Student Racing Team from Politecnico di Torino uses HyperWorks to Improve Weight, Manufacturability, and the Performance of Race Car

Overview

Formula SAE is a competition between university student teams, organized by the Society of Automotive Engineers. Each student team has to design, build, test, and promote a prototype, which is then evaluated in eight types of tests, ranging from pure performance and design to advertising and presenting the vehicle. The worldwide competition takes place during nine official events in four continents. All official events are subject to a single technical and sporting regulation. The basic idea of the Formula SAE is that a fictional company engages the team to realize a prototype with characteristics in accordance with the regulation, which occupies the market segment dedicated to the non-professional races autocross. One of the competing teams is SquadraCorse, the student team from the Politecnico di Torino, Italy. In the development of their cars the team applies Altair's HyperWorks suite, in particular HyperMesh for model creation as well as OptiStruct, the finite element solver and optimization tool of the suite, which helps them to create better and lighter components.

The SCXV SquadraCorse Racing Car

Customer Profile/The Team

SquadraCorse was founded in 2005 by ten automotive engineering students who had a passion for racing cars. Every year since the founding the students' team designs and builds a new vehicle to compete in the Formula SAE events: starting with their first vehicle, the SC05, up to their recent car, the SCXV which will compete in the 2015 events. SquadraCorse has yielded excellent results with their cars - thanks to their constant development, their desire to improve and their long-time experience. The trophies the team won in different categories in recent years prove that their approach is the right one to become more and more successful. To develop the new SCXV the SquadraCorse team has applied Altair's CAE software to further improve the vehicle's performance and in particular its weight. There are all in all 75 students involved in this year's project, in which every single student has his/her precise role.

There are mechanical engineers, who create the CAD model, others analyze and optimize the virtual model with CAE software while another group sets up the business plan and handles the marketing strategies. Finally there are those who actually build, test and last but not least drive the car in the competitions. The first project step in developing a Formula SAE race car is to decide which type of car the team wants to produce. Next, the engineering students create a CAD model of their car during the winter months, followed by production start in February. Once the car is ready, the students test their car on the racetracks near Turin, and during summer the team attends the European Formula Student. For more information visit: squadracorse-polito.com/WP/

Challenge

To get even faster, the team strives for weight reductions, while guaranteeing at the same time the quality, safety, and stiffness of the vehicle. Therefore every year the team optimizes some components of the vehicle to make them lighter and better. This season, the team made an effort to reduce the weight of the pedal box, in order to find a good compromise between light weighting and component/vehicle stiffness. In addition to that the team optimized the monocoque of the car, made of composite material. The design of composite components is especially challenging, since the weight and the stiffness of the component made of this material depend on the precise and load-specific layout of the carbon fiber plies. To find the perfect compromise between weight and stiffness the team had to apply CAE software, in this case they used HyperWorks and especially HyperMesh for preprocessing tasks and OptiStruct for the optimization of each component. During the composite optimization process the plies of carbon fiber were used only where they were needed to bear the applied loads.

"We are very happy about the partnership with Altair. Using HyperWorks gives us the chance to make better simulations, really close to the real world behavior of the car. We are able to reduce the car's weight as well as production costs while increasing its reliability at the same time. Without HyperWorks I think we couldn't start with the production of the parts as quickly as we can now."

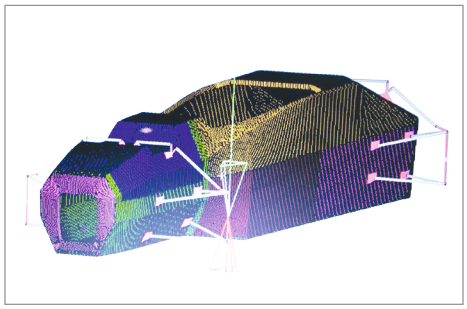
Raffaele Martini, Team Leader
SquadraCorse, Politecnico di Torino

Solution

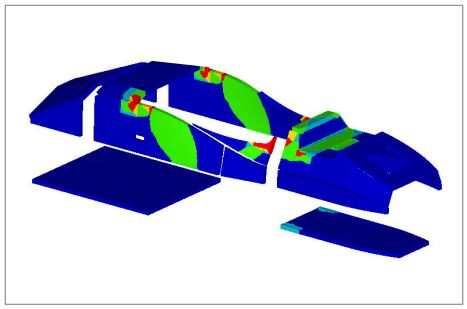
Within the development phase the students apply different CAD and CAE tools, such as the HyperWorks software, helping them to speed up the development process and to enhance the performance of the car. Accessible for the students in the team office, these tools help to save time, weight, and material to an extent that would not be possible without this virtual approach. Most of the team members have used HyperWorks to modify/optimize a CAD model to improve the weight of single components and of the entire vehicle. By using HyperWorks for a project like this, the students also learn to work with state of the art software tools, which they will also need in their future careers.

The development process of each component depends on the kind of material that will be used to build it: metal, plastics, or composites. For metals parts the team starts the development process with Inspire, an optimization software by solidThinking, a company of Altair. Inspire is based on OptiStruct, Altair's FE solver and optimization tool and enables the teams to get a quick start on the design of the ideal part. First a design space is defined to which boundary conditions and loads are applied. Then Inspire runs the optimization and offers, based on the set optimization goal, a component design that is as light and/or as stiff as possible. The result is then interpreted and imported in to a CAD System to create a more detailed CAD model. This is followed by different finite element analyses of the model to validate the design. After these first analyses the geometry is again optimized in detail, using OptiStruct.

To find the optimal material layout and design composite components a three step process can be applied: ply shape optimization, ply shape sizing, and a ply order optimization. The possibility to handle all three steps within OptiStruct makes the process particularly user-friendly. In the end the engineer receives a component that is optimized, not only regarding weight but also regarding stiffness and strength.



HyperMesh model of the monocoque including suspension supports



Composite optimization of the monocoque (ply thickness)

High-end visualization of the gearbox

Results/Benefits

The development approach with HyperWorks resulted in a weight reduction of 30% for those parts that were taken under consideration. The Altair software gives the team the chance to design, test and validate the single components even before a single prototype is built. In addition to the software itself, the students also benefit from a large number of tutorials and documentation about the software, provided by Altair.

HyperWorks enabled the students to:

- Reduce component and overall weight, hence to improve the performance of the car
- Handle composite design
- Speed up development time
- Reduce costs for prototyping and real world tests
- Fulfill SAE regulations
- Get ahead in their future careers by working with state of the art industry tools

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