

Lighter, Better, Faster – HyperWorks in the Construction of Formula Student Cars

Overview

The Formula Student Racing Team Elbforace is the racing team of the Technical University of Dresden. The team develops, designs, and manufactures every year a racing car that competes with 270 teams from all over the world at the Formula Student competition. In the season 2010/2011, the team decided to switch from a combustion engine to an electrical powertrain concept. Due to the additional weight that the electrical concept causes, i. e. due to the use of accumulators and an AC converter, the design of the remaining components of the car had to be optimized to still reach a minimum weight for the complete vehicle. The team used HyperWorks for meshing, finite element analysis, and for optimization tasks. Thanks to OptiStruct the team achieved significant weight savings with the redesign of the components, including full composite parts optimization.

Business Profile

The Formula Student Racing Team Elbforace was founded June 2006 and has grown to 70 active members at present. The team members come from different technical and economical disciplines of the Technical University of Dresden, among them engineering, economics, information technology, and sciences. The Formula Student is an international racing competition of the Society of Automotive Engineers (SAE). The students build a single seat formula racecar from concept to production with which they can compete against teams from all over the world. Every year a new car has to be developed. The Elbforace Team is currently competing in the Formula Student Electric, which was founded in 2009.

Challenge

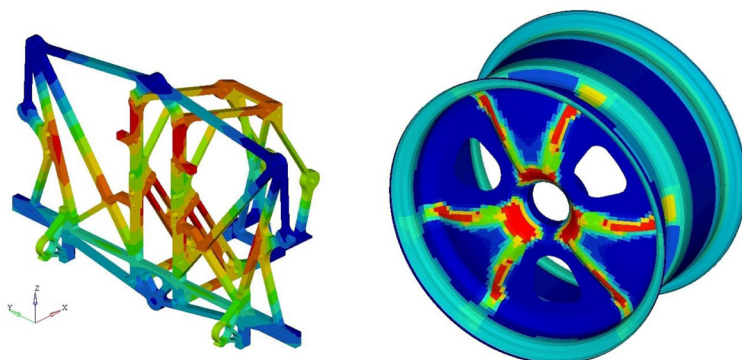
In the season of 2010/2011 the Team Elbforace decided to switch from a combustion engine to an electrical powertrain concept. This brings in additional weight due to the use of accumulators and AC converters. To optimize the race car performance, the design of the remaining components of the car had to be optimized to a minimum weight.



Monocoque on the torsion test bench.



Wheel carriers after milling.



Displacement of the engine mount while accelerating.

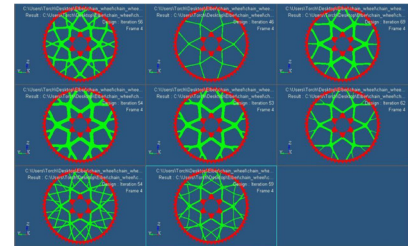
CFK wheel rim with colored illustration of the thickness.

"With HyperWorks we have been able to compensate the additional weight brought in by the use of an electric powertrain concept. With their software solutions, seminars, tips and valuable support, Altair helped us to reach the given weight and stiffness goals for our car."

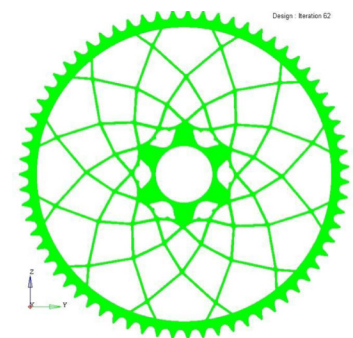
Philipp Heitzig, Elbforace

Solution

In order to maximize the overall race car performance, the Elbflorace Team identified several components of the car with weight saving potential. The chain rings, a back plate, and the CFK wheel rims were subject to an optimization process in order to minimize especially the rotating masses. With the given load cases, the components were optimized with OptiStruct to a minimum of weight while increasing the overall race car stiffness with the new back plate. The final geometry was evaluated by a finite element analysis calculated in RADIOSS to prove the stress and stiffness values of the final components. The CFK wheel rims were optimized in a three-stage optimization. In the first optimization stage the patch distributions were defined by performing a free-size optimization. After the “free size” optimization, OptiStruct was used in a size optimization to receive discrete thicknesses for the patches and to determine the exact number of layers. Following this optimization step, a stack optimization was executed and the sequence of the layers was diversified. For the monocoque, the optimization followed the same process. Since the monocoque was already at a minimum of mass, the goal was to optimize the torsional stiffness of the component while keeping the weight at the same level. The results of the analysis were evaluated in HyperView, the post processor of HyperWorks.



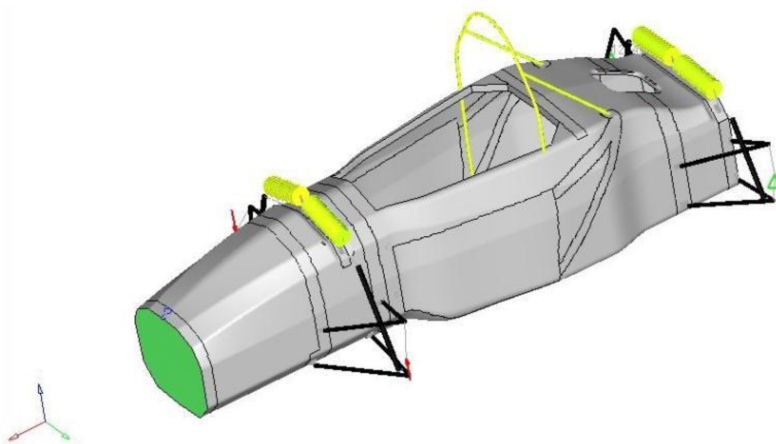
Optimization variants for the chain blade.



Chain blade after optimization.



Chain blade after manufacturing



Monocoque model for torsional stiffness.

Results/Benefits

By using HyperWorks, the Elbflorace Team was able to maximize the performance of its race car. Based on the according load cases the optimization with OptiStruct resulted in a weight reduction for the chain blades of 66% compared to a regular one and a weight reduction of 75% for the back plate compared to the original design. In addition, the back plate increased the torsional stiffness of the car by 7%. The torsional stiffness of the monocoque could be optimized to 2740 Nm per degree, which was proved with the real prototype on the test bench. By the use of HyperWorks, the weight of the race car was reduced by 15,5 kg. Recent achievements of the Elbflorace Team have been a 3rd place at the Formula Student Spain 2011 and an 8th place at the Formula Student Electric 2011 in Hockenheim for the Design Report.

HyperWorks and its optimization solution OptiStruct helped to:

- significantly reduce weight while increasing the stiffness
- save time and costs
- save material and prototypes