CASE STUDY | CLEMSON UNIVERSITY

Clemson University students turn imagination into innovation with HP Multi Jet Fusion technology

Engineering students at Clemson University design, create, and innovate with HP Jet Fusion 3D Printing Solutions

Color prototype produced by a Clemson University student.

Introduction

Clemson University is a public research university located in South Carolina. Founded in 1889, it is the second-largest university based on student population in the state.

Clemson's College of Engineering, Computing, and Applied Sciences (CECAS) has a deep commitment to research, education, and scholarship, engaging students in critical thinking and thereby inspiring new discoveries that can transform economic development in South Carolina, the United States, and the world.

• Industry

Education and research

• Sector

Higher education

• Objective

To use HP Multi Jet Fusion technology to produce prototypes and various engineering projects for Clemson University students and select external customers.

• Approach

In adopting an HP Jet Fusion 580 Color 3D Printer, Clemson students are able to expand their design and production capabilities in order to print sturdier, full-color prototypes with enhanced mechanical properties in a shorter amount of time.

• Technology | Solution

HP Multi Jet Fusion technology, HP Jet Fusion 580 Color 3D Printer

• Material

HP 3D High Reusability[1] (HR) CB PA 12

1. HP Jet Fusion 3D Printing Solutions using HP 3D High Reusability CB PA 12 provide up to 80% powder reusability ratio, producing functional parts batch after batch. For testing, material is aged in real printing conditions and powder is tracked by generations (worst case for reusability). Parts are then made from each generation and tested for mechanical properties and accuracy.

Challenge

Clemson has worked with a variety of 3D printing technologies since 2007, including fused deposition modeling (FDM), material jetting, and stereolithography (SLA), according to Timothy Pruett, Manager of the 3D Printing Lab for the Machining and Technical Services (MTS) group, part of the CECAS at Clemson.

Currently, the 3D Printing Lab offers 3D printing services to two sets of customers: students who design prototypes for classes and entrepreneurial projects and a select group of local companies, including automotive suppliers. Both groups require 3D printing services that can accommodate complex designs, withstand functional testing, and are dimensionally accurate. However, Clemson's legacy 3D printing technologies have struggled to keep up with these demands.

"As engineers, we have a lot of great ideas," said John Desjardins, Bioengineering Professor at Clemson University. **"3D printing is used in our senior design course to allow the student to see their product for the first time, to evaluate not just how it's going to look but also how it's going to work."**

For example, bioengineering students often use the lab's 3D printers to print prototypes of new products—like a new type of catheter or an apparatus to hold an infant's head in place during cranial surgery. Many of the students' designs include small, detailed features that need to be both strong and precise.

In the past, Pruett said his 3D printers have struggled to print these types of parts, and he would often have to ask students to redesign their parts to meet their desired tolerances and clearances.

"Many times, I'll print tiny bioengineering projects with (material jetting) and (when I) water-jet off the support material, sometimes there's no part left because they'll have some small feature that breaks off," said Pruett. **"I've found that even the tiniest feature made out of (HP's) nylon is a lot stronger."**

Since adopting the HP Jet Fusion 580 Color 3D Printer, Pruett said he has been able to print parts he did not think were possible to produce on 3D printers. This not only makes Pruett's students and customers happy, but it also encourages them to push the boundaries of their imagination—they no longer are restricted by previous design constraints.

Solution

In addition to the improved accuracy of HP Multi Jet Fusion 3D printing technology, Pruett is also impressed by its speed.

"If you give me the file by 3 o'clock, I'll give your parts to you the next day," Pruett said. **"I come in in the morning and parts are ready to be pulled out [of the printer]. I pull them out, bead blast them, and by 9 a.m., everybody's parts are ready."**

Due to the speed and capacity of HP MJF, Pruett's workflow has changed. With previous technologies, he mostly printed student and customer parts one at a time or in small batches. If there were multiple requests, he could get a backlog. However, thanks to HP Multi Jet Fusion's fast print speed and capacity to print multiple parts in the same build, he doesn't worry about this as much.

