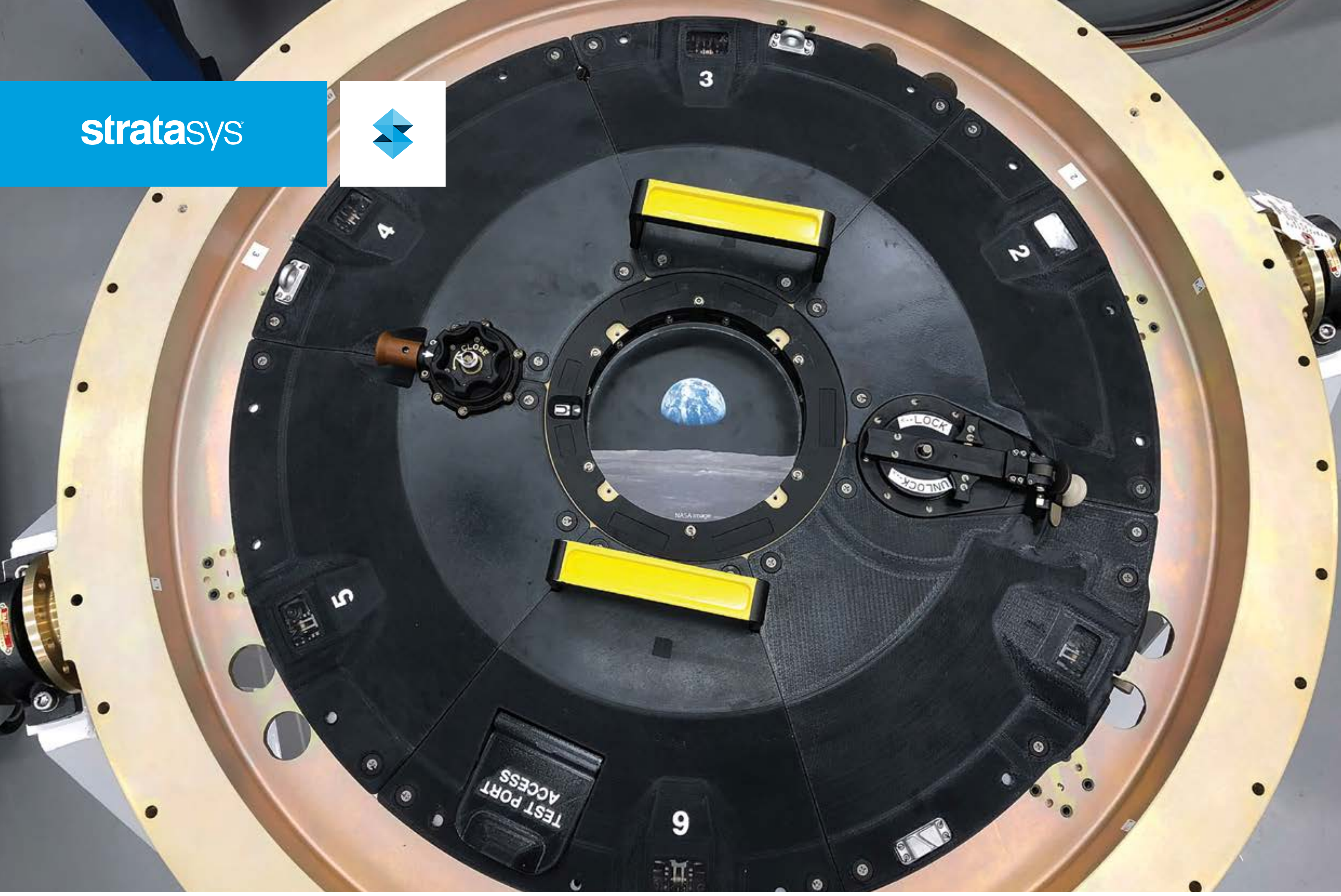
stratasys



Lower Production Costs with New 3D Printed Materials

INTRODUCTION

As a manufacturer, your success with 3D printing (3DP) and its capability to solve your production challenges are, in part, a function of mindset. Your "3D printing paradigm" largely governs how you view the technology and how it can or can't help. Frankly, any belief that 3D printing is not a manufacturing technology or that materials lack sufficient capability for manufacturing applications is simply outdated.

Lower Production Costs with New 3D Printed Materials

The truth is, more manufacturing companies are rapidly adopting 3D printing. In 2018, global expenditure on 3D printing is projected to be nearly $12.0 billion, almost a 20% increase over 2017*. Morever, manufacturing is the dominant player in this statistic, accounting for over half of worldwide 3DP spending.

