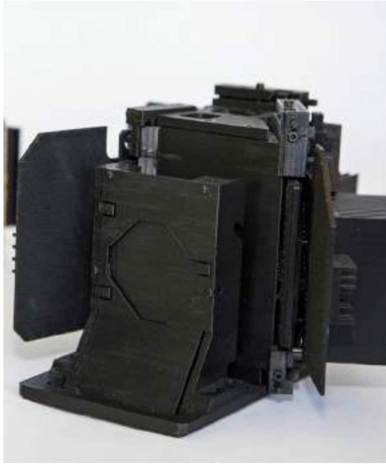
RESEARCH GUIDE

3D PRINTING SOLUTIONS

MATERIALS, TECHNOLOGIES AND PRINTERS: HOW TO MAKE THE RIGHT CHOICE FOR YOUR ORGANIZATION AND USE CASE



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INTRODUCTION

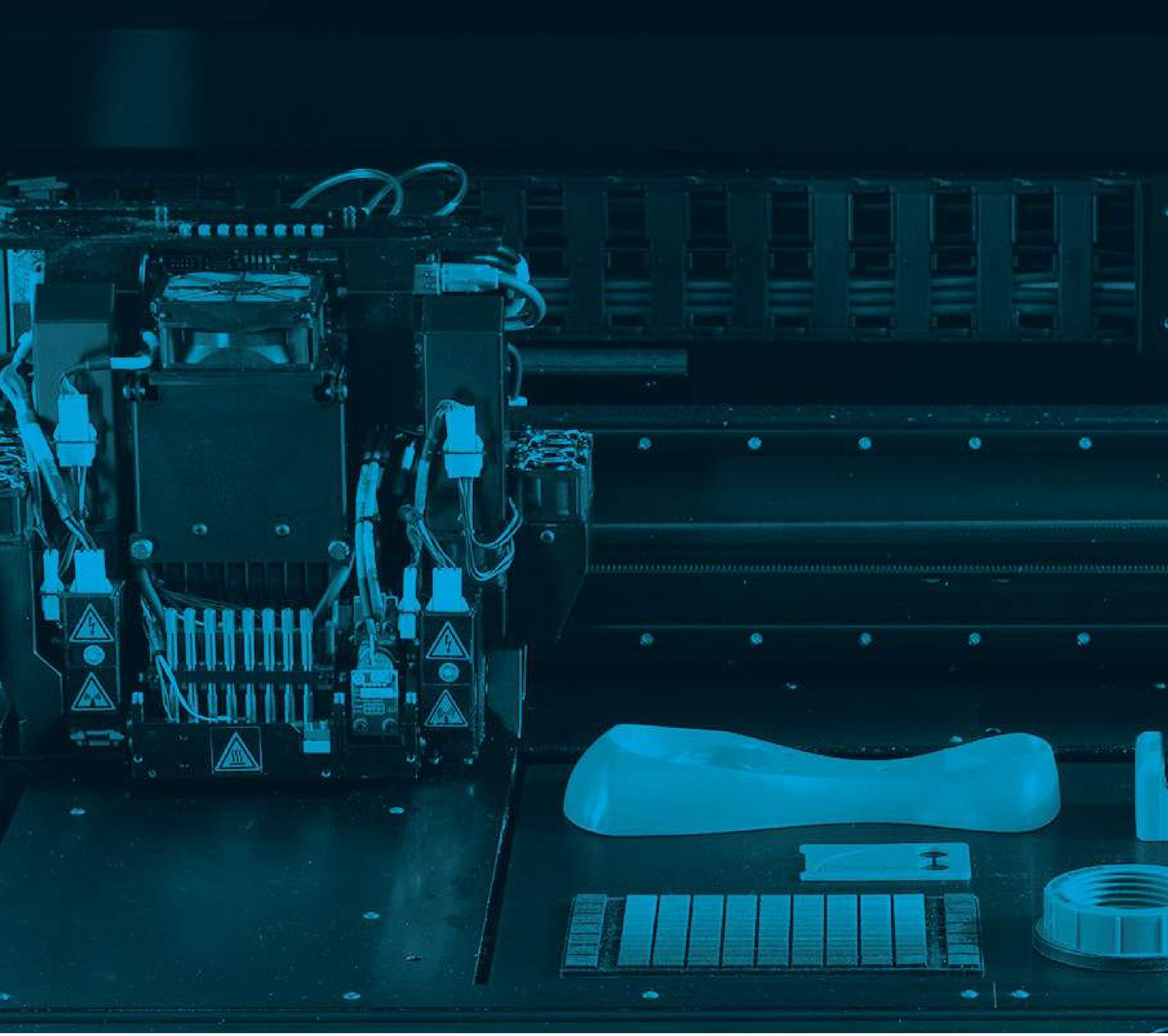
Are you a part of an engineering team that needs to bring products to market faster? Are you a product designer striving for greater innovation or customization? Or are you an educator who wants to boost engagement with exciting classroom projects?

No matter what sparked your interest in professional 3D printing, this guide can be your starting point. We'll help you ask the right questions while offering enough information about each technology and material to set you on the right path.

"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

CONTENTS



TECHNOLOGIES

In this section, you'll learn how each technology works, where it excels, and what materials are available. Because 3D printing is an area of constant change and rapid innovation, we'll cover what we know best: technologies and materials developed at Stratasys and those we've adopted to service the diverse needs of our customers.

WHAT WILL YOU 3D PRINT?

