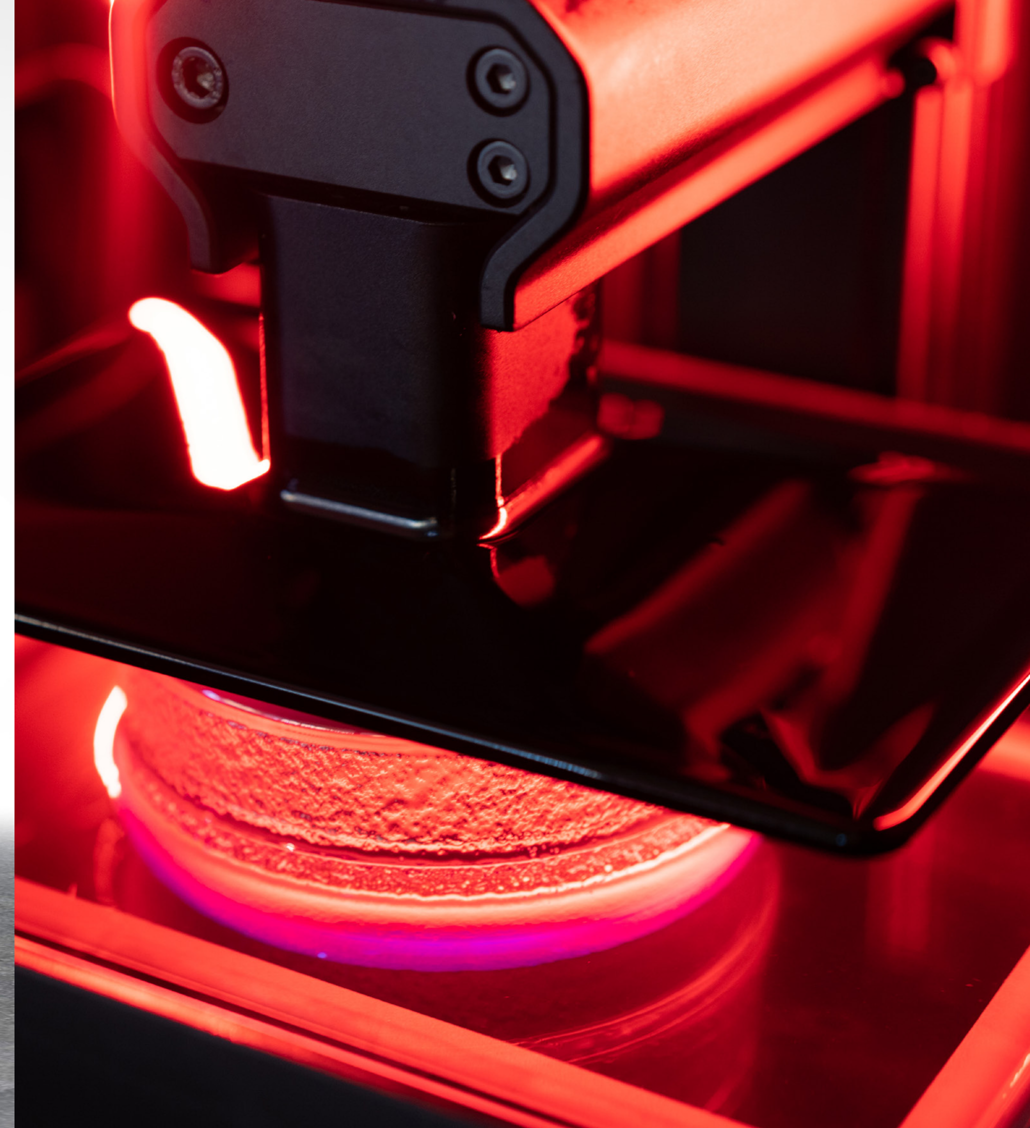
