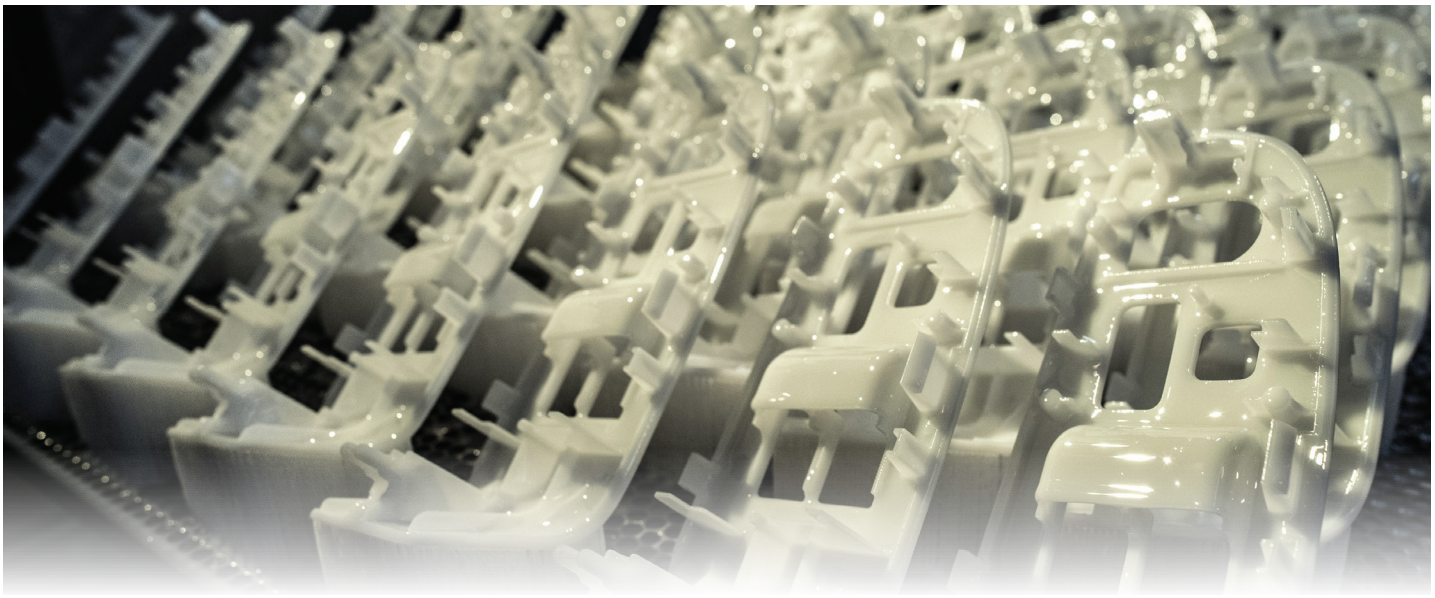
3D SYSTEMS

3D Printer Buyer's Guide

Insights to help you choose the right 3D printing approach for your needs



3D printing has become a critical part of manufacturing

3D printing is among the most important advancements in manufacturing since the Industrial Revolution. Once used strictly for prototyping, it now offers transformative advantages at every phase of product creation, from initial concept design to production of final products and every step in between. The rapidly growing selection of materials, new approaches to automation, and increases in speed are allowing for growth in applications for 3D printing across industries, ranging from aerospace and automotive to durable goods, healthcare, dental and jewelry.

By 2020, 3D printing will reduce new product introduction timelines by 25%.

— Gartner Predicts 2017: 3D Printing Accelerates

Business Considerations

Leveraging 3D printing effectively requires answering both business and technical questions. This guide will help you define what's most important to you and weigh the pros and cons of different approaches to 3D printing.

