Facts

Challenge

Build a reliable, lightweight axle-pivot with high rigidity, in the shortest possible time.

Solution

Production of a topology-optimized steering stub axle using EOS technology.

Results

- Optimized: perfect form and contouring for a reduced weight by 35% and an increased rigidity by 20%
- Speedy: significant shortage in development and production time
- Safety: reliable on the track

In the construction the student engineers employed for the first time an additive manufacturing process and the car went on to win the title. (Source: Rennteam Uni Stuttgart).

Easing to Victory – The Rennteam Uni Stuttgart Wins the Formula Student Germany with EOS support

Young engineers choose additive manufacturing to tap the full potential of the part

Short profile

The Rennteam Uni Stuttgart is an independent club composed of highly motivated students from a broad range of fields. It takes part in the Formula Student racing series, a competition for young engineers, across Europe, as well as being involved in other international competitions.

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The greater the force in play, the greater the resulting counter-force – a relatively basic rule of physics. Such rules are particularly relevant in motorsports, where the stresses placed on the utilized materials are extreme. Taking the circuit at high speeds exposes both driver and car to the effects of such forces. The young constructors of the Rennteam Uni Stuttgart are constantly striving to optimize the construction process and the use of materials.

More and more the sport demands that not only should the driver pilot the car ever quicker around the track but, within the principles of the Formula Student Germany series, he should do it safely. In the construction of the successful 2012 model the student engineers employed for the first time an additive manufacturing process in the building of the knuckles – and the car went on to win the title. EOS supported the team through its victorious Formula Student Germany season.

Challenge

The knuckle – also called the axle-pivot – connects the wheel axle with the wishbones and the track rod via a bearing. The braking system is then likewise fixed to it. The part conducts all the forces and momentum absorbed from the wheels to the wishbones and the tie rod, and on to the vehicle chassis itself. On the one hand, every constructor of an axle-pivot has the task of developing a part with the highest possible stability – otherwise the safety of the vehicle as a whole would be undermined. Besides a fracture, part deformation can also have serious consequences, as the kinematic design and, as a result, the drivability, would be negatively impacted.

On the other hand, the wheel mounts cannot, for a number of reasons, weigh too much. Every additional gramme increases lap times, and the wheel mounts belong to the so-called unsprung mass of a vehicle. The less there is of this mass, the better the suspension and shock absorption will function. A low wheel-mount weight allows the car to sit better on the track – important for fast laps and safe racing. As a consequence, constructors are faced with the tricky task of finding the perfect balance between rigidity and weight.

Thanks to additive manufacturing, the weight of the knuckles was reduced by 660 grammes in all. Numbers that were translated into faster lap times and reduced fuel consumption (Source: Rennteam Uni Stuttgart).

Previous production technologies offered the Stuttgart race team too little room to maneuver in the search for this perfect balance. "The wheel mount we'd been using over the last few years had already achieved a good balance between weight and rigidity, but we were sure we could improve on it," explains Yannick Löw from the Rennteam Uni Stuttgart. "We produced the part using the classic precision casting process. This, of course, led to limitations in freedom of form, which meant that the part's potential could never be fully realized. Even back then we'd decided that for the 2012 season we'd investigate new, innovative ways of manufacturing the steering stub axle." It didn't take long for the team to decide upon the path to take: The EOS-technology.

Solution

As early as the conceptual design phase, the engineers utilized the CAD software from EOS partners Within Technologies Ltd. Within is a young company, whose programmers wrote their software specifically for the additive manufacturing process. The program makes possible the optimization of latticed micro-structures of variable densities following examples found in nature. Thanks to this tool the constructors were able to match the part perfectly to the structural requirements. In this way, they were able to give the knuckle precisely the required physical properties – lightweight plus rigidity.

"By the simplified, so called, 3D-Print process, our machine honed powdered metal granules with the help of a laser, layer by layer, into the required part," explains Nikolai Zaepernick, Business Development Manager Automotive at EOS. "The victorious team from Stuttgart decided on our partner Within's software for the construction of the CAD model, as it was the most suited for the part and its purpose. The information for the manufacture of the part was provided for the Direct Metal Laser Sintering (DMLS™) machine from our universally deployable software, which had, so to say, translated the information from the existing 3D-CAD-model. The result was amazing and showed just how much the young engineers already understand about their subject."

Once the team had designed the steering stub axle, the production of the first component parts followed immediately. The fact that the development and production time could be significantly shortened when compared to previously utilized processes was important for the team. There were a number of reasons for the time savings. One is that with additive manufacturing the need to build negatives or mould forms falls by the wayside. In addition the entire process, from design through fabrication is more precise, meaning that often no reworking or refining is required. In this case the constructors from Stuttgart reached a high production quality in a very short time with minimal honing for fit, so that the part was almost immediately race-ready.

Results

The advantages can be summed up in concrete figures: The weight of the part was reduced by 660 grammes, saving the Rennteam Uni Stuttgart 35%. At the same time the engineers succeeded in increasing the rigidity by 20% - big numbers for motorsports, and numbers that translate into faster lap times and reduced fuel consumption. The best testimony was delivered by the team with the result in the final race of the series – a victory at the Hockenheimring that crowned the Stuttgart race team as Formula Student Germany Champions 2012.

"We are thrilled to have been able to bring the Formula Student Germany 2012 title to Stuttgart. The freedom in the construction process offered by the DMLS technology from EOS has played an important role in our success," says Löw. All those involved have shown with this victory that the engineering profession can be a lot of fun – and ultimately, that there are a multitude of interesting and exciting ways of responding to the shortage of technical specialists. And the allure of new technologies, such as additive manufacturing, can play a role in this, inspiring down the line more and more young people to take a serious look at a career in engineering.

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Yannick Löw,
Rennteam Uni Stuttgart

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