- FDM
- POLYJET
- STEREOLITHOGRAPHY
- LASER SINTERING
- METAL POWDER BED FUSION

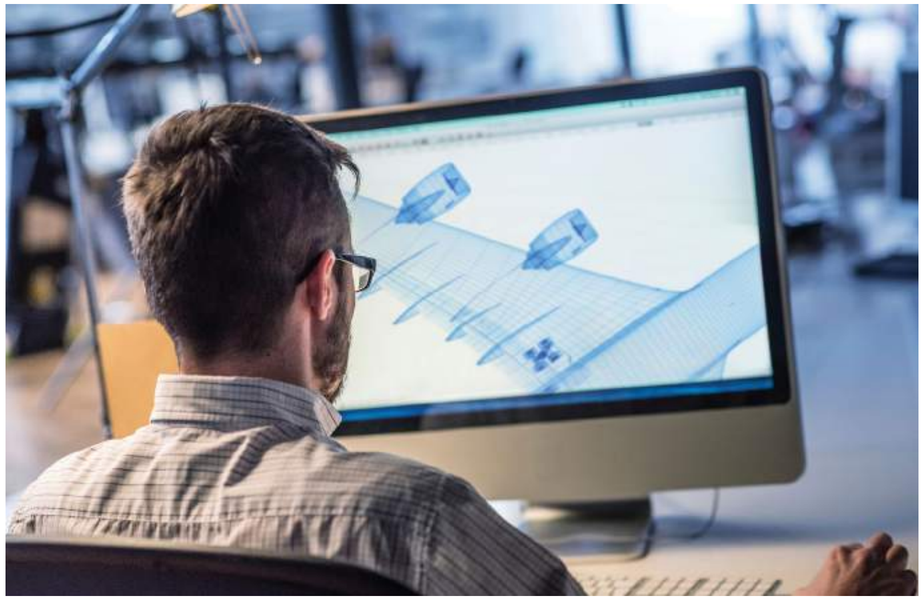
QUESTIONS TO GUIDE RESEARCH

WHAT IS YOUR GOAL?

Identify the primary problem you want to solve, and use it as a lens to guide your research. Professional 3D printing encompasses a wide range of materials, technologies and capabilities. By keeping your ultimate goal top-of-mind, you can stay focused on what's relevant and avoid information overload.

EXAMPLE GOALS:

- I want to test more design ideas in less time.
- I want to explain my ideas to colleagues or investors more clearly.
- I want to lead exciting classroom projects that promote sustained student engagement or foster interest in STEM subjects.
- I want to improve customization for products I already produce.
- I want to produce something that has proven impossible or impractical with other manufacturing methods.
- I want to create custom objects for use as tools, controls or variables in academic research.
- I want to support other manufacturing or production processes.
- I want to produce functional prototypes to correct errors and make improvements earlier in the design process.



In-house or outsource? We'll help you weigh your options.

WHAT WILL YOU 3D PRINT?

If you already know what you want to 3D print, ask yourself how it needs to look, what it needs to do, where it needs to function and how long it needs to last. Consider those requirements as you assess each technology and material.

What does it need to look like?

If aesthetics are important, consider both the materials you'll need and the steps you'll have to take to get the desired result.

- Does it need to be realistic, and what does that mean to you?
- Do you need to print in multiple colors and materials?
- Do you need to achieve the glossy surface finish of an injection molded product?

What does it need to do?

The use may dictate the need for tighter tolerances or tougher materials.

- Will it simply communicate an aesthetic concept, or will it need to function like your finished product?
- Will it need to hinge, snap, or bear a load?

Where does it need to function?

These factors will determine your need for specialized material properties like UV resistance, biocompatibility, or high heat-deflection temperatures.

- Will it need to stand up to heat or pressure?
- Will it be used outdoors?
- Will it be in prolonged contact with the human body?

How long does it need to last?

Some 3D printing materials are very functional over a short period of time and others can maintain their mechanical properties for years.

- Will you use the part one time, or will it need to withstand repeated use?

CONCEPT MODELS
FULL-COLOR MODELS
MULTI-MATERIAL MODELS
FUNCTIONAL PROTOTYPES
MOLDS AND PATTERNS
JIGS AND FIXTURES
PRODUCTION PARTS

"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 printer and they now constitute an integral part of our design and manufacturing process."

Piero Giusti, R&D CAD Manager, Ducati

FDM Technology

Synonyms and similar technologies: fused deposition modeling, fused filament fabrication, plastic jet printing, filament extrusion, fused filament deposition, material deposition.

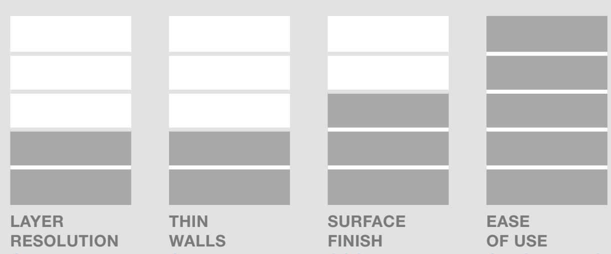
FDM systems and related technologies are by far the most accessible and widely used form of 3D printing, with variations found at the consumer level, the industrial level, and everywhere in between. 3D printers based on FDM technology build parts layer-by-layer from the bottom up by heating and extruding thermoplastic filament, most commonly, ABS.

Production-level systems work with a range of standard, engineering and high-performance thermoplastics with specialized properties like toughness, electrostatic dissipation, translucence, biocompatibility, UV resistance, and high heat deflection. This makes FDM ideal for a range of applications from classroom projects and basic proof-of-concept models to lightweight ductwork installed on commercial aircraft.

FDM works for a wide variety of applications from concept models to demanding production parts.

While it can't produce microscopic layer lines, FDM offers a choice between speed and resolution. Choosing coarser layers means larger parts can be built more quickly.

