Monash Motorsport takes advantage of optimization and additive manufacturing technologies and wins again!

Overview

Since their first Australian SAE Student Racing competition in 2000, the Monash Motorsport team has steadily improved the performance of their race car. The results speak for themselves: six consecutive victories in the Australasian competition, a strong performance in the European Formula Student competitions plus a current number 7 world ranking.
This success is based on a strong fundamental engineering understanding, innovative concepts and a passion to perform at the highest level. Recently the students discovered the benefits of combining Altair's OptiStruct optimization technology and 3D printing. Based on an initial prototype rear hub design from the 2013 car, the team proceeded to pursue titanium front hubs and uprights to decrease the car's unsprung mass. This was a tough challenge, since the former design was already made of lightweight aluminum. To tackle this, Monash Motorsport employed Altair's optimization technology OptiStruct to design and optimize a titanium upright, which was then produced using additive manufacturing technology from CSIRO. As a result, the students were able to reduce the component's weight by a further 30 percent whilst maintaining the component stiffness and reducing the development time and costs.

Racing Car of the Monash Motorsport team

Customer Profile

Monash Motorsport is a student-run organization based at Monash University's largest campus in Clayton, Victoria. A team of 70 students designs, constructs and races an open-wheel racecar in Formula SAE, the world's largest student engineering design competition with over 500 teams worldwide. In the Monash Motorsport team, students gain invaluable practical skills in their respective fields of both engineering and business, enriching their university experience and equipping them with knowledge that will allow them to prosper in their chosen career paths. www.monashmotorsport.com

Challenge

To continue competing at the highest level, the overall aim for Monash Motorsport was to develop faster, lighter, better and more innovative race cars while keeping development time and costs under control.

At the end of 2013, the team was facing new weight and performance challenges. With the evolution of 3D printing the students found a new technology that would help them to build even lighter cars. Additive manufacturing presents a number of exciting opportunities in part design as it allows organic shapes and structures to be made, which regular manufacturing methods would otherwise restrict. But it also creates new development challenges since the 3D printed components are only as good as their design.

The titanium upright was designed to be interchangeable with the existing upright, with only minor changes to be made after the tuning of the previous race car, M13. The design process for the upright consisted of FEA validation using a number of load cases. The hub design was also designed to be interchangeable. Within these constraints, the team had to conduct an optimization to find the ideal material distribution in the components while taking into account the additional manufacturing constraints of the additive manufacturing technology.

"Optimization of a structural part is all about efficient material use. Using OptiStruct takes the question of material distribution in a design out of the equation and tells you exactly what you need to do and where the material needs to be. If you use OptiStruct, you can skip all that messing around with different options, because it gives you the best options straight away."

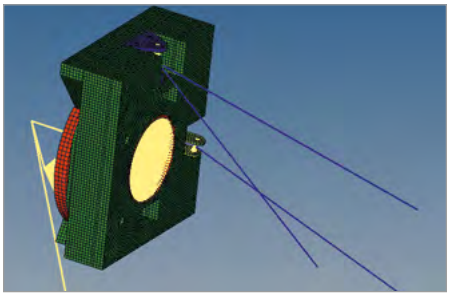
Mark Stroud, Monash Motorsport team

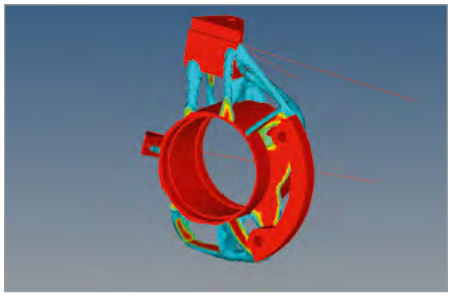
The Monash Motorsport team

Solution

The use of Altair's HyperWorks Suite enabled a simulation driven design process and an optimal structural design of the component planned to be produced with additive manufacturing. Working within the constraints of the current geometry, the students created a design space in Altair's optimization tool OptiStruct. By applying boundary conditions such as loads and manufacturing constraints they ran a topology optimization and OptiStruct helped them to create a stiffer and lighter component structure. The students then used the OptiStruct design proposal, interpreted it and created a working CAD design. This design was then validated with a further Finite-Element Analysis, using multiple load cases.

Many of the surfaces on the part were required to be within small tolerances. Additionally it also had many mounting surfaces. The entire manufacturing of the part was therefore closely considered, adding extra material to be machined off.





Optimization of the titanium upright with OptiStruct. left: Defining the design space is one of the initial steps in the optimization procedure; right: The topology optimization provides the ideal material distribution with the given boundary conditions.

The new titanium upright was designed to be interchangeable with the existing aluminum upright.

Results

OptiStruct helped Monash Motorsport to reach the highest possible weight saving and enabled them to achieve the overall goal of the project: a further reduction of weight from an already light upright design. The finished parts are a testimonial for the true capabilities of the combination of optimization with OptiStruct and latest manufacturing technologies such as election beam melting of titanium. The total combined weight saving was approximately 30 percent while being stiffer and therefore safer than the previous design. OptiStruct contributed to this result by delivering a design proposal, inspired by nature and with an optimized material distribution.

With 3D printing the team was able to use less than half of the titanium material used within the traditional manufacturing process. It also was much quicker to get the component manufactured, since the students didn't have to spend much time on CAM processes or to think about how the part would be machined. The overall printing process took only a day, which was a major time saving, compared to the manufacturing of the last year's aluminum part.

Benefits

- lighter and stiffer structure due to use of topology optimization with OptiStruct
- material, time, cost and prototypes savings due to optimized development process with the Altair HyperWorks suite
- lead time reduction thanks to the combined usage of engineering software tools and additive manufacturing technology

Monash Motorsport put in a fantastic effort over the weekend of the 13th of December. They won their sixth consecutive FSAE-Australasia title! With this success Monash Motorsport was the first team in Formula SAE history to take home six consecutive victories at a single competition.