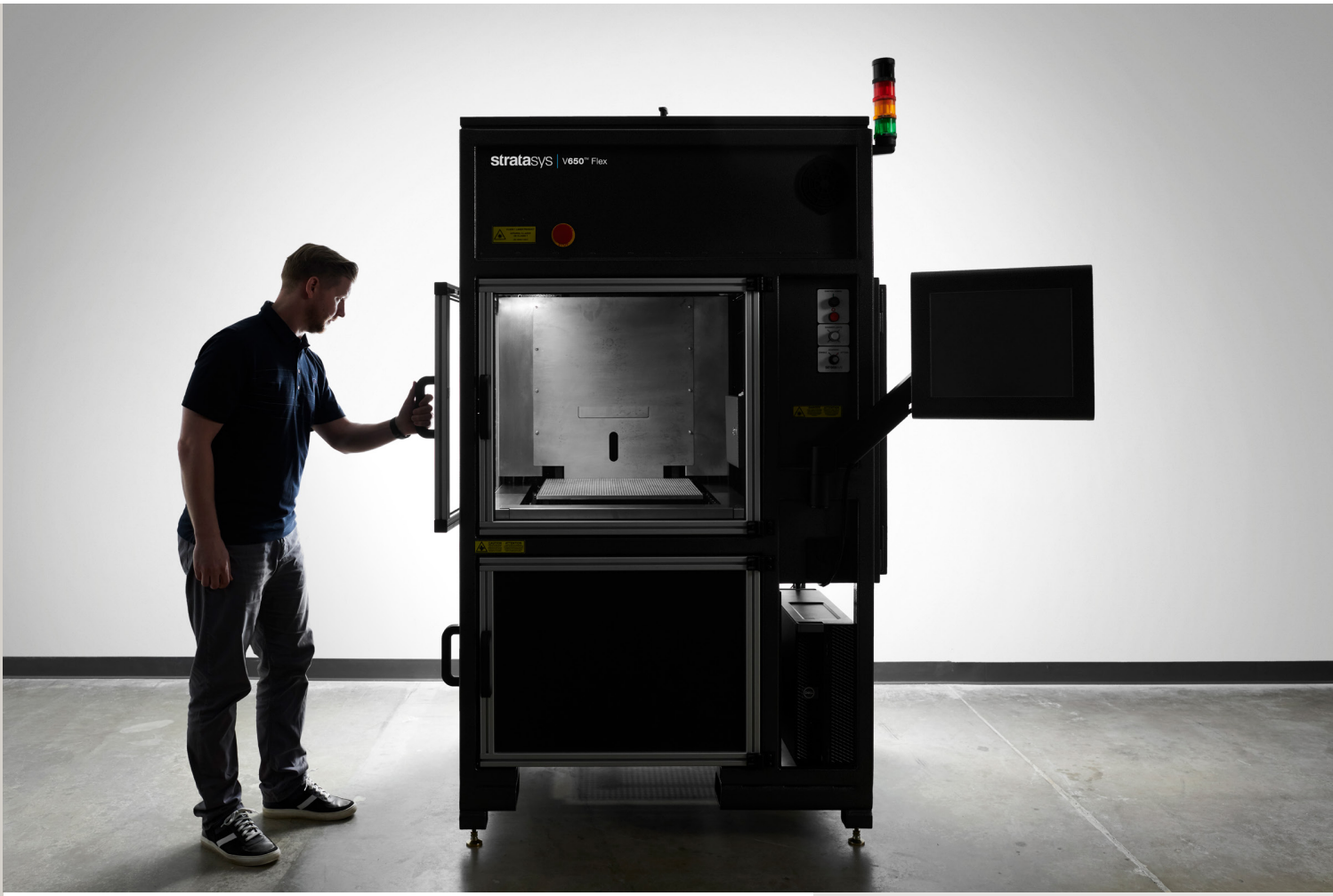


PolyJet Technology

Layer Resolution OUTSTANDING	●	●	●	●	●
Thin Walls OUTSTANDING	●	●	●	●	●
Surface Finish OUTSTANDING	●	●	●	●	●
Ease of Use VERY GOOD	●	●	●	●	

