CASE STUDY: FORMULA UBC LEVERAGES 3D PRINTING TO INNOVATE IN MOTORSPORTS

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UTILIZING NEWPRO3D'S INNOVATIVE DLP 3D PRINTING TECHNOLOGY AND ADVANCED MATERIALS FROM HENKEL, FORMULA UBC FIELDS A LIGHTER WEIGHT, HIGHER PERFORMANCE RACE CAR

"In automotive racing, you either continuously improve, or get left behind," says University of British Columbia student, team engine lead, and driver, Jerry Xiao. "In order to remain competitive we need to optimize every aspect of our car. The engine is the heaviest part of the vehicle. Anything we can do to make it lighter, or redistribute its weight gives us an advantage."

Background

Formula SAE is a student design competition organized by SAE International (previously known as the Society of Automotive Engineers, SAE). Based on a set of rules, students from each participating university design, build and test a prototype. The cars are judged in a series of events that evaluate their performance, in addition to their design, manufacturing and cost.

In 2018 a team of 52 engineering students from the University of British Columbia competed against 120 other university teams from around the world. The team at Formula UBC finished 43rd overall at Formula SAE Michigan in May of 2019. This year they made several refinements to their car, in preparation for its next opportunity to compete.

Each member contributes his or her skills in a specialized area of interest such as powertrain, chassis, suspension, electronics, controls or aerodynamics. In addition to being one of the team's drivers, Jerry Xiao is responsible for the car's engine. It features several custom-designed engine subsystems including a custom air intake, tuned exhaust, dry sump lubrication, and cooling system.

APPLICATION:
Performance automotive racing parts

MATERIAL:
LOCTITE 3D 3843

TECHNOLOGY:
Digital Light Processing (DLP) photopolymer 3D printer

The Challenge

Formula UBC Racing is a student engineering team that designs, builds, and races an open wheeled, formula style race car. Each year students build a new car from scratch. The team competes in the international Formula SAE (FSAE) Collegiate design series and has been active since 1991.

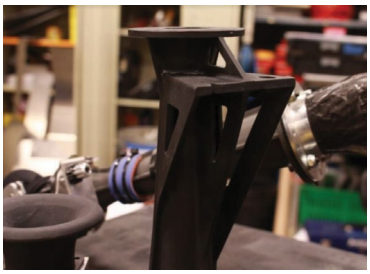
Over the past couple of years, the team at Formula UBC has been focused on improving reliability and refining their car's subsystems through testing and validation, with an emphasis on addressing specific areas of weakness from previous years.

The team identified several engine parts that would benefit from a redesign. Working with 3D printing equipment supplier NewPro3D, Formula UBC began investigating ways to leverage additive manufacturing to reengineer how these key parts were produced.

Formula UBC race car and engine

The Solution

"Like all internal combustion engines, ours runs on a mix of gasoline and oxygen. Enabling the engine to breathe more air can have a big impact on horsepower," says Mr. Xiao. "However, as with many other racing formats, we're limited by the rules as to how much air we can allow. Every car must include a 20mm restrictor plate, but there is some flexibility when it comes to how it's designed and incorporated. We saw 3D printing as a way to improve tolerances to the point where they were exactly conforming."



3D printed intake neck and bellmouth

In 2018, the engine team began experimenting with NewPro3D's technology and redesigned two parts for 3D printing, including the air intake's bellmouth and a throttle mounting bracket. Their efforts helped reduce weight and improv the car's overall performance.

For the 2019-2020 season, the team's plans got more ambitious. First they redesigned the car's intake neck throttle cable bracket. Using Loctite's 3D 3843 material, they were able to additively manufacture a one piece assembly. To ensure the part would meet the rigors of racing, it was tested and the team

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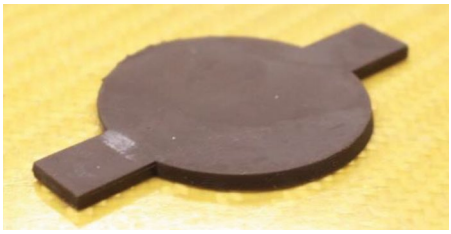
found that it would withstand 30 pounds of pulling force in either direction without any measurable flex, making it more than capable of performing under stress.



3D printed throttle valve

Also this year, the team redesigned the car's throttle valve. When flow testing they found that the old design was a significant barrier to peak performance. The previous part was also machined and used a screw and a round shaft to mount the valve. The limitations of this design made it difficult to achieve the tight tolerances that are needed for maximum airflow. As a result it was actually robbing the car of power before air ever got to the restrictor.

The new 3D printed design allowed air to flow more freely, producing more power and enabling the engine to more closely mirror its simulation models. Part of this was due to the design itself. But the assembly technique also contributed. Instead of using the screws and rounds shaft, they were able to adjoin the new throttle valve to a more efficient hinge.