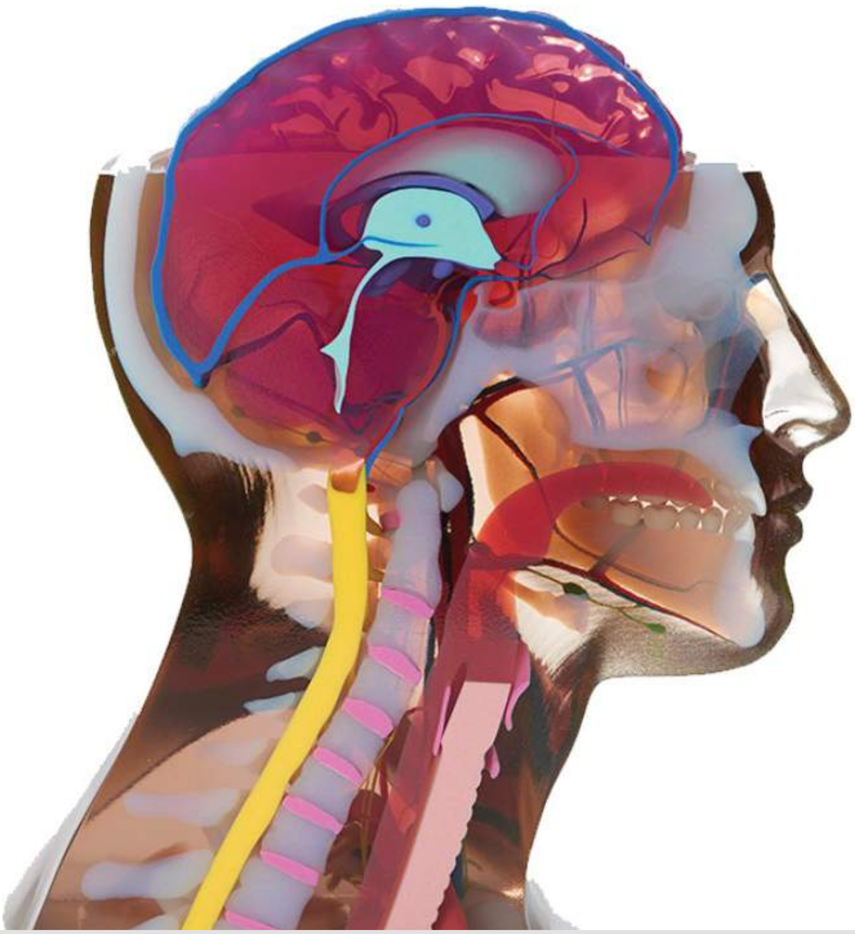
FDM PERFORMANCE SCALE



Support: Soluble, breakaway

- ⊕ Durability, reliability, familiar materials, easy support removal, office-friendly operation.
- ⊖ Visible layer lines, anisotropic strength (weaker along layer lines)

CONCEPT MODELS · FULL-COLOR MODELS · MULTI-MATERIAL MODELS · FUNCTIONAL PROTOTYPES · MOLDS AND PATTERNS · JIGS AND FIXTURES · PRODUCTION PARTS



> "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*

PolyJet Technology

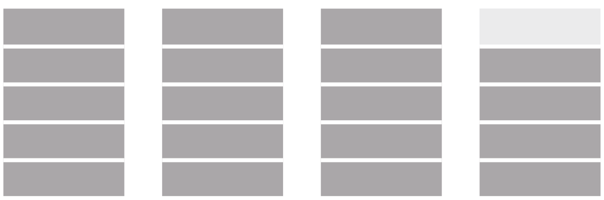
Synonyms and similar technologies: multijet printing, photopolymer jetting

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 in a flash of 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 plastics and rubber to human tissue — and produce a full gamut of colors. Product designers use PolyJet models when end-product realism is the key to gaining useful feedback from colleagues, clients, sponsors or investors. But the versatile technology is also proven irreplaceable in specialized applications ranging from injection molding to Hollywood special effects to surgery-planning models.

Compare office-friendly technologies: FDM and PolyJet.

POLYJET PERFORMANCE



LAYER RESOLUTION: OUTSTANDING
THIN WALLS: OUTSTANDING
SURFACE FINISH: OUTSTANDING
EASE OF USE: VERY GOOD

Support: Soluble, water jet

+ Realism, versatility, easy support removal, office-friendly operation.

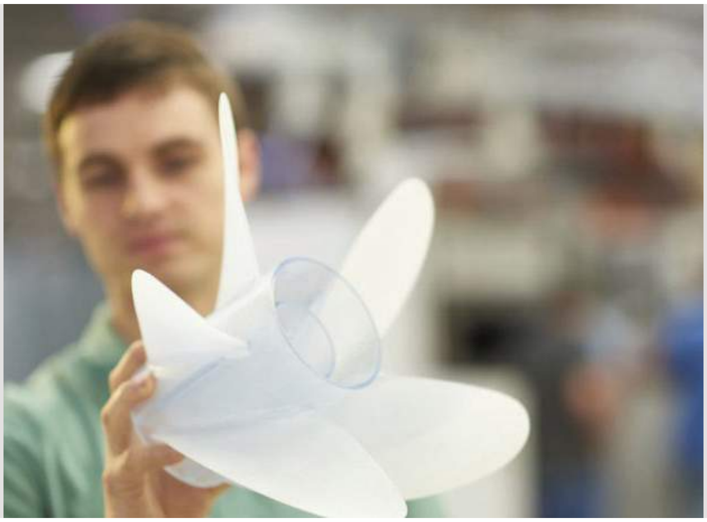
− UV-sensitivity

CONCEPT MODELS
FULL-COLOR MODELS
MULTI-MATERIAL MODELS
FUNCTIONAL PROTOTYPES
MOLDS AND PATTERNS
JIGS AND FIXTURES
PRODUCTION PARTS

Stereolithography

Synonyms: SLA, vat photopolymerization

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. It uses a UV laser to cure and solidify fine layers of photopolymer in an open vat.