Strengths
Realism, versatility, easy support removal, office-friendly operation

Weaknesses
UV-sensitive, not optimal for functional prototyping



Stereolithography

Layer Resolution VERY GOOD	●	●	●	●	
Thin Walls OUTSTANDING	●	●	●	●	●
Surface Finish OUTSTANDING	●	●	●	●	●
Ease of Use GOOD	●	●	●		

Strengths
Precision, surface smoothness

Weaknesses
UV-sensitive, extra post-curing steps, not as office-friendly as FDM and PolyJet

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

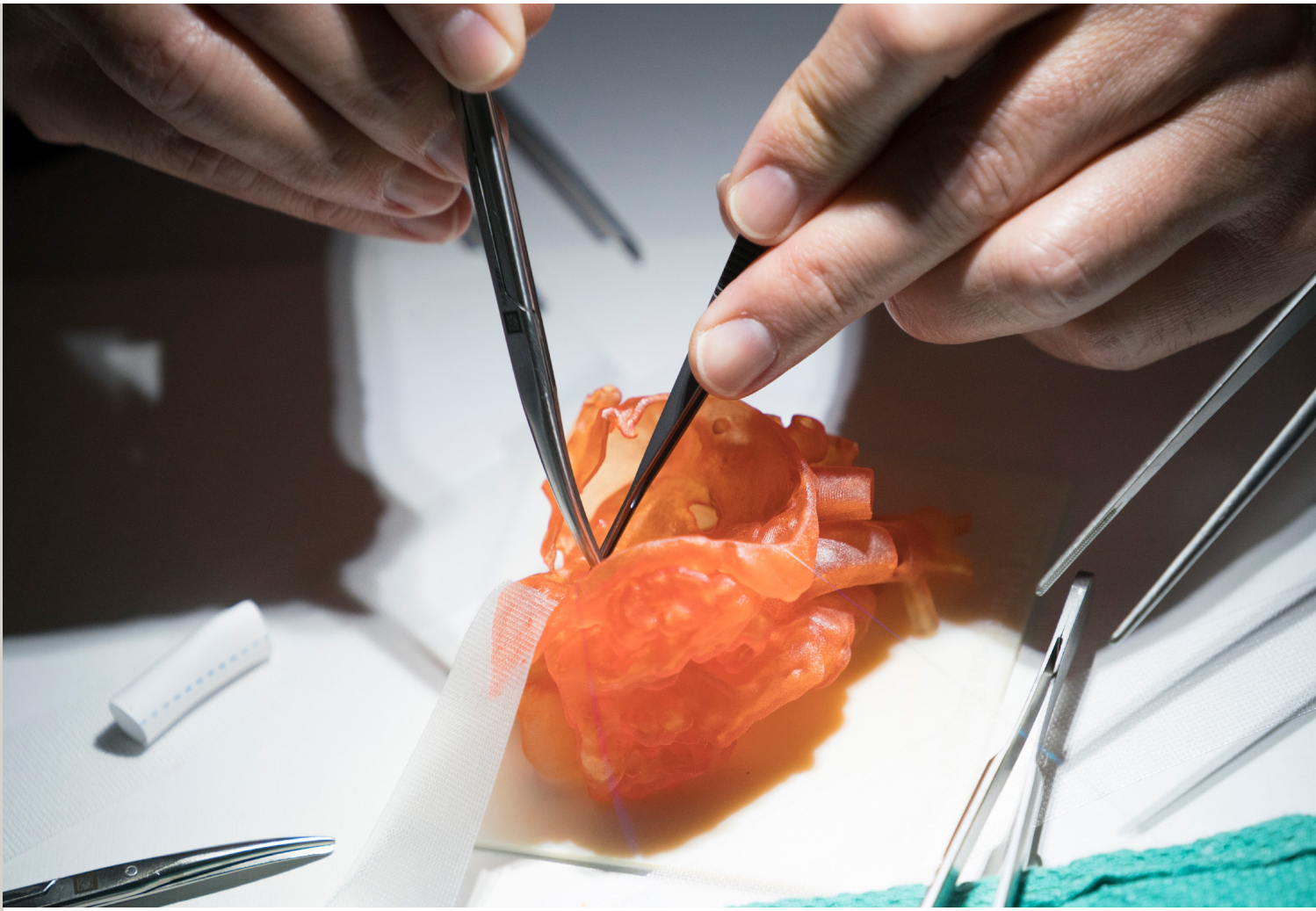
For applications that require higher heat resistance, chemical resistance, impact strength, fire retardancy or mechanical strength, production-level 3D printers work with specialized plastics that meet stringent engineering requirements.