THREE KEY QUESTIONS TO ASK YOURSELF:

1. **What are the expected benefits to your business?**

   3D printing can offer a variety of business benefits, and it's important to clearly define the specific benefits you're seeking. Is your number one priority to **reduce costs** in R&D, product development, or manufacturing? Or are you looking to **generate more revenue** by getting products to market faster or creating entirely new product lines made possible by additive manufacturing? Or perhaps you're new to this technology and need to **explore 3D printing's potential** with a well-rounded approach that offers maximum flexibility. Understanding your business priorities will help you select the right 3D printing approach for your needs now and in the future.

2. **What is the total cost of operation?**

   It's important to look at total cost of operation (TCO) when it comes to 3D printing. As you evaluate different approaches—including competing vendors, print technologies, and in-house versus outsourced—keep the following in mind:

   - Capital cost of the printer(s)
   - Consumables (including materials and supplies like print heads)
   - Warranties
   - Labor time, especially as it relates to post-processing parts
   - Facilities (some 3D printers have plumbing, ventilation, or other requirements) and floor space

3. **How does the solution fit into your overall long-term additive manufacturing strategy?**

   3D printing stands to enhance every manufacturer's strategy going forward. It is changing how products are made even now, at just the beginning of this innovation curve. The global consulting firm Ernst & Young categorizes companies into one of four levels of maturity when it comes to additive manufacturing strategy.

LEVEL 1: NO EXPERIENCE

Typically, in this first level a company's leadership has little or no awareness of how 3D printing can help their company become more productive or successful.

LEVEL 2: EXPERIMENTING AND TESTING

This is where department leaders start to invest, test, and understand the technology. The business has not yet developed structured processes for the application of 3D printing.

LEVEL 3: APPLICATION IN 'CHAMPION' DEPARTMENTS

In this setting, there is clear direction on the applications of 3D printing within a certain department. There are measurable results within specific departments or areas of application, and a desire to expand the benefits to other parts of the business.

LEVEL 4: STRATEGIC APPLICATION ACROSS COMPANY

At this level, there is C-level sponsorship and applications of 3D printing are embedded within the company's strategy.

Source: EY Global 3D Printing Report 2016, 3DP Maturity Model

WHERE WOULD YOU CATEGORIZE YOUR COMPANY?

No matter where your company fits within this maturity model, you need a 3D printing solutions provider that is there for you every step of the way.

3D Systems, the inventor of 3D printing, is here to help

We believe in a collaborative, customer-centric approach where we begin by understanding your priorities, challenges, needs, and desired outcomes. We combine the broadest portfolio in the industry including software, hardware, materials, and professional services to deliver solutions that are tailored to your specific needs.

TECHNICAL CONSIDERATIONS

No single 3D printing technology can do it all. There are many different 3D printing technologies, each with strengths and weaknesses that make them great for some applications and unsuitable for others. Each offers unique materials – from elastomers to plastics to metals and more – and uses vastly different methods to create parts. Some make tough, production-grade parts that stand up to years of demanding service, while others make parts intended for short-term use. Some make large batches of parts at one time, while others are optimized to get one or a few parts printed as quickly as possible.

Rather than go into specific detail about each technology, this guide will help you make the critically important step of matching the right technology to your application.

Beware the printer manufacturer that claims one print technology can address all of your needs.

No one offers as many print technologies as 3D Systems

We offer the largest portfolio of best-in-class solutions because we know that one size does not fit all. With six different print engines across more than two dozen printers tailored to specific industry and application needs, we have the right solution for you.

See the entire lineup of 3D Systems printers

In-house 3D Printing, Outsourced, or Both?

You're probably reading this buyer's guide because you're looking to address a specific type of application right now. What type of applications will you have in the future? Will you generally need to print the same type of part, or will it vary from project to project (e.g., stainless steel parts today and flexible plastic parts tomorrow)? One of the first decisions you need to make is whether you'll print in-house, outsource, or take a hybrid approach.

IN-HOUSE 3D PRINTING

If all or most of your 3D printed parts will be similar in terms of material and performance characteristics, then owning in-house 3D printers that are optimized for that application makes the most sense.