Since 2014**, a 3D printed part's strength and durability has been the second-ranked concern of non-adopters, a reflection, in part, on the materials. Advanced, high-strength 3DP materials are already available and employed in mission-critical applications. As materials develop, 3DP adoption and applications rapidly grow, challenging years of incremental improvements in conventional manufacturing.

Another way to look at this is by taking the limited view of 3D printing's capability for manufacturing, your company is being left behind, to the benefit of your competition. That fact was echoed in a 2016 Forbes article quoting an astute CEO of a leading Midwest industrial equipment manufacturer. The CEO recognized her company needed to disrupt itself before the market did, by relying on advanced technologies like 3D printing.

Manufacturers of discrete products employing 3DP technology with high-performance materials are moving faster than competition and realizing time and cost efficiencies that non-3DP adopters aren't. These are documented facts, exhibited in this white paper.

To help you assess your current assumptions about the impact 3D printing can have on manufacturing, consider the following questions:

- How much would your production efficiency increase and costs decrease with more effective and quickly replaceable tools and manufacturing aids?
- Would the adoption of high-performance materials provide new opportunities to decrease cost by replacing metal parts and/or tools with lighter yet strong 3D printed alternatives?
- How much would functional rapid prototyping with high-strength materials decrease your product development cycle and how much would that decrease your costs and accelerate time to revenue?

**According to the IDC Worldwide Semiannual 3D Printing Spending Guide*

*** A PwC (PricewaterhouseCoopers) report on 3DP in US industrial manufacturing*

Lower Production Costs with New 3D Printed Materials

- If you've tried 3D printing with desktop printers, have you assessed their true cost in terms of reliability, repeatability and build quality, in comparison to 3D printers designed for manufacturing?

The reality is that Stratasys FDM® 3D printing technology provides easy, effective solutions for the typical challenges manufacturers face every day: reducing cost, improving production efficiency, and minimizing lead times and delays.

The remainder of this white paper will highlight examples of these solutions and show you how small to large manufacturers benefit from this technology.

LOWER YOUR TOOL LEAD TIMES AND COST

Featured Material – ULTEM™ 9085

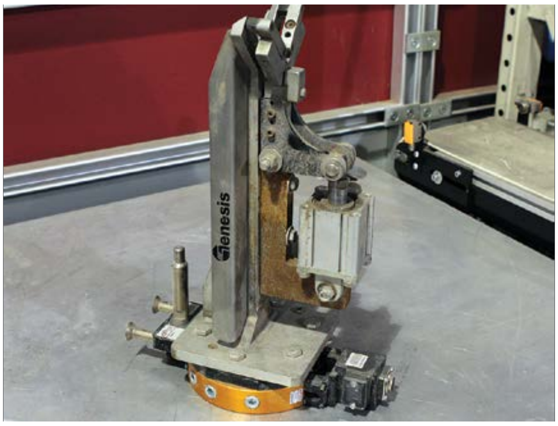
Capable Printers – Fortus 450mc™ / Fortus 900mc™ / F900™

Genesis Systems Group, headquartered in Davenport, Iowa, designs, builds and implements robotic automation systems. Its expertise enables the production of a wide array of products in the automotive, construction, aviation and recreational vehicle industries, to name a few. One of Genesis' specialties is building robotic, waterjet cutting systems used to trim composite parts. To hold the parts, Genesis uses end effectors or "grippers" attached to the robot's arm.

To create these grippers Genesis has relied on CNC machining, but the lead time and cost are very expensive. As an alternative, Genesis engineers examined the feasibility of using 3D printing to reduce the time and cost of making the grippers. They determined that while most 3D printed parts were not rugged enough to withstand the rigors of the water jet cutting process, grippers created with high-strength ULTEM 9085 resin material was more than suitable for the task. In addition, engineers were able to leverage FDM's ability to create intricate and complex shapes by creating an internal channel for a pneumatic air line, allowing the grippers to hold parts with a vacuum. This eliminated the need for cumbersome, external pneumatic lines that could be damaged in the waterjet environment.

By using 3D printing, Genesis reduced the time to create end effectors to three days and significantly reduced the cost — an 85% reduction in production time and an even greater 94% reduction in cost. The redesigned end effector, made with lightweight ULTEM 9085, also reduced the end effector's weight from 35 pounds to just 3 pounds, enabling use of a smaller motor to power the robot.

Lower Production Costs with New 3D Printed Materials



End effectors traditionally machined from metal were large, bulky and heavy.

The ULTEM 9085 gripper resulted in a much lighter tool that was much faster to produce.

Comparison Between End Effectors Made With Traditional Machining and 3D Printing

	Lead Time	Weight
CNC machining	20 days	35 lbs
FDM ULTEM 9085 resin	3 days	3 lbs
Savings	**17 days (85%)**	**32 lbs (94%)**

"Normally, it would take weeks to get traditional grippers made. With the FDM gripper, you can have a new end effector complete and bolted up to the robot within a day or so."