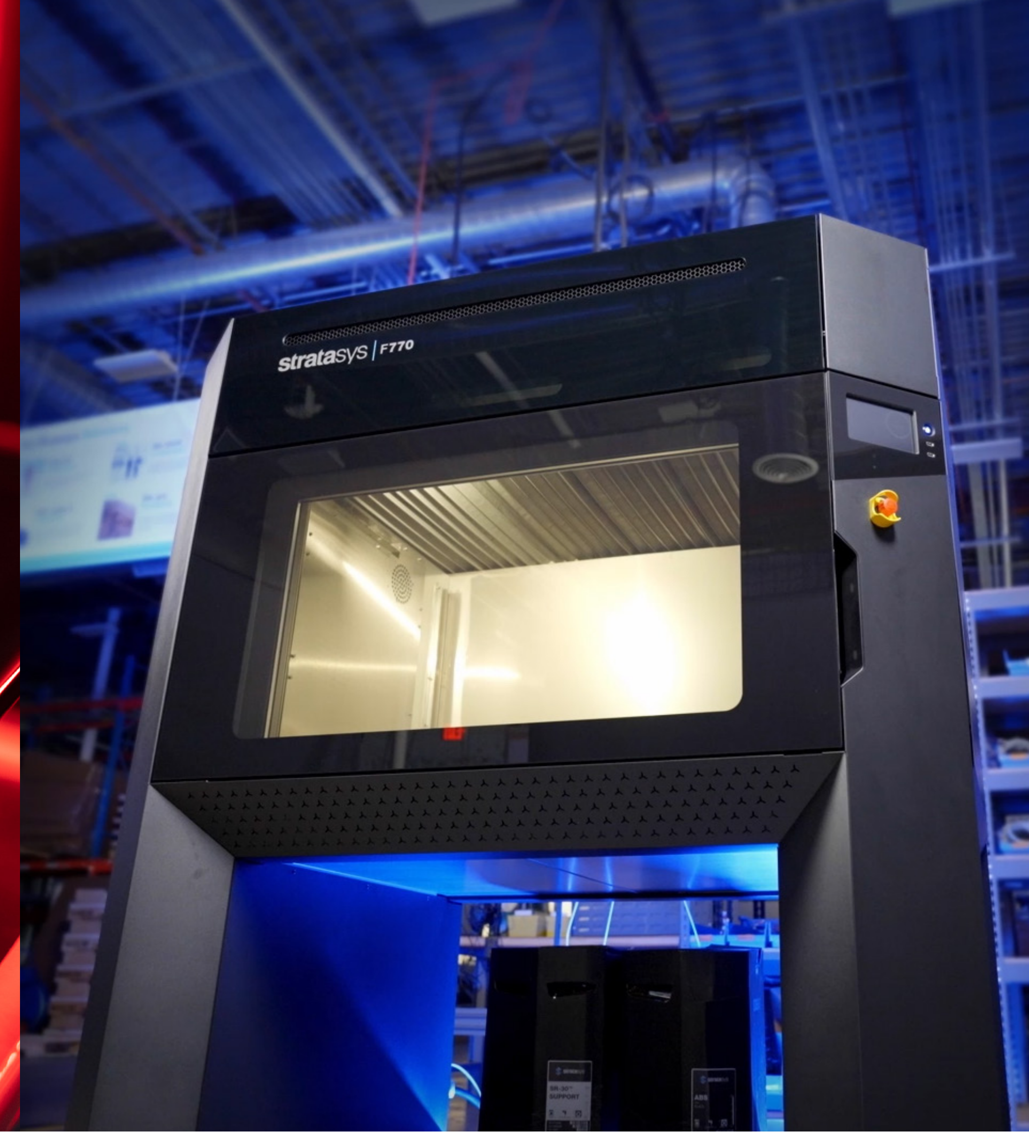