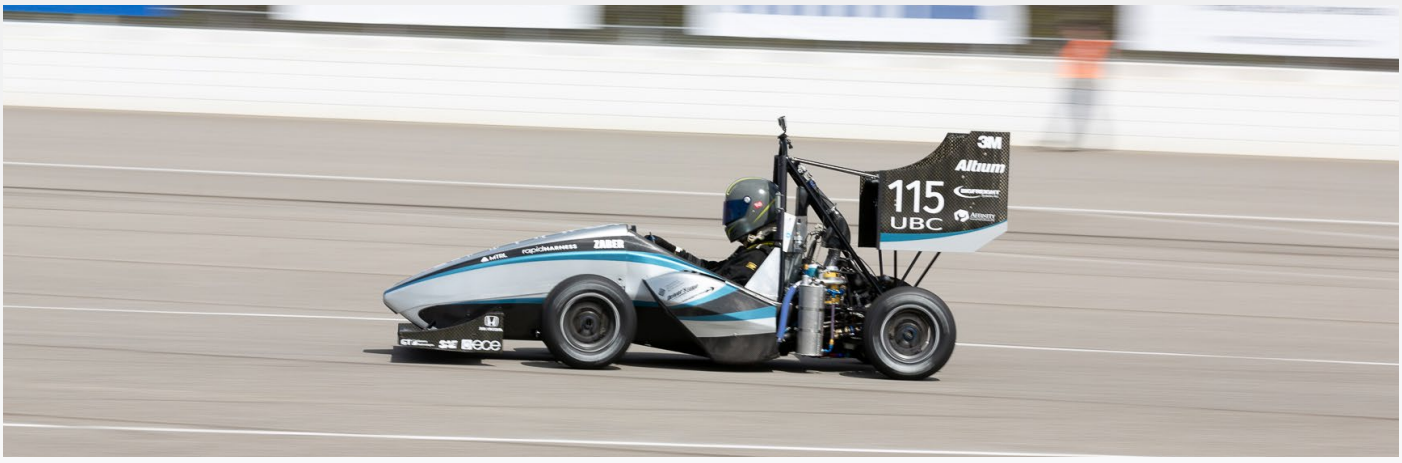
BENEFITS

"Advanced materials like composites and plastics have helped us lower the car's weight and redistribute it lower, closer to it's center of gravity," says Mr. Xiao. "But the combination of NewPro3D's 3D printing technology and Henkel's material have also helped us increase performance. Over two years, we've improved our intake system to the point where the engine is yielding significantly more horsepower and torque."

Air intake with 3D printed parts

The new intake neck with integrated throttle cable bracket weighed 20 grams less than the previous design, helping lighten the overall weight of the car. With its tighter tolerances, it also helped maximize airflow.

The flat throttle valve also contributed to the car's increased performance. It allows air to flow at 99 grams per second versus the previous design's 45 grams per second, an increase of 120%! The power gains were most noticeable starting at 10,000 RPMs, all the way up to the redline of 15,000 RPM's, which is the powerband and where the driver spends 20% of his or her time.



Formula UBC race car operating at peak performance

The design freedom offered by additive manufacturing was a key factor for Formula UBC Racing. Working with CAD and flow simulation software, they were able to generate designs that couldn't be made with traditional processes. Working with NewPro3D they were able to prototype and test with end-use parts. They could conduct flow tests and force analysis in an operational environment, and have confidence knowing the parts would perform on the track.

3D printing also helped reduce the time and cost of building new parts. Typically the team receives a new rule book in November. They spend about six months designing and refining their car. In the past it would take weeks for them to be machined and finished. With NewPro3D's assistance they were able to get two batches of parts in less than 10 days.