SL PERFORMANCE SCALE

LAYER RESOLUTION
VERY GOOD

THIN WALLS
OUTSTANDING

SURFACE FINISH
OUTSTANDING

EASE OF USE
GOOD

Support: Breakaway

⊕ Precision, surface smoothness

⊖ UV-sensitivity, extra post-curing steps

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 are also attractive for medical, automotive and other prototypes that call for flow visualization, light transmittance or thermostability.

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, and investment casting patterns that are used to produce metal parts for aerospace, automotive, power generation and medical applications.

Compare photopolymer technologies: Stereolithography and PolyJet

> "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*

CONCEPT MODELS

FULL-COLOR MODELS

MULTI-MATERIAL MODELS

FUNCTIONAL PROTOTYPES

MOLDS AND PATTERNS

JIGS AND FIXTURES

PRODUCTION PARTS

"Originally, we would hand-build [UAV] ailerons, and it would take about 24 manhours each. When we had them grown in LS through Stratasys Direct Manufacturing, we had the ailerons designed, built and assembled on the UAV in three days. LS ... is efficient and, from an aesthetic standpoint, produces parts that are gorgeous."

Dr. Nicholas Alley, CEO, Area-I

Many of these chrome interior details were created with laser sintering technology. Parts were electroplated to achieve a shiny metallic finish.

Laser Sintering

Synonyms: selective laser sintering, SLS, powder bed fusion

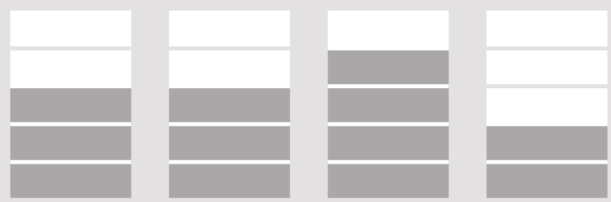
Laser Sintering (LS) excels at building components with good mechanical properties and extremely complex geometries, including interior features, undercuts, thin walls or negative draft. It builds parts using a high-powered CO_2 laser to selectively melt and fuse powdered thermoplastics.

LS parts can be created from a range of powdered polyamide materials, including nylon 11, nylon 12, and polyamides with various fillers, like carbon fiber or glass spheres, to enhance their mechanical properties. The resulting parts are comparable to those produced with traditional manufacturing methods, and can be watertight, airtight, heat resistant, and flame retardant.

Compare plastic-melting technologies: FDM and LS

LS is a great option when the geometric complexity of a part makes it difficult to produce through other processes or when the anticipated production volume doesn't justify the time and expense of tooling.

LS PERFORMANCE



LAYER RESOLUTION: GOOD

THIN WALLS: GOOD

SURFACE FINISH: VERY GOOD

EASE OF USE: OK

Support: None

⊕ Tough materials, isotropic properties (equally strong in all directions)

⊖ Limited material options, complex operation, extra steps to change materials and post-process parts, not office friendly

CONCEPT MODELS

FULL-COLOR MODELS

MULTI-MATERIAL MODELS

FUNCTIONAL PROTOTYPES

MOLDS AND PATTERNS

JIGS AND FIXTURES

PRODUCTION PARTS

"This surgical tool has turned our vision of transforming ACL reconstruction into a reality faster, and someday will hopefully eliminate repeat knee injuries to keep more athletes off the bench and on the field."

Dr. Dana Piasecki, Orthopedic Surgeon, DanaMed

DanaMed's surgical tool was produced at Stratasys Direct Manufacturing with INCONEL 718.

MPBD makes low-volume production feasible for complex metal parts. It can produce thin walls and other features that are difficult or cost-prohibitive to machine or cast.

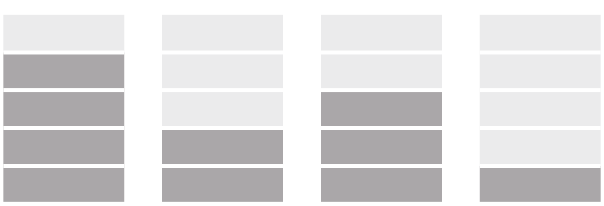
Metal Powder Bed Fusion

Synonyms: metal powder bed sintering, MPBD, selective laser melting, metal laser melting and direct metal laser melting

Metal powder bed fusion (MPBF) can produce complex geometries not possible with other metal-manufacturing processes. Using a precise, high-wattage fiber laser, it micro-welds powdered metals and alloys to form fully functional components that are comparable to their wrought counterparts.

Additive metals like ICONEL®, aluminum, stainless steel, and titanium create strong and durable parts with hard-to-achieve features like internal cavities, conformal features, thin walls, internal cavities, undercuts and interlocking components. These capabilities are ideal for prototypes and low-volume parts that need to be consolidated or customized, ruling out traditional processes like machining and casting.

METAL POWDER BED FUSION PERFORMANCE



LAYER RESOLUTION VERY GOOD

THIN WALLS OK

SURFACE FINISH GOOD

EASE OF USE POOR

Support: Metal

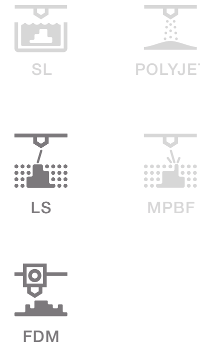
⊕ Compared with machining, MPBS produces complex parts more cost-efficiently, creates less waste, and consumes less energy.