HYBRID

A blended approach, with in-house printing for your most common applications and On Demand Manufacturing for everything else, combines the fast turnaround of in-house printing with the flexibility of On Demand Manufacturing.

OUTSOURCED

If you need varied materials and performance characteristics in your 3D printed parts, then On Demand Manufacturing may be the right choice.

3D Systems' On Demand Manufacturing Services

3D Systems' On Demand Manufacturing Services offer a broad range of processes and technologies to fit all your needs from prototyping through production. By selecting 3D Systems as your manufacturing partner, you gain access to a global network of industry-leading facilities and nearly four decades of experience in 3D printing and advanced manufacturing solutions.

See On Demand Manufacturing Capabilities

Evaluation Guide

FIND THE RIGHT 3D PRINTER FOR YOUR APPLICATION

This guide provides you with an evaluation framework that will help you clearly define your 3D printing needs. Your answers to these questions will help 3D Systems experts identify the right 3D printing approach for your application. Fill in your answers for your specific application so you can share it with the 3D Systems expert who will be reaching out to you soon.

1. Size of single largest part

3D printers come in many different print volumes, and bigger does not necessarily equal better. You'll want to balance maximum print volume with accuracy and printer cost. 3D printers that can both print large parts and achieve high levels of accuracy generally have the highest upfront investment.

We recommend selecting the largest part size you plan to print most of the time. If you have an occasional need to print parts larger than that, outsourcing those big parts to On Demand Manufacturing may be the most cost-effective approach.

What is the size of the single largest part you expect to 3D print?	
Your typical largest part *(check one)*:	
Fits in the palm of your hand Approximately 4 in x 4 in x 4 in (10 cm x 10 cm x 10 cm)	◉
Fits in a shoebox Approximately 12 in x 8 in x 5 in (30 cm x 20 cm x 13 cm)	○
Fits on your desk Approximately 20 in x 15 in x 10 in (50 cm x 38 cm x 25 cm)	○
Large Approximately 60 in x 30 in x 20 in (150 cm x 75 cm x 50 cm)	○

2. 3D printed part strength requirements

Fundamentally, finding the right 3D printing technology boils down to one thing: do the parts you print do what you need them to do? Do they have the mechanical properties your application needs? While there are many nuances and specific requirements in terms of how you need 3D printed parts to perform, it's helpful to define in very general terms what performance you expect from parts for your intended application.

Which category best describes how you need 3D printed parts to perform?	
Part strength and durability requirements *(check one)*:	
Production strength and durability Performs similarly to molded plastics (in the case of plastic printers) or cast metals (in the case of metal printers) for long-term use (e.g. production parts, functional prototypes subject to high mechanical stress).	◉
Functional prototype/limited-use strength Performs similarly to molded plastics for short-term use (e.g. functional prototypes subject to low mechanical stress, one-time use products, short-run tooling, injection molds, RTV molds, carbon fiber molds, jigs, fixtures).	○
Appearance Specific mechanical properties are not important. Parts must be robust enough to be handled and shipped, but no mechanical loads will be applied (e.g. visual prototypes, sales models, artistic objects).	○
Sacrificial patterns Printed objects will serve as sacrificial patterns for investment casting of metals (e.g. Wax or resin patterns).	○

3. Quantity of parts per month

Knowing how many parts you expect to print per month will help you select the optimal printer for your needs and neither overspend nor be stuck with a printer that can't keep up with your anticipated part quantities.

How many parts per month do you anticipate printing?	
Number of parts per month *(check one)*:	
1-50	◉
51-500	○
501+	○

It's important to note that "raw" print speed (time to get one part from the 3D printer) and throughput (productivity of the printer) are not the same thing. Many 3D printers can print parts in batches. For example, one part might take two hours to print, but 10 of the same part can be printed in two and a half hours on the same printer.

4. Time-to-part or throughput

As noted above, there is a significant difference between "raw" print speed and throughput, or productivity. This is one of the trickiest concepts in 3D printing, and often vendors will only publish raw print speed, which can lead to selecting the wrong printer for your needs.

