SLM SOLUTIONS

Case Report
Lightweight Brake Pedal for Racing Cars

TU Graz
Graz University of Technology

Material reduction with high-strength, lightweight material and topology optimization

Additive manufacturing in motorsports at TU Graz Racing Team

Institute of Production Engineering of Graz University of Technology

The Institute of Production Engineering of Graz University of Technology is dedicated to production technology and digitalized manufacturing within the context of its activities in teaching and research. Particular emphasis is placed on the technological foundations of metal-cutting and additive manufacturing, machine tool manufacturing and the embedding of state-of-the-art production systems in a fully digitalized value-added chain.

TU Graz Racing Team

Fig. 1 TU Graz Racing Team builds racing cars to participate in international Forumla Student races

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The TU Graz Racing Team designs and manufactures racing cars to participate in international Formula Student races. Every year, approx. 50 team members from a wide variety of disciplines, from mechanical engineering and telematics to business administration, work on a common goal: to build the best racing car within the Formula Student.

Fig. 2 An additively manufactured brake pedal is installed in the race car "TANKIA"

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CURRENT SITUATION / CHALLENGES

Additively-made Brake Pedal in Lightweight Construction

The brake pedal was created in collaboration between the Graz University of Technology and the TU Graz Racing Team and represents the first joint step in terms of topology-optimized components for the Formula Student. The application of SLM® technology contributed significantly to implementing the complex geometric designs.

The brake pedal is installed in the latest racing car "TANKIA 2018" of the TU Graz Racing Team. As usual in racing, consistent lightweight construction is of utmost importance. Since the Formula Student is also a design contest, it is important to convince the responsible judges with innovative production-engineering approaches. Used meaningfully, 3D-printing in racing is certainly such an approach.

SLM® SOLUTION

Topology Optimized Brake Pedal with Functional Integration

The Institute of Production Engineering of Graz University of Technology sees high potential in topology optimization paired with metal-based additive manufacturing. In contrast to conventional manufacturing processes, only 3D-printing can best implement complex geometric designs based on topology optimization.

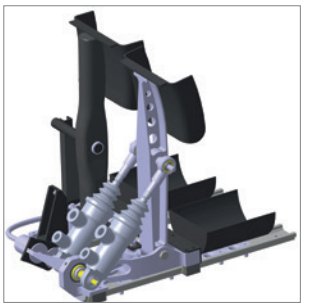

Fig. 3 Original pedalbox
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To meet the challenge of lightweight construction, the long-standing design of the brake pedal, which had previously been manufactured as a milled part, was discarded. The component was completely redesigned with topology optimization in mind to meet not only the strength requirements but also ergonomic styling.

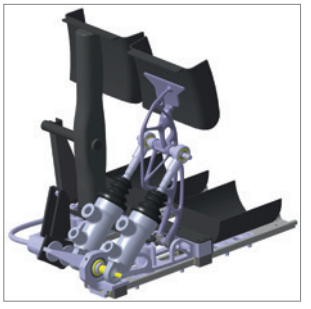

Fig. 4 Topology optimized brake pedal inside the pedalbox
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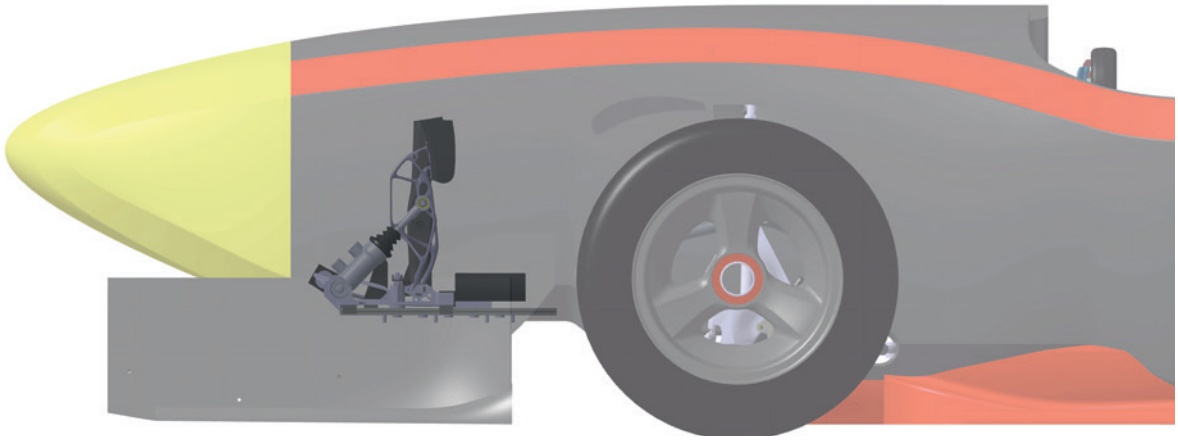

Fig. 5 By optimizing the topology and using Ti6Al4V high-strength lightweight material, the weight of the brake pedal was reduced
© TU Graz Racing Team

The component was prepared with Additive.Designer®, the new processing software from SLM Solutions for 3D-printing. The topology was optimized with the kind support of Altair and the software solidThinking Inspire.

Weight Reduction

By optimizing the topology and using Ti6Al4V high-strength lightweight material, the weight of the brake pedal built on an SLM®280 could be reduced from 153 g to 108 g, a reduction of 29.4%. The stiffness was slightly reduced by the consistent lightweight construction compared to the original component, but within an acceptable range.

Additionally, the team was able to exploit another benefit of the Selective Laser Melting technology-functionality integration. The new design and production technology allowed for the reservoir of brake fluid to be fed directly to the pedal.

Fig. 6 Additively-manufactured brake pedal designed with Additive.Designer®

SUMMARY

Lightweight Brake Pedal for Racing Cars

- Collaboration of the Institute of Production Engineering of Graz University of Technology with the TU Graz Racing Team
- Development of the racing car "TANKIA 2018" for participation in the Formula Student design contest
- Goal is the development of a brake pedal with the important characteristics required in racing with the help of SLM® technology
- In addition to consistent lightweight construction, strength and ergonomic aspects are important
- Material savings of 29.4% thanks to high-strength lightweight construction material and topology optimization
- Additional functional integration due to integration of the brake fluid reservoir directly on the pedal

Fig. 7 The goal was the development of an improved, lightweight brake pedal with the help of SLM® technology
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About SLM Solutions

The Lübeck-based SLM Solutions Group AG is a leading provider of metal-based additive manufacturing technology. SLM Solutions focuses on the development, assembly and sale of machines and integrated system solutions in the field of selective laser melting.

SLM® technology offers diverse options in the metal-based additive manufacturing of parts, such as a new design and geometric freedom, lightweight construction through the reduction of metal part weight, significant advantages in terms of production speed and the manufacturing of internal undercut parts in low quantities.

Our products are utilized globally by customers from the most varied sectors, particularly in the aerospace, automotive, tooling, energy and healthcare industries, as well as in research and education.

They particularly value the following advantages of our technology partnership:

- Highest **productivity** using patented multi-laser technology
- Highest material density and **part quality** through our innovative gas stream management
- Completely closed **powder management** in an inert gas atmosphere
- Cutting-edge process monitoring using various **quality control modules**
- Multilingual open **software architecture** with customer adaptability
- Ultracompact **modular design**
- Long-term and **confidential customer relationships**
- **A technological leader and pioneer** in metal-based additive manufacturing with decades of market experience

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