⊖ Requires a production environment with specialized equipment and skilled labor for support removal and finishing.

MATERIALS

If you already you how your part needs to look, what it needs to do, where it needs to function and how long it needs to last, you've got most of the criteria you need to select a suitable 3D printing material. We we won't cover every material there is, but we'll address the most popular plastics, photopolymers and metals used for professional prototyping and production applications.

CONTENTS



MATERIALS
STANDARD PLASTICS

"Dimensional accuracy and dimensional stability were critical for the design verification. The FDM system, with its ABS plastic, gave us both."

Tae Sun Byun, Principal Research Engineer, Hyundai Mobis

The handle and blade guard on this prototype were 3D printed with ABS plastic.

This rake was 3D printed with strong, UV-stable ASA thermoplastic.

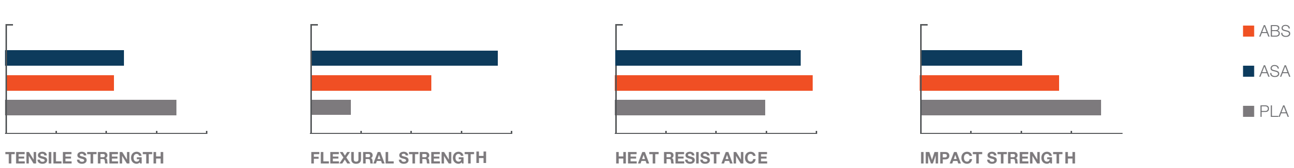
Standard Plastics

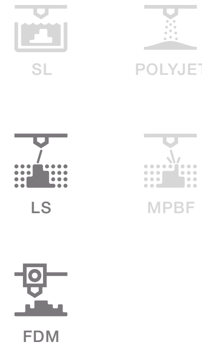
The most widely used category of 3D printing materials includes some of the same general-purpose plastics found in mass-production processes like injection molding. Production-level FDM systems work with several formulations of ABS thermoplastic that have specialized properties like electrostatic dissipation, translucency and biocompatibility. They also work with ASA for applications that need better aesthetics or UV-resistance.

3D printed parts will bear many similarities to their injection-molded counterparts, so you can accurately test form, fit and function before investing in tooling. While you should evaluate each material based on the mechanical, thermal, electrical, chemical and environmental properties you require, you can also leverage what you already know about these familiar plastics.

Find detailed specifications at stratasysdirect.com/materials

STANDARD PLASTICS

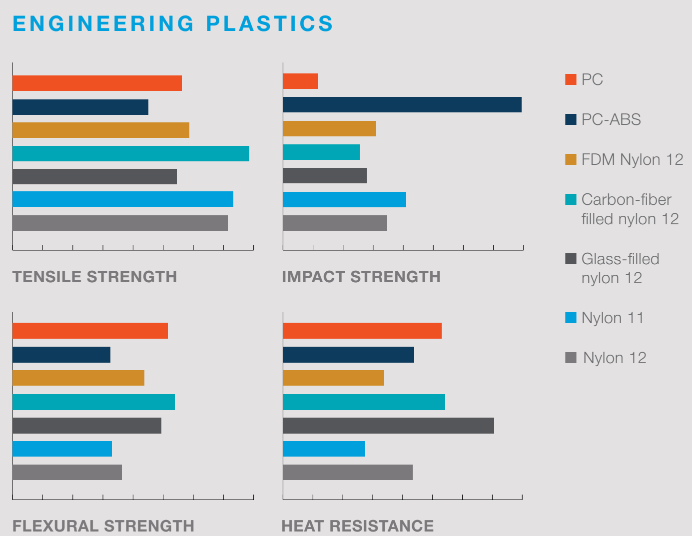




> "The PC-ABS material provides 70% of the strength of production ABS, so it's strong enough for nearly every prototype. Just as important, we've found the system provides accuracies of +/-0.001 inch per inch which is sufficient for almost every prototype."
>
> *Randy Larson, Fabrication Shop Supervisor, Polaris*

Engineering Plastics

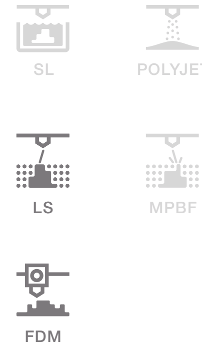
For applications that require higher heat resistance, chemical resistance, impact strength, fire retardancy or mechanical strength, production-level 3D printers work with specialized plastics that meet stringent engineering requirements.



FDM works with one of the most widely used industrial thermoplastics, PC, as well as impact-resistant PC-ABS, biocompatible PC-ISO, and fatigue-resistant FDM Nylon 12™.

LS works with standard nylon 11 and nylon 12 materials and a variety of reinforced polyamides with specialized properties like improved tensile strength, heat resistance, biocompatibility, rigidity or electrostatic dissipation. Specific formulations are FST rated for use in automotive and aerospace applications, or FDA certified for food contact.

Find detailed specifications at stratasysdirect.com/materials



"The rugged factory environment often puts high demands on 3D printing materials and based on our experience, ULTEM™ 1010 [resin] is fully capable of meeting the challenge."