"[Students] put together their prototypes and bring me their CAD files," he said. **"I assess them to determine which [3D printing] technology is best for them. Lately, everything I see is going to the HP machine. And [students] are excited because I am telling them they can get their parts the next day."**

Result

The HP Jet Fusion 580 Color 3D Printer produces high-quality parts at an affordable price point, according to Pruett. This has already made the printer more attractive to Pruett than Clemson's legacy technologies. Indeed, Clemson's FDM printers were affordable, but produced parts with layer lines, and material jetting printers produced smooth parts, but had high material prices, Pruett explained. Now with HP, he does not have to deal with these tradeoffs.

"It will probably replace 60 or 80 percent of the work I do with the other machines," Pruett said.

The potential to print in color is yet another contributing factor to Pruett's enthusiasm about the HP Jet Fusion 580 Color 3D Printer.

"When we start printing parts in color, the models are going to be much more appealing aesthetically," Pruett said.

"The students are going to make their gadget, put their name on the side of it, design their own logo, and it's going to look like a professional product."

Ultimately, Pruett said color was the first thing to catch his eye about the HP Jet Fusion 580 Color 3D Printer, but now he is so enthusiastic about the entire package—the speed, cost, the strength of the nylon, the ease of printing—that he sees color as just another added benefit.

"When I first saw this machine, color is what got me excited about it," said Pruett. **"But now this machine is so awesome I'd almost be just as happy as if it never had color—even though it is nice to print the Clemson orange!"**

Color prototype produced by a Clemson University student.

Student stories

As a doctoral student and research assistant in Clemson's mechanical engineering department, Beau Pollard studies bio-inspired locomotion.

One of Pollard's projects involved building a bio-inspired aquatic robot. The flexibility of a natural swimmer's fins or tails are a key parameter for their swimming performance.

"Adding flexible materials to enhance the swimming performance of our robot is easy experimentally but it makes the robot extremely difficult to model theoretically," said Pollard. Alternatively, using multiple rigid bodies connected by springs captures some of the desired flex characteristics without exponentially increasing the theoretical modeling.

"The FDM printers that we originally used would not have been able to produce multiple bodies connected by springs, but the HP printer has accomplished this accurately and repeatability," Pollard said. **"The ability to print the springs along with the rigid bodies has significantly decreased my build time and allowed us to collect more experimental data.**

"We recently wanted to look at cases where we had some variables in joint stiffness in these robots," Pollard added. **"This joint stiffness is something that's not very easy to attain with torsional springs, but with this new 3D printer, we actually were able to print nylon springs that are already attached to the body and the tail, which are working quite well. That's a huge advantage for us because that probably eliminated a couple of weeks of trial-and-error attempts. Instead of taking weeks or even a month, it took two days."**

Spencer Marsh—a graduate student in Clemson's bioengineering department—had previous experience with 3D printers in Clemson's 3D Printing Lab. When printing clip inserts for a left ventricular bioreactor, parts that are repeatedly pumped with pressure just like a normal human heart, Marsh noticed that parts made with previous 3D printing materials were continuously breaking. With HP 3D HR CB PA 12, Marsh and his fellow students have yet to experience any breakage.

"[HP's material] is giving us a lot more room for flexibility as far as the intricacy of the designs," Marsh said. **"[Due to] the lack of mechanical properties with ABS, we couldn't print a plate. We could print the inserts, but we still had to buy the provided plates from the company. Because {HP 3D HR CB PA 12 is] so much stronger, we're able to print entire pieces, which has allowed us to expand upon projects.**

"The level of detail is also impressive," Marsh added. **"We have small features down to millimeter scale, and the print is accurate enough to use with minimal adjustments (sanding, etc.)."**

As far as being able to offer these capabilities to students, Desjardins said: **"They've been able to realize their dream, what they're thinking in their head, what they're seeing on their computer, so it's really a moment for them of true learning inflection. We're exposing them to how 3D printing processes work, they're able to use that in their education, but we're also teaching them how things are going to be made in the future."**

Connect with an HP 3D Printing expert or sign up for the latest news about HP Jet Fusion 3D Printing
hp.com/go/3Dcontactus

Learn more about HP Multi Jet Fusion technology at
hp.com/go/3DPrint

© Copyright 2019 HP Development Company, L.P.

The only warranties for HP products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. HP shall not be liable for technical or editorial errors or omissions contained herein.

4AA7-5900EEW, August 2019