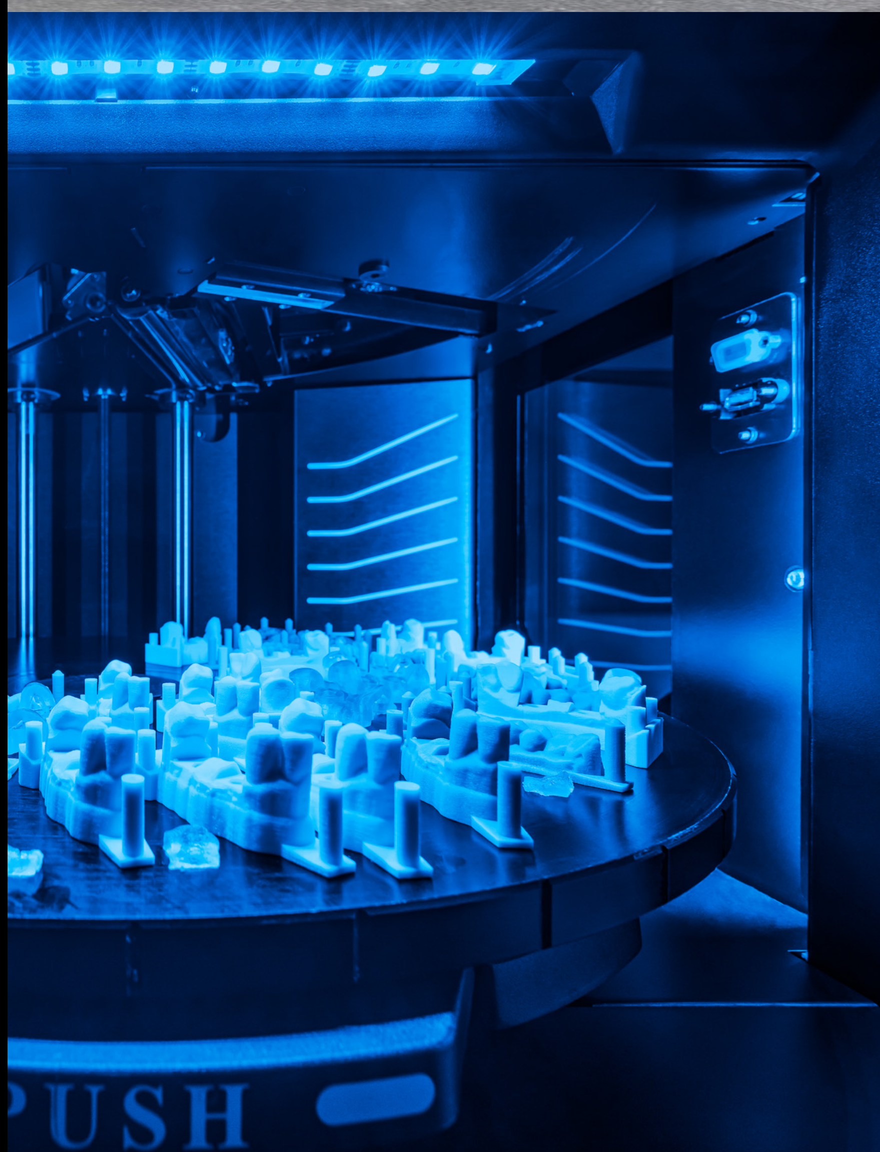





