3D Printing Technology Comparison: FDM vs. SLA vs. SLS

Written by: Formlabs

Additive manufacturing, or 3D printing, lowers costs, saves time, and transcends the limits of fabrication processes for product development. From concept models and functional prototypes in rapid prototyping to jigs, fixtures, or even end-use parts in manufacturing, 3D printing technologies offer versatile solutions in a wide variety of applications.

Over the last few years, high-resolution 3D printers have become more affordable, easier to use, and more reliable. As a result, the technology is now accessible to more businesses, but choosing between the various competing 3D printing solutions can be difficult.

Which technology is suitable for your particular application? What materials are available? What equipment and training do you need to get started? How about costs and return on investment?

In this article, we'll take a closer look at the three most established technologies for 3D printing plastics today: fused deposition modeling (FDM), stereolithography (SLA), and selective laser sintering (SLS).

www.systematics.co.il

מוקד שירות: 03-7660101
דוא"ל: info@systematics.co.il

טלפון: 03-7660111
פקס: 03-7660120

סיסטמטיקס בע"מ
רחוב ראול ולנברג 4, תל אביב 69719

Fused Deposition Modeling (FDM)

Fused Deposition Modeling is the most widely used form of 3D printing at the consumer level, fueled by the emergence of hobbyist 3D printers. FDM 3D printers build parts by melting and extruding thermoplastic filament, which a print nozzle deposits layer by layer in the build area.

FDM works with a range of standard thermoplastics, such as ABS, PLA, and their various blends. The technique is well-suited for basic proof-of-concept models, as well as quick and low-cost prototyping of simple parts, such as parts that might typically be machined.

FDM parts tend to have visible layer lines and might show inaccuracies around complex features. This example was printed on a Stratasys uPrint industrial FDM 3D printer with soluble supports (machine starting at $15,900).

FDM has the lowest resolution and accuracy when compared to SLA or SLS and is not the best option for printing complex designs or parts with intricate features. Higher-quality finishes may be obtained through chemical and mechanical polishing processes. Industrial FDM 3D printers use soluble supports to mitigate some of these issues and offer a wider range of engineering thermoplastics, but they also come at a steep price.

Stereolithography (SLA)

Stereolithography was the world's first 3D printing technology, invented in the 1980s, and is still one of the most popular technologies for professionals. SLA uses a laser to cure liquid resin into hardened plastic in a process called photopolymerization.

See how stereolithography works.

SLA parts have the highest resolution and accuracy, the clearest details, and the smoothest surface finish of all plastic 3D printing technologies, but the main benefit of SLA lies in its versatility. Material manufacturers have created innovative SLA resin formulations with a wide range of optical, mechanical, and thermal properties to match those of standard, engineering, and industrial thermoplastics.

SLA parts have sharp edges, a smooth surface finish, and minimal visible layer lines. This example part was printed on a Formlabs Form 2 desktop SLA 3D printer

SLA is a great option for highly detailed prototypes requiring tight tolerances and smooth surfaces, such as molds, patterns, and functional parts. SLA is widely used in a range of industries from engineering and product design to manufacturing, dentistry, jewelry, model making, and education.

Selective Laser Sintering (SLS)

Selective laser sintering is the most common additive manufacturing technology for industrial applications.

SLS 3D printers use a high-powered laser to fuse small particles of polymer powder. The unfused powder supports the part during printing and eliminates the need for dedicated support structures. This makes SLS ideal for complex geometries, including interior features, undercuts, thin walls, and negative features. Parts produced with SLS printing have excellent mechanical characteristics, with strength resembling that of injection-molded parts.

SLS parts have a slightly rough surface finish, but almost no visible layer lines. This example part was printed on a Formlabs Fuse 1 benchtop SLS 3D printer

The most common material for selective laser sintering is nylon, a popular engineering thermoplastic with excellent mechanical properties. Nylon is lightweight, strong, and flexible, as well as stable against impact, chemicals, heat, UV light, water, and dirt.

The combination of low cost per part, high productivity, and established materials make SLS a popular choice among engineers for functional prototyping, and a cost-effective alternative to injection molding for limited-run or bridge manufacturing.

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מוקד שירות: 03-7660101
info@systematics.co.il :דוא"ל

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פקס: 03-7660120

סיסטמטיקס בע"מ
רחוב ראול ולנברג 4, תל אביב 69719

Compare FDM, SLA, and SLS Technologies

Each 3D printing technology has its own strengths, weaknesses, and requirements, and is suitable for different applications and businesses. The following table summarizes some key characteristics and considerations.

	Fused Deposition Modeling (FDM)	Stereolithography (SLA)	Selective Laser Sintering (SLS)
Resolution	★★☆☆☆	★★★★★	★★★★☆
Accuracy	★★★★☆	★★★★★	★★★★★
Surface Finish	★★☆☆☆	★★★★★	★★★★☆
Throughput	★★★★☆	★★★★☆	★★★★★
Complex Designs	★★★☆☆	★★★★☆	★★★★★
Ease of Use	★★★★★	★★★★★	★★★★☆
Pros	Fast Low-cost consumer machines and materials	Great value High accuracy Smooth surface finish Range of functional applications	Strong functional parts Design freedom No need for support structures
Cons	Low accuracy Low details Limited design compatibility	Average build volume Sensitive to long exposure to UV light	Rough surface finish Limited material options
Applications	Low-cost rapid prototyping Basic proof-of-concept models	Functional prototyping Dental applications Jewelry prototyping and casting Modelmaking	Functional prototyping Short-run, bridge, or custom manufacturing
Print Volume	Up to ~200 x 200 x 300 mm (desktop 3D printers)	Up to 145 x 145 x 175 mm (desktop 3D printers)	Up to 165 x 165 x 320 mm (benchtop 3D printers)
Materials	Standard thermoplastics, such as ABS, PLA, and their various blends.	Varieties of resin (thermosetting plastics). Standard, engineering (ABS-like, PP-like, flexible, heat-resistant), castable, dental,	Engineering thermoplastics. Nylon 11, Nylon 12, and their composites.

