

Lighter and Stiffer Components for Student Race Car of Università della Calabria with HyperWorks

Overview

The principal objective of the worldwide competition organized by Formula SAE is the planning, design, and fulfillment of a single-seat car for non-professional drivers, i. e. student teams from all over the world. The project requires team effort and close collaboration on the part of all groups involved: skilled engineers and engineering students specialized in different sectors. All of them have to respect deadlines and follow project steps according to the rules established within the Formula SAE regulations. The achievements of each team are rated by SAE in the following categories: Design, Cost & Manufacturing Analysis, Presentation, Acceleration, Skidpad, Autocross, Fuel Economy, and Endurance.

Among the competing teams is the UNICAL REPARTO CORSE team of Università della Calabria, Italy which has currently 50 members and has participated since 2006. In the development of his latest car the team has benefited strongly from Altair's HyperWorks suite for simulation and optimization task.

The UNICAL REPARTO CORSE Team

The UNICAL REPARTO CORSE team is divided into two groups. While 25 students are responsible for the current year's project, the other part of the group is already working on next year's race car. Both teams work closely together, sharing knowledge, skills, and competences. The department at the Università della Calabria, Italy involved in the Formula SAE project is DIMEG (Mechanical and Management Engineering Department).

The project to develop and build a new vehicle that competes in the races is usually handled in four steps:

- Car planning, component simulation and optimization, CAD Model.
- Creation of a business plan: presentation of a start-up in the amateur automotive sector with all related analysis: feasibility, costs, profits.
- Cost report: Prototype costs and analysis.
- Manufacturing: Car realization with sponsor support.

Since the performance of the race car is closely linked to the basic design, the students employ modern CAE technology to set up, simulate and optimize the car design. This enables them to minimize weight, increase component stiffness where necessary, and to determine the ideal design direction right at the start of the project. In parallel, the students from the management engineering departments work on a business and marketing plan, cost calculation, and reports. Finally the students of the mechanics department bring in their experience when it comes to manufacturing the parts and the vehicle. For more information please visit: www.unicalrepartocorse.it.

Challenges – how to make the car fast and light enough to make it to the top

All teams know that in order to finish among the best in each category – from design to costs to racing performance, their car has to show the best possible performance while also being light. While safety aspects play a big role, the components also have to be stiff enough to support a better dynamic performance of the race car and they have to provide a certain structural strength to endure the loads that occur at the speed at which the car is driven. One major challenge of the project was therefore to reduce the overall weight of the car while keeping an eye on component stiffness and internal stresses at different loading conditions. To meet these challenges and to stay within the set development goals regarding development time, material usage, and costs, the teams have to find a way to get their vehicle design right without needing many prototypes and test runs. This can be reached by using advanced CAE software technology within the development process of the vehicle and its components right from the project start.



On the track – the 2014 vehicle of Unical Reparto Corse

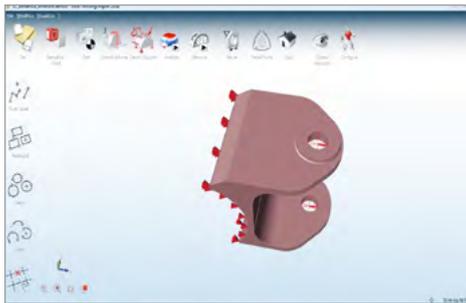
“The Altair tools provide us with many benefits. Thanks to HyperWorks and Inspire we could reduce the development time, increase the simulation speed, and receive better results in the screening. In addition we were able to reduce the weight of all the components developed with the tools and increase the overall stiffness significantly.”

Marco Caira, business and management, responsible for the UNICAL REPARTO CORSE Formula SAE team of the Università della Calabria

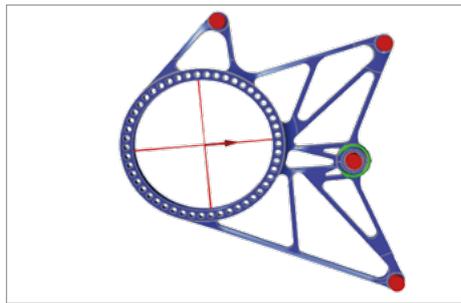
Solution – lightweight design for better acceleration, handling, and fuel efficiency

All the mechanical engineering students participating in the project use HyperWorks as an important tool within the development of the car. HyperWorks is used for various simulation and optimization tasks and supports the engineering students in reaching the targeted project goals. In addition, solidThinking Inspire is applied for static simulations and structural optimizations. solidThinking, a provider of industrial design and optimization software tools, is a daughter company of Altair. The software Inspire, which is based on Altair's solver OptiStruct, enables design engineers, product designers, and architects to create and investigate structurally efficient concepts quickly and easily. First, the engineering students of UNICAL REPARTO CORSE used Inspire to create and optimize models of parts and subsystems and then deployed the full version of Altair's FE solver OptiStruct in a later step to structurally analyze the parts. Inspire and OptiStruct are used particularly within the development of the differential supports and frames as well as for suspensions joints.

For the development of the differential supports the team created a design space and applied bonds, boundary conditions, and three different load cases. Depending on the applied loads and the available design space, the team received different optimization results as possible design proposals for the component. At the end of the optimization process they obtained a final CAD model which they used to validate the structural analysis. For the frame suspension joints the team tried to reduce the tension near holes. In a second step the engineering students assessed the results and choose the optimal solution for each component, which was then again simulated and verified before a first prototype was built.



Topology optimization with solidThinking Inspire



The weight of the differential support could be reduced by 265 gram (34%).



All components were optimized and validated before a prototype was built.

Benefits – lighter and stiffer components for better results

Using HyperWorks – in particular OptiStruct – as well as solidThinking Inspire it was possible to reduce i. e. the weight of the differential support by 265 gram (34%). The newly designed part had a weight of only 515 grams compared to the 780 grams of the prior component design, while being also stiffer than the predecessor. Thanks to Altair's CAE technology the team was able to determine the ideal design and to evaluate the new component's performance before the prototype was built, leading to significant savings in development time and costs.

In addition to a better ranking for engineering design and fuel efficiency, the reduced weight and the increased stiffness of the new components will support the team particularly in those disciplines of the competition where a good dynamic performance of the car is required such as the events for Skid Pad, Acceleration, Autocross, and Endurance.