INDUSTRIAL ADDITIVE MANUFACTURING

TECHNOLOGY COMPARISON GUIDE

stratasys

INTRODUCTION & OVERVIEW

Industrial 3D printing, also called additive manufacturing (AM), is a broad technology field that covers a range of processes that produce three-dimensional objects from a digital model. The physical parts are built by adding successive layers of material and there are a variety of different processes that are commercially available to achieve this. 3D printing processes differ from conventional manufacturing processes, which use subtractive techniques where the desired shape is created by taking material away from a solid block.

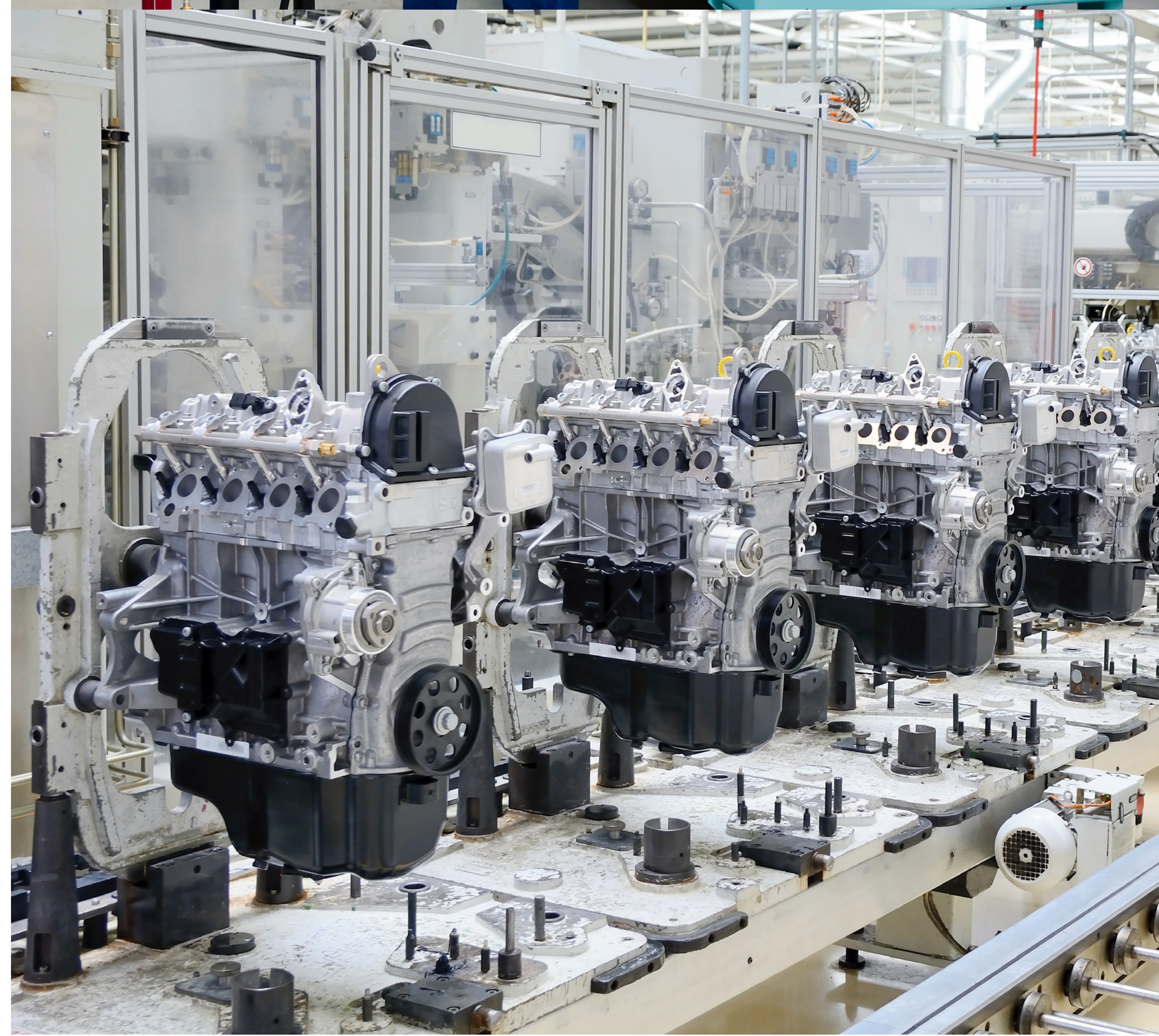
In this way, 3D printing can bring increased efficiencies and broader business opportunities. It also demands a different approach. 3D printing releases you from traditional manufacturing constraints and opens up a new level of geometric complexity that is not limited by the restrictions of conventional machine and mold tools.

3D printing offers designers, engineers and manufacturers a powerful tool that can support their work in a number of ways. The ability to design and make prototypes, manufacture tools and/or end-use production parts in a matter of days or even hours, is a significant and compelling benefit that should not be overlooked.

Despite being a relatively young method of manufacturing, the number of commercially available 3D printing technologies continues to expand along with the palette of materials. It can often be difficult to navigate all of the available technologies and identify which technology will best suit your needs.

Stratasys was one of the first original equipment manufacturers (OEMs) in the field with its proprietary Fused Deposition Modelling (FDM) process. Today, alongside FDM, Stratasys offers a spectrum of industrial polymer 3D printing technologies that are reliably utilized across many industry sectors. Stratasys technologies can support any or all of the manufacturing process chain, from original concept through to final product.

This document will not only provide an introduction to all of the Stratasys technologies and lay out how they compare across the most important metrics; it will also highlight the manufacturing process chain, where Stratasys industrial 3D printing fits into it and pose probing questions to help you decide which technology is best suited to your application(s), operations and business needs.



INTRODUCING STRATASYS INDUSTRIAL ADDITIVE MANUFACTURING TECHNOLOGY PORTFOLIO

FDM® Technology

SLA Technology

P3™ DLP Technology

SAF™ Technology

PolyJet™ Technology

GrabCAD Print™

The Stratasys technology portfolio includes industry leading 3D printing software to streamline the additive manufacturing workflow and to make print preparation as seamless and as efficient as possible.