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מוקד שירות: 03-7660101
info@systematics.co.il :ל"דוא

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סיסטמטיקס בע"מ
רחוב ראול ולנברג 4, תל אביב 69719

	Fused Deposition Modeling (FDM)	Stereolithography (SLA)	Selective Laser Sintering (SLS)
		and medical (biocompatible).	
Training	Minor training on build setup, machine operation, and finishing; moderate training on maintenance.	Plug and play. Minor training on build setup, maintenance, machine operation, and finishing.	Moderate training on build setup, maintenance, machine operation, and finishing.
Facility Requirements	Air-conditioned environment or preferably custom ventilation for desktop machines.	Desktop machines are suitable for an office environment.	Workshop environment with moderate space requirements for benchtop systems.
Ancillary Equipment	Support removal system for machines with soluble supports (optionally automated), finishing tools.	Post-curing station, washing station (optionally automated), finishing tools.	Post-processing station for part cleaning and material recovery.

Watch our webinar for a detailed comparison of FDM, SLA, and SLS technologies and applications

Costs and Return on Investment

Ultimately, you should choose the technology that makes the most sense for your business. Prices have dropped significantly in recent years, and today, all three technologies are available in compact, affordable systems.

Calculating costs does not end with upfront equipment costs. Material and labor costs have a significant influence on cost per part, depending on the application and your production needs.

Here's a detailed breakdown by technology:

	Fused Deposition Modeling (FDM)	Stereolithography (SLA)	Selective Laser Sintering (SLS)
Equipment Costs	Mid-range desktop printers start at $2,000, and industrial systems are available from $15,000.	Professional desktop printers start at $3,500, and large-scale industrial machines are available from $80,000.	Benchtop systems start at $10,000, and industrial printers are available from $100,000.
Material Costs	$50-$150/kg for most standard and engineering filaments, and $100-200/kg for support materials.	$149-$200/L for most standard and engineering resins.	$100/kg for nylon. SLS requires no support structures, and unfused powder can be reused, which lowers material costs.
Labor Needs	Manual support removal (can be mostly automated for industrial systems with soluble supports). Lengthy post-processing is required for a high-quality finish.	Washing and post-curing (both can be mostly automated). Simple post-processing to remove support marks.	Simple cleaning to remove excess powder.

Try our simple, interactive tool to calculate cost per part and lead time when 3D printing on the Form 2, and to compare time and cost savings to other production methods.
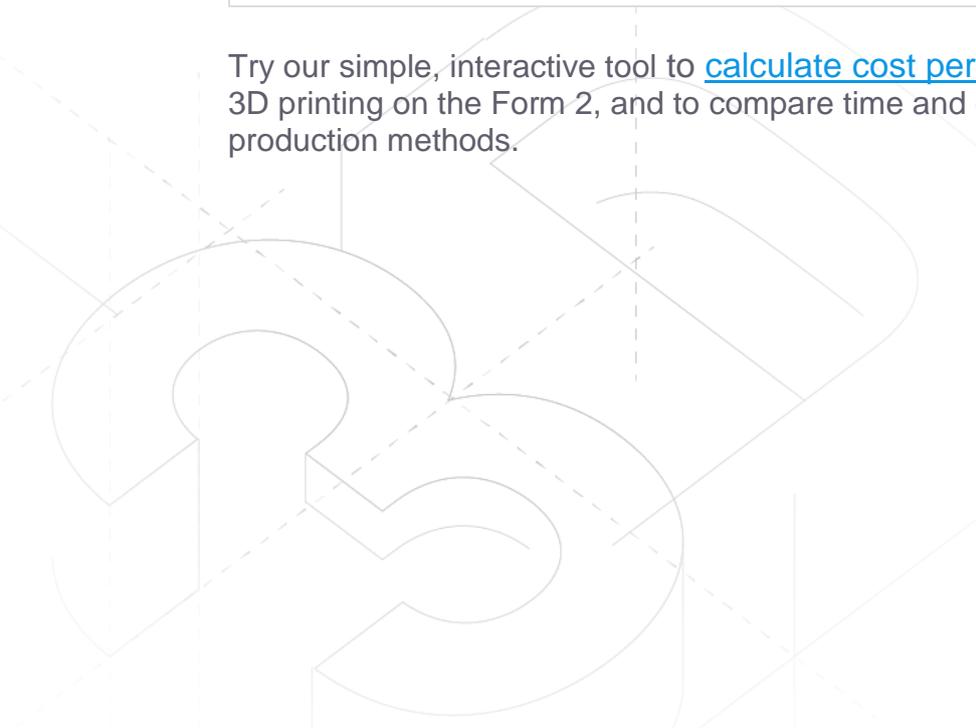
Learn More About 3D Printing

Prototypes of a ski goggles' frame printed with FDM, SLA and SLS technology (from left to right).

We hope this article has helped you focus your search for the best 3D printing technology for your application.

Explore our additional resources to master the intricacies of 3D printing, and dive deeper into each technology to learn more about specific 3D printing systems.