High-Performance Plastics

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

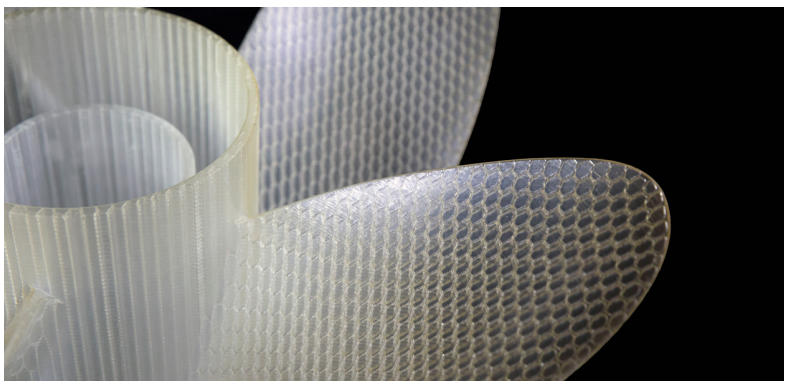
Printing Methods

FDM Technology



Photopolymers

Photopolymers are liquid resins that cure upon exposure to UV light. They're available in clear, grey and white opaque as well as a special formulation for investment casting patterns, and produce a smooth, beautiful finish. However, they are UV-sensitive and not as durable as production-grade thermoplastics.



Printing Methods

Polyjet Technology

Stereolithography

Cost of Ownership

If you're considering bringing 3D printing in-house, learn about each of 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 and PolyJet 3D printers can be installed in any office environment, while SL printers have special requirements.

Labor
All FDM and PolyJet printers are easy to use and don't require extensive training. SL 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 too many change orders or a stagnating product line.