Larry Crano, Automation Specialist
UTC Aerospace Systems

High-Performance Plastics

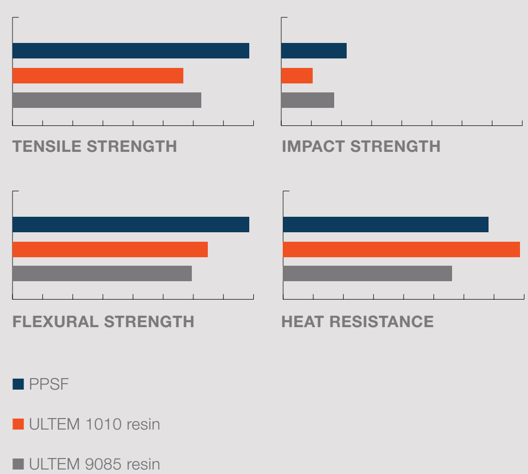
High-performance plastics offer the greatest temperature stability, chemical stability and mechanical strength for the most demanding engineering applications.

Production-level FDM systems work with autoclave-sterilizable PPSF, FST-rated ULTEM 9085 resin and biocompatible ULTEM 1010 resin. ULTEM 1010 resin is available with food-contact and bio-compatibility certifications, and ULTEM 9085 resin can be produced to meet strict aerospace-industry requirements or custom specifications.

LS technology can also be modified to work at the elevated temperatures needed to build parts from PEKK. This material resists chemical deterioration and damage while maintaining good flexural and compressive strength at temperatures higher than typical nylon-based LS parts can sustain.

Find detailed specifications at stratasysdirect.com/materials

HIGH-PERFORMANCE PLASTICS



SL POLYJET
LS MPBF
FDM

> "The first time the entrepreneur sees his idea and feels it in his hands is a crucial moment. We need to give him the most realistic prototype possible."
>
> *Michael Librus, CEO, Synergy*

SL has empowered doctors at the Texas Cardiac Arrhythmia Institute to create accurate models of their patients' hearts before performing surgery.

Find detailed specifications at stratasysdirect.com/materials

Photopolymers

Photopolymers are liquid resins that cure upon exposure to ultraviolet (UV) light. Stereolithography (SL) works with single photopolymers that mimic the properties of common thermoplastics like ABS, polycarbonate and polypropylene. They are available in clear, grey and white opaque as well as a special formulation for investment casting patterns.

PolyJet technology can additionally simulate polypropylene, and can even mimic ABS by combining a heat-resistant photopolymer with another that has superior toughness. In fact, this ability to jet multiple photopolymers means PolyJet can mimic a wide range of materials in a single model. For realistic effects, PolyJet can combine rigid, rubberlike, heat-resistant, transparent and opaque materials to produce parts with varied color, opacity, hardness, flexibility or thermal stability – and the most advanced system can even produce a photorealistic gamut of colors.

Photopolymers are smooth and beautiful, so they're excellent for prototyping and work well for certain tooling applications, too. However, they are UV-sensitive and not as durable as production-grade plastics.

VERSATILE MATERIAL CHARACTERISTICS

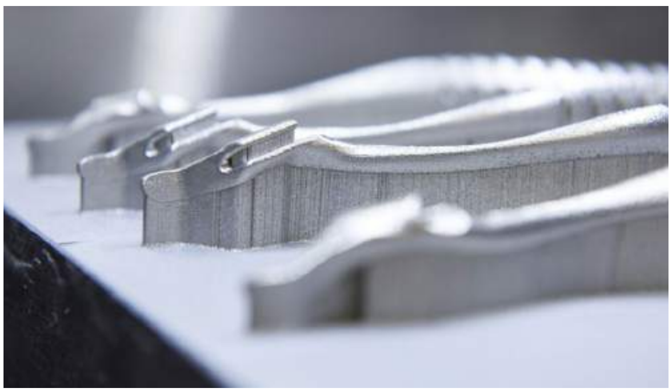
MATERIAL SIMULATIONS	POLYJET	SL
ABS	•	•
POLYPROPYLENE	•	•
PC	–	•
RUBBER	•	–
MULTIPLE MATERIALS IN A SINGLE BUILD	•	–
PLANT AND ANIMAL TISSUE	•	–

MATERIAL PROPERTY	POLYJET	SL
BIOCOMPATIBLE	•	•
HEAT RESISTANT	•	•
TRANSPARENT	•	•

MATERIALS
METALS

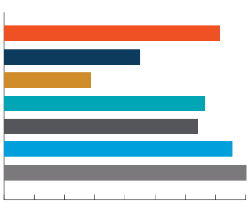
"Being able to make design changes and 3D print new tools within days was extremely important to helping us perfect the design. We could get feedback from a doctor, make design adjustments and send an updated [tool] within a week – something we wouldn't be able to do with investment casting or injection molding."

Jim Duncan, CEO, DanaMed, Inc.

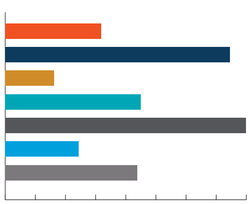


DanaMed's surgical tool before support removal and finishing.

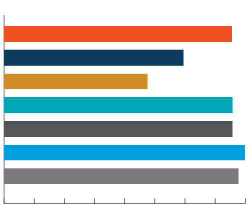
METALS



ULTIMATE TENSILE STRENGTH



ELONGATION



HARDNESS

- Stainless Steel 17-4 PH
- Stainless Steel 316L
- Aluminum (AlSi10Mg)
- ICONEL 718
- ICONEL 625
- Titanium (Ti64)
- Cobalt Chrome (CoCr)

Metals

Some 3D printing applications require specialized properties that only metals can deliver. When a high-performance thermoplastic won't suffice, additive metals and alloys deliver dense, corrosion-resistant and high-strength parts that can be heat treated and stress relieved.

INCONEL, titanium and cobalt chrome are best-suited for demanding production applications that require high tensile strength. But when speed is key, parts can be built faster with aluminum than with any other additive metal. And while it also has good mechanical properties, that quick build time has made it a favorite for metal prototypes. Additionally, multiple stainless steel compositions offer good weldability and corrosion resistance.