Some 3D printers are optimized to print a single part very quickly but slow down when you try to print multiple parts simultaneously. Others are slower to print one part but can print 10, 50, or 100 parts simultaneously in only slightly more time. Similarly, some 3D printed parts need to be post-processed one-by-one, whereas others can be post-processed in batches.

Defining which is more important for your application—getting a single part printed and post-processed as fast as possible (time-to-part), or printing as many parts as possible per day, week, or month (throughput)—is important to making the right choice in printers.

Which is more important for your application?	
Speed or productivity *(check one)*:	
Time-to-part is most important	◉
Throughput is most important	○

Expert tip: When comparing 3D printers, make sure you understand the total time for your typical parts at your typical volumes. Many vendors don't explain all the steps involved in getting parts in hand, such as part cleaning, thermal curing, or cool down times.

5. Accuracy/precision/repeatability

Accuracy, precision, and repeatability are complex topics that have many nuances and are dependent on a variety of factors including part size, material, geometry, post-processing, print orientation, and more. 3D Systems' experts will help you determine the best approach for your specific needs, but in very general terms, defining your typical part tolerances will help us narrow the selection of 3D printers for your application.

What are your typical part tolerances for printed parts?	
Part tolerance *(check one)*:	
Part tolerances tighter than 0.100 mm / 0.004 in My parts must fit in tight tolerances (for example, less than 0.1mm/0.004in). I'm willing to make trade-offs in print speed, part cost, and printer cost to ensure my parts are extremely accurate to the CAD model.	◉
Part tolerances tighter than 0.500 mm / 0.020 in My parts must fit in moderate tolerances (for example, less than 0.5mm/0.02in). While we may need tighter tolerances on individual features, global tolerances are moderate.	○
Part tolerances above 0.500 mm / 0.020 in Time-to-part, throughput, or durability are more important.	○

Many 3D Systems printers can print parts with tighter tolerances than those noted above. Identifying tolerance thresholds is a convenient starting point for more in-depth conversations about accuracy, precision, and repeatability with a 3D Systems expert.

Note that certain accuracy requirements can also be met with secondary processing. 3D Systems offers advanced software that combines the best of additive and subtractive manufacturing. You can, for example, print extra stock for secondary machining, taking advantage of the speed and design freedom of 3D printing with the precision of CNC machining.

6. Part aesthetics

Some applications require printed parts that are visually appealing or have specific look and feel requirements. Other applications are purely functional, and part appearance doesn't matter as long as it performs as expected.

While there are many ways to get the exact look and feel you need for a given part, including post-processing techniques such as sanding and painting, you'll want to choose the printer that best fits your application's aesthetic requirements.

How important is each of the following aesthetic qualities?					
Aesthetic quality	Not very important				Very important
Smooth surface finish	○	○	◉	○	○
Fine feature detail & sharp edges	○	○	◉	○	○
Full color parts	○	○	◉	○	○
Clear/transparent parts	○	○	◉	○	○

7. Flexibility of print options

Each 3D printing technology has a unique set of material options. An important consideration is how frequently you anticipate switching the materials you're using. Some 3D printers are configured to run one material most or all of the time with infrequent changeovers, whereas others make it easy to swap materials with little downtime or wasted material. Still others can print in multiple materials simultaneously. A 3D Systems expert will be able to advise you on the selection of materials and how easy it is to switch between them.

How frequently do you anticipate needing to print in different materials?	
Material capability *(check one)*:	
One material all or most of the time All of our parts can be printed in the same material, with switching materials maybe once or twice per **year**.	◉
Occasional switching of materials We may need to switch materials a few times **monthly** to print parts with different properties (color, stiffness, flexibility, temperature resistance, etc.)	○
Frequent switching of materials We need to be able to swap materials **weekly** or daily, so quick changeovers with minimal downtime is important.	○
Multi-material in a single part or build We need to print in multiple materials simultaneously within a single print to achieve different properties (rigid or flexible).	○

3D Systems On Demand Manufacturing can print parts in almost any material, including metals and plastics, so you can achieve printed parts in materials that your 3D printer doesn't support.