REDUCE DEVELOPMENT COSTS WITH FUNCTIONAL PROTOTYPING

Featured Material – Carbon Fiber Nylon 12

Capable Printer – Fortus 450mc

Thule makes products that let people "bring with them what they care for most," such as car racks and carriers, luggage and bags, and kids' accessories. Thule engineers rely on rapid prototyping to flesh out these product designs. However, one challenge the engineers typically faced was the inability to print prototypes with the stiffness and strength of fiber- or glass-reinforced injection molded parts that would enable the company to perform functional performance testing.

As a solution, Thule turned to Stratasys FDM Nylon 12CF™, a carbon fiber-filled thermoplastic that offers excellent strength and stiffness. It let Thule take the next step in the prototyping process and functionally test their designs. Clamp mechanisms with teeth that enage

Lower Production Costs with New 3D Printed Materials

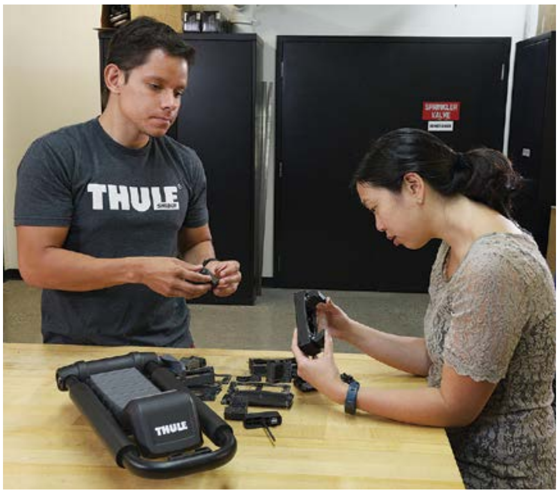
This kayak rack is typical of Thule products.

each other would break with other materials. But with the carbon fiber nylon 12 material, that's no longer a problem. Ultimately it gives Thule the ability to accelerate their product development process, since they can create prototypes, functionally test them and quickly re-print and re-test as needed to optimize the design. According to Thule prototyping engineer, Rob Humphries, "every time we print a part

in carbon fiber it takes two weeks off the time it would have taken us to send it out."

Engineers print three to four iterations in a week, with the ability to print a new version every night and improve it the next. That saves Thule's overall development cost and gets their products to market faster. "If we had to wait two weeks between iterations, a designer's project schedule would be shot," says Humphries. "The speed with which we're able to iterate puts better ideas into design." In less than a year, Thule has saved over $45,000 and innumerable days of development.

Nylon 12CF has performed so well for Thule that the company has begun printing assembly fixtures and manufacturing aids for their Connecticut manufacturing plant. This has also saved them time and money in comparison to outsourcing. Wanting to capitalize on the benefits of 3D printing, Thule sought quotes to have large production fixtures 3D printed out-of-house. But the cost averaged about $18 per cubic inch of material, versus just over $4 per cubic inch if



Thule engineers use FDM Nylon 12CF (carbon fiber) material to create functional prototypes.

Lower Production Costs with New 3D Printed Materials

they printed the fixtures in-house. Thule decided to keep the job in-house and in the process, saved enough money to pay for two Fortus 450mc 3D Printers.

“Nylon 12CF has been game-changing for us,” said Humphries. “Nothing that we could get affordably or quickly has the properties that Nylon 12CF does. It lets us more accurately model our production parts, test faster, and get to market faster.”

CUT COMPOSITE TOOL LEAD TIME FROM MONTHS TO DAYS

Featured Material – ULTEM 1010
Capable Printers – Fortus 450mc / Fortus 900mc / F900

Dassault Falcon Jet is a leader in business aircraft development, creating some of the world’s most advanced and efficient business jets. Dassault’s desire to innovate and reduce time to market led them to pursue new manufacturing solutions that included lay-up tools for a composite interior panel.

The lay-up tool would traditionally be made using fiber-reinforced polymer (FRP), resulting in a 10-16 week lead time and costing $20,000-$30,000 to produce. Instead, Dassault redesigned the tool, 3D printing it with ULTEM 1010 resin material. For this particular panel, the cure temperature of 250 °F at one atmosphere (vacuum only) is well within the performance range of ULTEM 1010 resin material, which is capable of withstanding cure cycles over 350 °F.

The result was a much lighter tool that could be easily transported by hand, instead of the traditional tool that requires a forklift. It also incorporates an open support structure, which helped optimize the airflow around the tool while minimizing 3D printing material use.

More significant, however, was the lead time and cost savings. The ULTEM 1010 lay-up tool was produced in about 3 weeks, including post-processing, for $5,600, compared with the FRP tool that takes upwards of 16 weeks to procure and costs an average of $25,000.