Stratasys develops, supports and manufactures a comprehensive technology range to produce the parts that you need, in the volumes that you need, when you need them. To help you focus in on which technology will best support your needs, we pose the following questions:

- What do you need your parts for? (Prototyping / Tooling / End use)
- What are the functional priorities of your part/s? (Strength / Heat resistance / Aesthetics etc)
- What size are your parts?
- What volumes of parts are required? Do you need them all in one go or over a period of time?
- Have you considered the ROI of producing in-house versus Contract Manufacture using 3D Printing?

STRATASYS: ORIGINAL EQUIPMENT MANUFACTURER (OEM)

INDUSTRIAL POLYMER ADDITIVE MANUFACTURING TECHNOLOGIES

General Technology Name	Powder Bed Fusion / PBF	Material Extrusion / ME	Material Jetting / MJ	Vat Polymerisation Stereolithography / SLA®	Digital Light Processing / DLP
Stratasys Technology Name	Selective Absorption Fusion / SAF	Fused Deposition Modelling / FDM	PolyJet	Neo Stereolithography	P3 - Programmable PhotoPolymerization
	SAF uses HAF™ infrared absorption fluid to selectively fuse polymer powder in layers followed by exposure to infrared energy.	The ME process involves heating and selectively extruding plastic filament, in successive layers to build part.	Micro droplets of photopolymer resin are directly jetted through multiple nozzles. As each layer is deposited, it is cured by UV light.	SLA utilises laser/s to selectively cure a vat of resin, one layer at a time.	DLP utilizes a projected light source to cure resin materials layer by layer.
	SAF is an industrial-grade technology that enables cost-effecitve end-use part production. SAF parts are accurate and consistent.	Stratasys FDM machines are highly developed and can process industrial grade thermoplastic materials.	With microscopic layer resolution down to 0.014 mm, PolyJet can produce thin walls & complex geometries using a wide range of materials.	The Neo series of 3D printers build high-quality parts with superior surface quality, accuracy and detail.	P3 is an evolution of DLP that precisely orchestrates light, temp, pull forces & pneumatics to optimize prints & deliver Injection molding part quality / surface finish with incredible accuracy.
	SAF Advantages: 1. Productive, reliable, and cost efficient 2. High quality, strong and durable parts 3. Best accuracy and consistency	FDM Advantages: 1. Clean, user-friendly 2. Large parts 3. Strong parts	PolyJet Advantages: 1. Highly accurate parts 2. Fine features 3. Multi-material / full color parts	SLA Advantages: accurate part production offering superior surface finish with less visible stair stepping.	P3/DLP Advantages: 1. The most accurate 3DP technology 2. High performance materials 3. High volumes & scalable
	SAF Applications: Allows for cost-effective, high-throughput volume production of consistent, functional end-use parts.	FDM Applications: Prototyping, Jigs and Fixtures, tooling, Production-End use parts	PolyJet Applications: Visual and Functional Prototyping for Design and Engineering (functional parts, form fit parts, high fidelity full color) Production – End use parts (Fashion, Dental, Accessories, Collectibles)	SLA Applications: • General Prototyping • Functional Prototyping • Wind Tunnel Modelling • Investment Casting • Composite Tooling • Fluid Flow Testing	P3/DLP Applications: 1. Production-grade end-use parts for up to medium volume series with injection-molding-like quality. 2. Industrial-Grade functional prototyping

STRATASYS MATERIALS	Stratasys develops in-house materials to maximise the efficiency and optimal capabilities of its technology portfolio. Stratasys also works with partner companies that specialize in material development and distribution.

STRATASYS: ORIGINAL EQUIPMENT MANUFACTURER (OEM)