As with any material, understanding the differences between various metal compositions with similar properties will be an important step when picking a metal for your project.

Find detailed specifications at stratasysdirect.com/materials

OPERATIONS

While you may have identified the ways your organization could benefit from 3D printing, the path to operational implementation may not be clear. Do you buy one 3D printer? Do you establish a 3D printing lab? Do you order parts on-demand? Each route has its unique benefits depending on your business objectives. In this section, we'll explain the skills, equipment and facilities required for each technology, so you can gauge organizational readiness, and assess what makes sense from an operations perspective.

CONTENTS

QUESTIONS TO GUIDE RESEARCH

WHAT IS YOUR ULTIMATE OPERATIONAL GOAL?

Consider the primary business drivers for bringing 3D printing to your organization, and keep them top-of-mind as you assess potential paths to implementation.

EXAMPLE OPERATIONAL GOALS:

- We need to go to market faster.
- We need to shorten the design cycle.
- We want to attract industry partners to work with our school.
- We need to attract bright employees, students or faculty.
- We need to better customize products we already produce.
- We need to emphasize innovation in our company.
- We want to promote an entrepreneurial culture.

WHAT SKILLS DO YOU HAVE IN HOUSE?

Bringing 3D printers in-house will require some training – and some technologies may even call for hiring new talent. For FDM and PolyJet technologies, Stratasys offers training online or in-person through instructor-led courses, webinars and e-learning modules. We're also working with colleges and universities worldwide to prepare the next generation of designers, engineers and technicians.

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 ENVIRONMENT 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.

FDM

Train on build setup, minor maintenance, machine operation and finishing.

POLYJET

Train on build setup, minor maintenance, machine operation and finishing.

LASER SINTERING

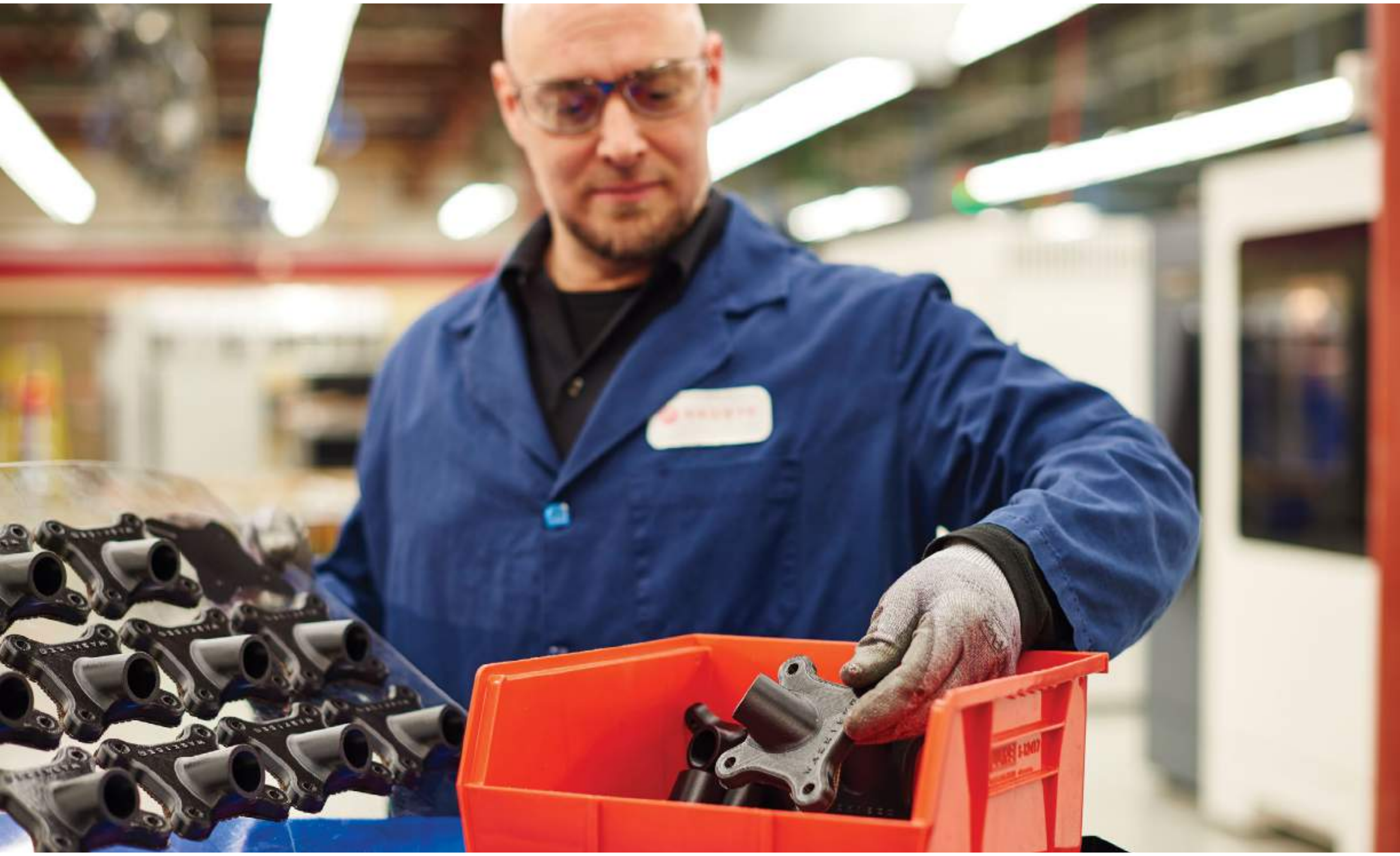
Train on build setup, moderate maintenance, machine operation and finishing; significant technical acumen in materials behavior and optical delivery systems; knowledge of heat transfer principles will be valuable.