> "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**

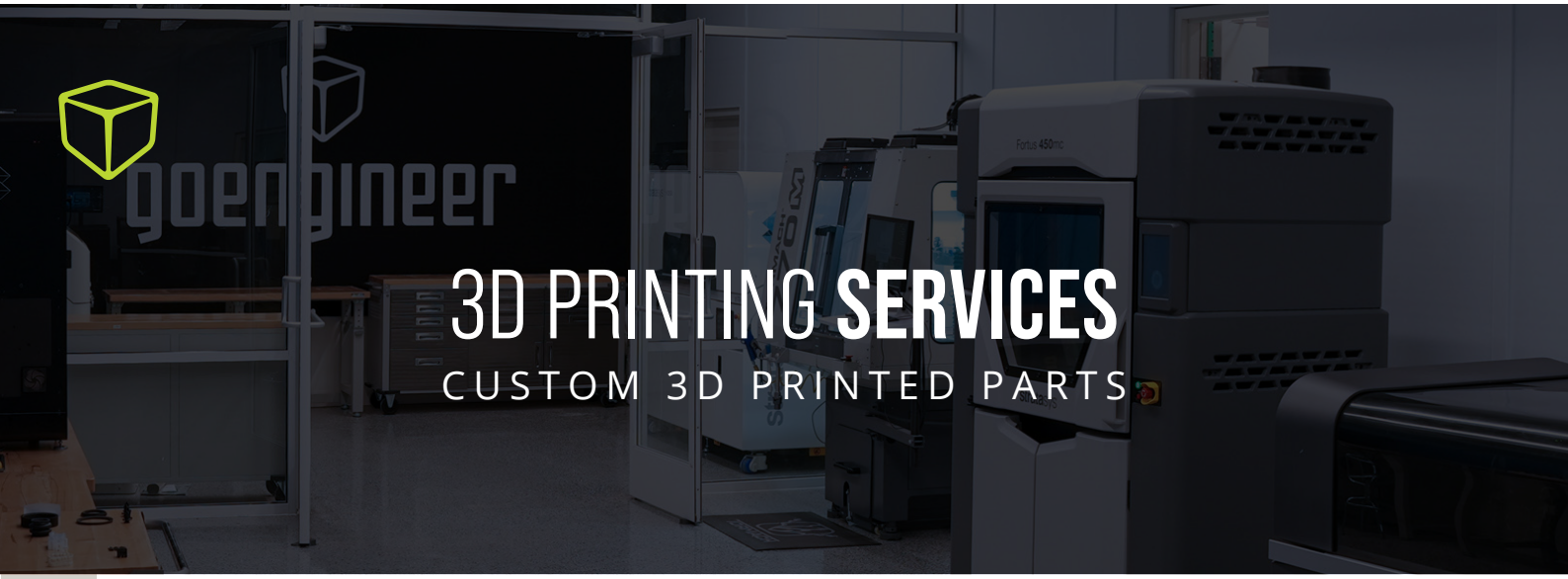
Cost Comparison

	Under $10K	$10-50K	$50-200K	$200-500K
FDM Printer	●	●	●	●
PolyJet Printer		●	●	●
SL Printer				●

	Material Costs			Time and Labor Requirements			Facilities and Equipment		
FDM Printer	$	$$		$	$$		$	$$	$$$
PolyJet Printer	$	$$	$$$	$	$$	$$$	$	$$	$$$
SL Printer	$	$$		$	$$	$$$	$	$$	$$$

Support and Services

When you make the decision to embrace 3D printing, consider all you're getting. Look for companies with the capability to provide the support you'll need, now and in the future. From consulting to rapid prototyping to on-demand parts, Stratasys offers a wide range of 3D printing services at every stage of the process.



3D PRINTING **SERVICES**

CUSTOM 3D PRINTED PARTS

Whether you need a quick prototype for testing or a full-functioning production part, GoEngineer's 3D printing services team can help you. Our 3D printing labs located throughout the U.S. contain the latest additive manufacturing technologies for printing FDM, PolyJet, SLA, and metal materials.

10,000+ PARTS

Our 3D printing service bureau has been printing parts since 1999 and produces hundreds of parts per month for businesses throughout the U.S.

24/7 PRINTING

Stratasys 3D printers can handle large print jobs for days or weeks at a time. No matter the size of your order, we can ensure the job will get done by your deadline.

50+ MATERIALS

Our labs are equipped with the latest technology in Additive Manufacturing. We can produce parts in FDM, PolyJet, SLA and Metal technologies, with over 50+ materials.

FULL PANTONE

Ensure your prototype looks and feels as realistic as possible with Stratasys 3D printing technology. Get access to full-pantone palette options to bring your prototype to life.

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stratasys DIAMOND PARTNER

Customers rate their support from GoEnginner:

98% EXCEPTIONAL

2% Satisfactory

#1 RESELLER
STRATASYS AND SOLIDWORKS

We really appreciate the training you provided... It was incredible and everyone felt that it was a very worthwhile experience.

Trong B.

Dryden Flight Research NASA

Your help took minutes, but moved my project forward immensely.

Samuel A Morgan

ADVANCED CERAMICS MANUFACTURING

22 MILLION +
YOUTUBE CHANNEL VIEWS

60 OFFICES
ACROSS THE UNITED STATES

100+ CERTIFIED TECHNICAL

WORLD CLASS SUPPORT

Everyone on your support team has always given great tech support when I have called - Thanks!

Brian M.

ThermoGenesis

"3D printing helped me take somebody from being inoperable to operable, and we saved her life."

Raymond P. Burke, M.D.
Cardiovascular Surgery

Nicklaus Children's Hospital

"We're extremely grateful to have GoEngineer as the service vendor for our Stratasys machine! They have been nothing short of excellent in all of our communications with them. Thank you for supporting the work we do here at NASA."

Alex Mazhari

NASA

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