INDUSTRIAL POLYMER ADDITIVE MANUFACTURING TECHNOLOGY COMPARISON

TECHNOLOGY	SAF™ Technology	FDM® Technology	PolyJet™ Technology	SLA Technology	P3™ DLP Technology
MACHINES	SAF H350	F3300 F900 Fortus 450mc F123CR F123 Series F770	J3 DentalJet J5 DentaJet J720 Dental, J700 Dental J5 MediJet, J850 Digital Anatomy J850 TechStyle, Anatomy J55 Prime J826 Prime J850 Prime, J850 Pro J35 Pro, J4100	Neo800 Neo450e Neo450s	OriginOne OriginOneDental
Build Size X x Y x Z	315 x 208 x 293 mm	Up to 914 x 610 x 914 mm	Up to 490 x 390 x 200 mm	800 x 800 x 800mm (Neo800) 450 x 450 x 450mm (Neo450)	192 x 108 x 370 mm
MATERIALS (Type &form)	Thermoplastic Powder	Thermoplastic Filament	Liquid resin (photopolymer + ink)	Thermoset Resin	Thermoset Resin
MATERIAL (Characteristics)	Currently available SAF PA12 and SAF PA11 materials. Raw color Gray	A range of rigid, flexible and biocompatible thermoplastic materials, including ABS, PLA, Nylon, PC & ULTEM™.	Full color, High opacity, Ultra transparency Rigid, Flexible, Bio grade, Digital ABS	Any commercially available 355nm photopolymer resin. Stratasys recommend Somos® resin, that offer clear/transparent, ABS-like, PP-like, tough, high-temp and application specific materials.	Very broad range of performance materials for diverse applications: tough, flexible, high-temperature, weatherable. Including specialty materials like FR/FST, ESD, and medical-grade materials.
RESOLUTION	Recommended minimum feature size: 0.5 mm	0.1270 mm - 0.5080 mm	Down to 14 um layer thickness	Layer Resolution 50 to 200 μm* Minimum Feature Size 0.2 mm in X & Y† / 0.4mm in Z†	50 um
ACCURACY	± 0.2 mm	Varies widely depending on material and parameters	±100um	Dimension <100 mm ±0.1 mm Dimension >100 mm 0.15%†	±100um X/Y/Z **
STRENGTH of PARTS	Strong, almost mechanical isotropy behavior	Strong	Moderate	Moderate	Strong parts with isotropic properties.
RAW SURFACE SMOOTHNESS	Moderate	Moderate	Very High	Very High	Very High
POST PROCESSING	Powder removal & cleaning required. Other finishing solutions including polishing & dyeing are optional.	Support removal - soluble and mechanical options available.	Support removal – water soluble	Support remova > Dry > Cure	Wash > Dry > Cure

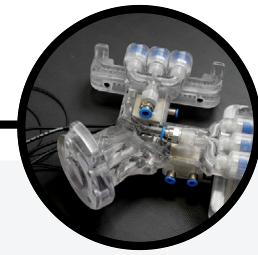
***† Accuracy & minimum feature size will vary depending on material & parameters**
**** Geometry/material dependent**

HOW STRATASYS CUSTOMERS ARE APPLYING OUR TECHNOLOGY

SAF™ Technology

With SAF, you can print 1,000 parts without a lot of hands-on labor or support removal, the quality is phenomenal with less post-production work like filling, sanding, priming and painting. So from an aesthetic standpoint, it's just hands-down better.

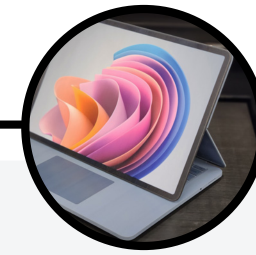
Kim Gustafon
co-owner of 3D Composites



FDM® Technology

The Fortus 450 MC and the ABS-ESD7 material offer the ideal combination to optimally meet our requirements.

Benjamin Heller,
Project Lead Disruptive Technology,
Siemens Digital Industries



PolyJet™ Technology

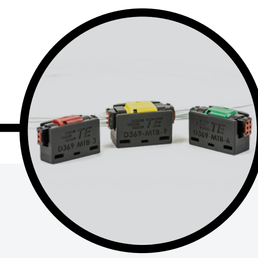
The increased dimensional accuracy, coupled with full-color printing has made the Stratasys J850 our primary 3d printing tool for prototyping complex mechanical prototypes. Parts off the J850 require little to no post processing (sanding, painting etc.) making it possible to create multiple iterations at a much quicker pace compared to past methods.

Karsten Aagaard
Microsoft Principal Model-Maker

SLA Technology

With client demand for 3D printing increasing across the product development cycle, we looked to update and expand our capacity with the latest SL technology. Stratasys' Neo systems proved to be the best solution with a larger build size, faster print speed, and more flexibility, quality and reliability.

Philip Martin
Director, Ogle Models and Prototypes



P3™ DLP Technology

Stratasys has been a great partner in helping us optimize accuracy and repeatability for connectors that require +/- 50 micron accuracy, and demonstrating the possibilities of using additive manufacturing to produce part volumes in the tens thousands.

Mark Savage
Senior Manager, Additive Manufacturing
of TE Connectivity

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