STEREOLITHOGRAPHY

Train on build setup, moderate maintenance, machine operation and finishing; knowledge of optical delivery systems; proper hazardous material handling.

METAL POWDER BED FUSION

Train on build setup, moderate maintenance, machine operation and finishing; knowledge of optical delivery systems, advanced hazardous material handling. Engineering or science degree is a prerequisite. Emphasis on mechanical engineering and metallurgy is suggested.



FDM

Any air-conditioned environment; dedicated space, ventilation and compressed air for larger 3D production systems that process engineering and high-performance plastics.

STEREOLITHOGRAPHY

Dedicated manufacturing space for machine(s); ventilation; specialty multi-stage alcohol treatment bath station with containment.

POLYJET

Air conditioned environment; dedicated space for larger systems.

METAL POWDER BED FUSION

Dedicated manufacturing space; ventilation systems for airborne particulates; ventilated work stations; air conditioned environment; fireproofing; compressed air; argon lines run to each machine.

LASER SINTERING

Dedicated manufacturing space for machine; breakout areas for ancillary processes; access to water for chillers; special dedicated air handling to remove particulates; compressed air; nitrogen lines run to each machine.

FDM

Support removal system and optional finishing system.

STEREOLITHOGRAPHY

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

POLYJET

Support removal system.

METAL POWDER BED FUSION

Chillers, static-free vacuums, machine filters, sieving equipment, metal working equipment (mills, lathes, band saws, etc), stress relief oven, metalworking/ finishing hand tools.

LASER SINTERING

Media blasters, powder handling equipment, sifters, powder mixing equipment, chillers, lift carts.

BUDGET

For anyone who needs to build a business case for 3D printing, we'll touch on the financial benefits, factors that contribute to total cost of ownership and alternatives to bringing 3D printers in house.

CONTENTS

GUIDING QUESTIONS

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 like Stratasys Direct Manufacturing might be your best option.

WHAT IS YOUR MAIN FINANCIAL OBJECTIVE?

To build a broader business case for adoption, first decide on your top financial objective. Will you reduce costs? Increase revenues? Focus on one of these benefits and build your case by demonstrating how 3D printing helps you achieve it.

HOW MUCH DO YOU SPEND ON PROTOTYPING NOW?

If you'll base your business case on cost reduction, you'll need to know how much you're spending now. Be sure to include the time and cost of tooling production, finishing and assembly. You'll find opportunities to save time and money by consolidating parts, eliminating prototype tooling and reducing manual work.

WHAT REVENUE-GENERATING OPPORTUNITIES DO YOU SEE?

Basing your business case on revenue instead of cost reduction won't be quite as straightforward, but if you see significant business opportunities for greater customization, faster time-to-market, or innovative designs that can't be produced any other way, it might make sense to take this approach.

HOW WOULD YOU BENEFIT BY PROTOTYPING MORE?

How would your business benefit from a faster and more iterative prototyping process? Could you:

- Detect errors sooner?
- Avoid tooling rework?
- Reduce engineering change orders?
- Improve quality and reduce warranty claims?
- Launch more products?
- Increase market share?

These benefits, while more difficult to predict precisely, may be essential to your business case.

"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. You will never get away from conventional methods and highly skilled technicians, but you can give them the proper tools and new technology that can make their job easier and competitive."

Mitchell Weatherly, Sheppard Air Force Base

If you're building a business case for purchasing one or more 3D printers, you'll need to consider more than just the cost of the machine and materials. Facility requirements, associated labor and service contracts may all contribute to the total cost of owning a professional 3D printer.

MACHINE

Professional 3D printers range widely in price, from under $3000 to over $1 million.

MATERIALS

The cost of materials and the amount you'll consume will be a big contributor to your total cost of ownership.

EQUIPMENT AND FACILITIES

Some 3D printers can be installed in any office environment, while others have special requirements.

LABOR

Depending on the technology, you may need a skilled operator dedicated to your system, or you may be able to train existing employees in a few hours.

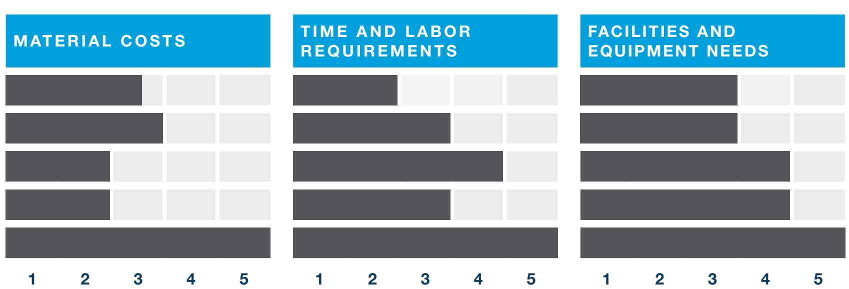
SUPPORT AND MAINTENANCE

An annual service contract can help you minimize downtime and maintain your production schedules while keeping your costs stable and predictable.

THE COST OF DOING NOTHING

Decision-makers often stick to the status quo. You'll need to show them the cost of inaction, whether that's too many change orders or a stagnating product line.

	UNDER $10K	$10-50K	$50-200K	$200-500K	$500K+
FDM	✓	✓	✓	✓	
PolyJet		✓	✓	✓	
LS				✓	
SL	✓	✓	✓	✓	✓
MPBF				✓	✓



Figures shown are for informational purposes only and based solely on what we've deemed typical. Actual costs will vary based on manufacturer, region, contractual agreements and other factors.

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