8. Initial investment and total cost of operation

Depending on your application and your company's level in the additive manufacturing maturity model, you may prioritize a low cost of entry so that you can experiment and test how 3D printing will benefit your business. On the other hand, if you have an additive manufacturing strategy in place and know how 3D printed parts fit into your business strategy, making the higher initial investment in a production 3D printer will result in a lower total cost of operation.

Which budget/ROI priority is more important?	
Budget/ROI priority *(check one)*:	
Low initial investment is most important We expect to use 3D printing less frequently, and are willing to trade off part properties, higher per-part costs and lower throughput for a lower initial investment.	◉
High throughput and/or production-grade parts is most important We are willing to make the upfront investment to print in high volumes and/or print production-grade parts, and enjoy a low per-part cost when printing in high volumes.	○

9. Specific part properties

Many applications require specific part qualities. Check the box next to each property required for your 3D printed parts, or write in specific part properties that are not listed.

What are the requirements for your 3D printed parts?	
Specific part property	
Metal	☐
ABS-like	☐
Polypropylene-like	☐
Elastomeric	☐
Nylon	☐
Castable	☐
Biocompatible	☐
High temperature resistance	☐
Flame retardant	☐
Clear	☐
Food safe	☐
Dental	☐
Other: _____	

Save your answers in this PDF and share it with your 3D Systems representative. They will review your answers and discuss it with you to recommend the best 3D printer for your needs.

3D Systems' Materials

3D Systems offers materials for each of the requirements listed above. With the industry's most extensive and versatile portfolio of plastic, elastomer, composite, wax, metal, and other material types, our printer and material combinations can meet the performance characteristics your application needs.

Learn more about 3D Systems materials

3D Systems 3D Printers

SOLUTIONS FOR PROTOTYPING TO PRODUCTION, IN PLASTICS AND METALS

With the broadest scope of 3D printing technologies, we offer you a perfect combination of process, material, and application expertise to integrate the right solution into your specific workflow.

DIRECT METAL (DMP) PRINTERS

Rethink metal part design and produce products, components, and tools with reduced weight, increased functionality, and simplified assemblies. Save time, cost and part weight with an integrated precision metal manufacturing solution from 3D Systems.

DMP Printers

STEREOLITHOGRAPHY (SLA) PRINTERS

The gold standard in accuracy and precision, these 3D printers offer an expanded range of plastic materials and operate with minimal waste to deliver the most productive and reliable operation, including large build volumes.

SLA Printers

SELECTIVE LASER SINTERING (SLS) PRINTERS

Suitable for prototypes and end-use production parts, 3D Systems' Selective Laser Sintering platforms offer a wide range of nylon materials that meet almost any need: high durability, heat resistance, elongation, glass-filled, flame resistance, certified Class VI for medical, chemical resistance and ISO 10993 for food contact.

SLS Printers

FIGURE 4 PRINTERS

The industry's first scalable, fully-integrated 3D printing platform. Figure 4 solutions deliver accurate parts in a diverse range of robust, production-grade materials for immediate part turnaround without the costs and delays of tooling.

Figure 4 Printers

COLORJET (CJP) PRINTERS

Suitable for prototypes through to end-use From educational settings to the most demanding commercial environments, 3D Systems' family of ProJet® x60 3D printers provide unparalleled color capabilities at exceptional print speeds, efficiency, and low operational costs.

CJP Printers

MULTIJET (MJP) PRINTERS

The industry's first scalable, fully-integrated 3D printing platform. Figure 4 solutions deliver accurate parts in a diverse range of robust, production-grade materials for immediate part turnaround without the costs and delays of tooling.

MJP Printers

DESKTOP PRINTERS

Ideal for engineering, manufacturing, and jewelry applications, 3D Systems' desktop 3D printers excel at low-volume, small-part prototyping and direct 3D production across a wide range of high-quality materials.

Desktop Printers