This capability means composite part manufacturers can dramatically cut what was traditionally a long, costly tool development process. Equally beneficial is the capacity to quickly change a tool’s design, as needed, providing greater flexibility to arrive at the optimal design.

Lower Production Costs with New 3D Printed Materials

The lighter, FDM tool is shown in the upper portion of the photo compared with the typical FRP tool shown below.

Unbagging the composite lay-up on the ULTEM 1010 tool.

Composite Lay-Up Tool Time and Cost Comparison

	Cost	Lead Time
Conventional FRP Tool	$25,000	16 weeks
ULTEM 1010 Resin Tool	$5,600	1-3 weeks
Savings	**~$20,000**	**~13 weeks**

DECREASE THE COST OF PRODUCTION PARTS

Featured Material – Antero (ESD) PEKK

Capable Printer – Fortus 450mc

Manufacturing spacecraft may be more niche than producing thousands of consumer products but the manufacturing challeges are no different. Staying on budget and producing to schedule is still paramount.

Lockheed Martin is the prime contractor for NASA's Orion space vehicles and relies on Stratasys FDM technology to create numerous parts on the spacecraft. But space vehicles have unique material requirements, one of them being electro static dissipative (ESD) properties. Having an ESD-capable 3D printing material gives Lockheed Martin the flexibility to use a light, yet strong material.

"There's always been the attraction of having an ESD-compliant polymer," says Brian Kaplun, Lockheed Martin's manager of additive manufacturing. "There were ESD compliant polymers available but they were ABS, and ABS is not something we would be able to fly on a spacecraft," due to mechanical, functional and dimensional stability issues.

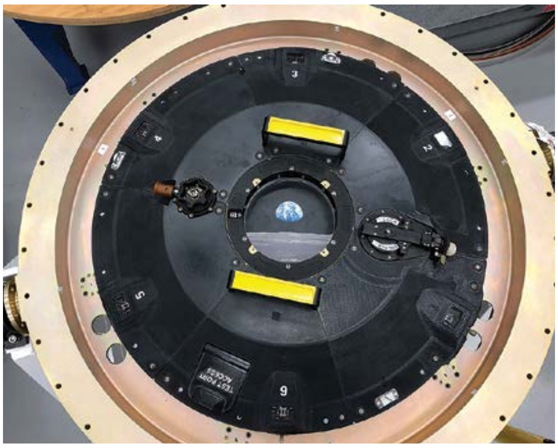
Lower Production Costs with New 3D Printed Materials

Using Antero (ESD), a Stratasys PEKK-based thermoplastic with ESD properties, Lockheed Martin was able to take advantage of its capabilities, while leveraging the time-saving advantages 3D printing offers over traditionally fabricated parts in other materials.

With Antero (ESD), Kaplan says, “We got a material that’s strong and capable of being used as a structural polymer that has those ESD qualities that we were looking for. We’ve been able to see orders of magnitude savings both in cost and schedule on all of these parts because the part builds are very consistent, the material properties are well understood, and the build parameters are becoming better understood. Also, the properties of the ESD PEKK eliminate a large amount of the post-processing that we would otherwise have to do. So that also nets a tremendous amount of time savings.”

The Orion spacecraft hatch covers are made entirely from Antero (ESD), allowing Lockheed Martin to save by avoiding secondary operations to achieve the necessary ESD characteristic. Other materials would require additional coatings or plating to deflect static charge, which made Antero (ESD) very attractive to Lockheed Martin.

One of the Orion hatch segments 3D printed with Antero (ESD) PEKK material.



The finished hatch made up of several 3D printed sections.

CONCLUSION

Any belief that 3D printing is not a manufacturing technology is simply an outdated mental model. As is the case with any manufacturing technology, no one methodology provides the complete answer to today's complex manufacturing challenges. However, 3D printing, as does machining, casting or injection molding, has its place on the production floor and complements these existing technologies, evidenced by the preceding case studies.

Stratasys offers high-strength, high-capability materials and reliable 3D printers with a proven track record of delivering consistent results. They give small and large manufacturers the tools needed to reduce cost, meet schedule and get to market faster by providing more effective alternatives to existing materials and production methods.

To learn more about how 3D printing with high-performance materials can solve your manufacturing challenges, visit our website or talk with a Stratasys representative.

STRATASYS.COM

HEADQUARTERS
7665 Commerce Way, Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937 3000 (Intl)
+1 952 937 0070 (Fax)

1 Holtzman St., Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys

THE **3D PRINTING SOLUTIONS** COMPANY™

For more information about Stratasys systems, materials and applications, call 888.480.3548 or visit www.stratasys.com