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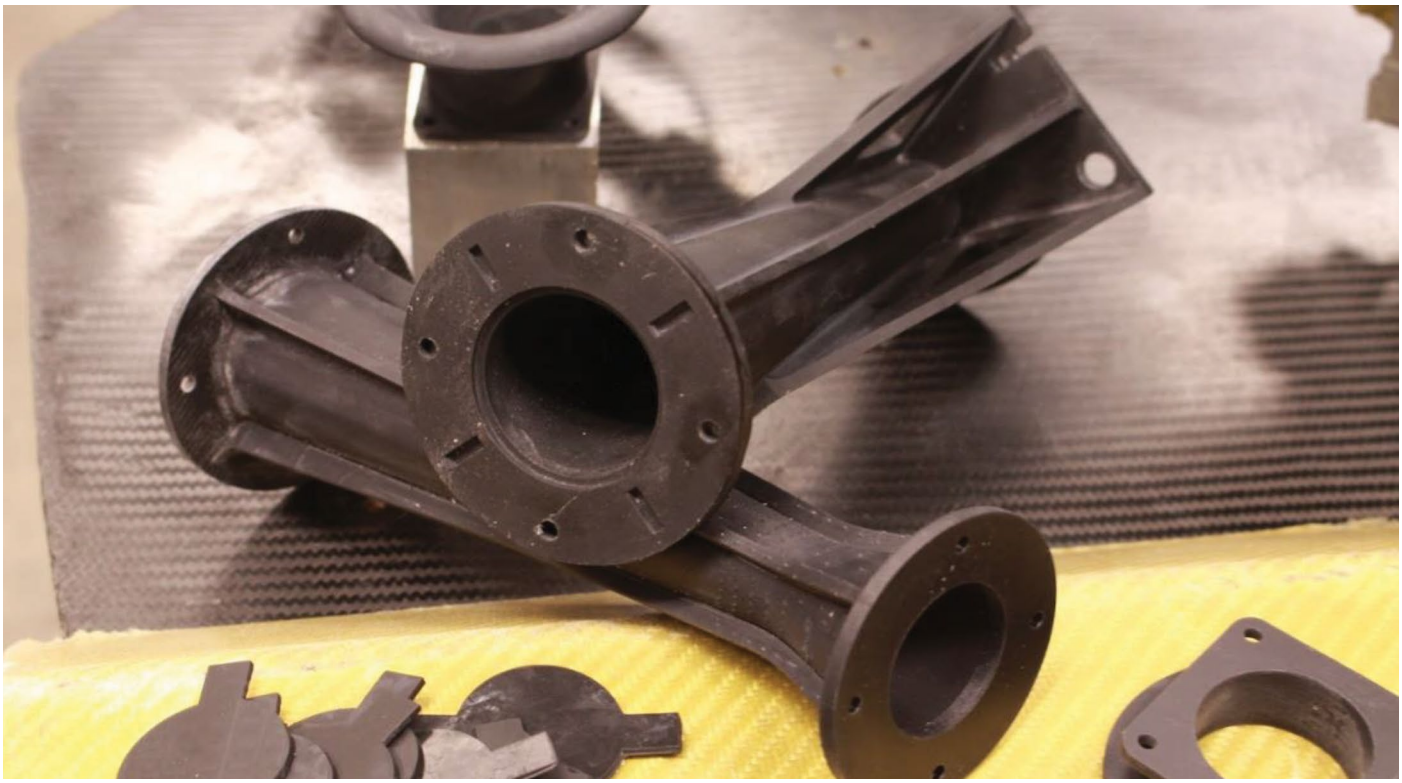
"From our perspective, it's great to work with such a talented group of young engineers, says Gabriel Castanon," COO of NewPro3D. They're innovative, creative and motivated to win. We're excited to help them on their journey while also validating opportunities in motorsports and across the automotive industry."

Beyond the air intake system there are other opportunities for advanced materials and additive manufacturing. Right now the car uses an open floor design. While it is lightweight, it does not maximize its aerodynamics. Instead the team is considering a carbon fiber floor that will.

Parts on NewPro3D N1 3D Printer



Further, the engine team is looking at how 3D printing might be used to improve the car's dry sump lubrication system. The current oil pan is machined from aluminum, which suffers the same limitations as the older intake neck and throttle valve designs. An additively manufactured version would not only channel the oil more effectively, but also further lighten the car's overall weight.

Want to learn more about Henkel's unique material solutions for the additive manufacturing industry? Visit Henkel's LOCTITE 3D Printing at **LoctiteAM.com** or reach out to us via **loctite3dp@henkel.com**

About LOCTITE

LOCTITE Additive Manufacturing delivers unique photopolymers with production capability, customize resins and deliver engineering services to identify the best application to address your needs. With a constantly growing portfolio of high-performance materials, specialized equipment and post-processing solutions, LOCTITE overcomes the limitations of conventional 3D printing to enable additive manufacturing for the production of durable, functional parts. Through its strategic partnership with technology leaders for specialized equipment, LOCTITE is driving the adoption of 3D printing beyond prototyping and toward the production of final parts. **(www.LoctiteAM.com)**

About NewPro3D

NewPro3D is a Vancouver based company that focuses on ultra-fast 3D Printing of photopolymers. NewPro3D's unique technology for digital light processing (DLP) produces 3D models at record speeds. Specifically, the company's Intelligent Liquid Interface (ILITM) consists of a transparent wettable membrane that is chemically designed to facilitate faster movement between cured layers, eliminating the slow mechanical processes used on conventional 3D printing techniques. Reach out to NewPro3D via **(https://newpro3d.com)**