Case Study: **HofSpannung**

Formula Student Team Develops Suspension System of Electric Racecar with Adams

Based on an Interview with HofSpannung Motorsport e.V.

Adams in Vehicle Development

More than 380 teams from 36 countries compete in the Formula Student with racecars they developed themselves. The students combine business and technical achievements, theory and practice with the sporting challenge. MSC Software support the Team HofSpannung Motorsport with free licenses for Adams, the standard product for vehicle motion design at all big automotive OEMs.

Team HofSpannung Motorsport e.V. from Hochschule Hof launched their development “Bonnie” in Varano de´ Melegari in the Italian province of Parma. The 40 members team took on company-specific roles and shared tasks like marketing, fundraising and sponsor search, and finance, as well as the actual vehicle development. “By working in this small “company” we were able to directly apply what we learned and gain a significant advantage for our transition into into professional life,” said Frank Meyer, head of suspension and braking system. The 25-year-old mechanical engineering student has been an active member of Hofspannung since 2016. “I particularly enjoy taking on responsibility and making significant contributions to the racecar design.”

Bonnie: The fourth generation of the fast electric cars from Hof comes with 30 percent weight reduction and accelerates to 100 km / h in 3.5 seconds

“In the beginning, we simulated simple problems like part collisions, spring deflection, camber, caster, king pin inclination. Individual items quickly checked and optimized to reach the desired vehicle behavior.”

Frank Meyer, Head of Suspension and Braking System, HofSpannung

A new racecar for every season

The Formula Student Germany (FSG) rules specify that each car may only be used for one season. “To be accepted, a vehicle must have significant changes compared to its predecessor,” said Juergen Theilmann, who holds a Master‘s degree in automotive engineering and is now working on a master in simulation technology in Hof. In the suspension design team, he evaluated the kinetic and kinematic effects of multibody physics with the current industrial standard – Adams.

“Bonnie” was the fourth electric racecar developed by HofSpannung, and followed a completely new concept. The car was designed with only one electric drive, as compared to two in its predecessor, and therefore needed a differential. Team HofSpannung, focused on sustainable materials and green technology, with the intent to make the car 30 % lighter and without using too many carbon parts which are difficult to recycle. To put this concept design on the racetrack, the suspension development required determining the loads on the components and dimensioning them accordingly.

Teamwork: Juergen Theilmann discussing with the Gerrit Loch, head of “Frame and Body”.

Standard product for vehicle design

For the actual design and verification of the suspension, the students used the specially configured Adams Car platform, which contains several task-specific modules.

“This helps us make faster progress than if we were to import 3D models from the NX 3D-CAD system,” stated Frank Meyer. In Adams Car, subsystems or full vehicles can be built and verified in a short time. “Adams Car was developed for vehicle applications,” adds Juergen Theilmann. “Once you have gotten used to the nomenclature of the software, which has to be applied like a programming language, you will get first results very quickly.”

MSC provides a special database for Formula Student applications, which contains realistic templates for wheels, tires, suspensions, all material data, and an axle test bench. “In the beginning, we simulated simple problems like part collisions, spring deflection, camber, caster, king pin inclination,” explained Frank Meyer.

Key Highlights:

Product: Adams

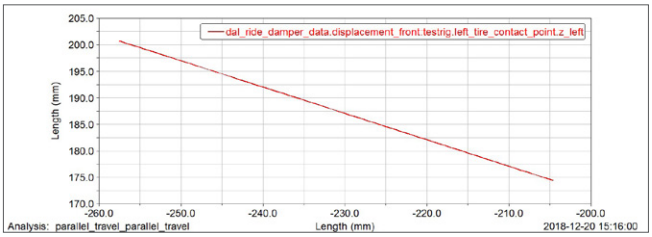
Industry: Automotive

Challenge: Optimized Vehicle Design

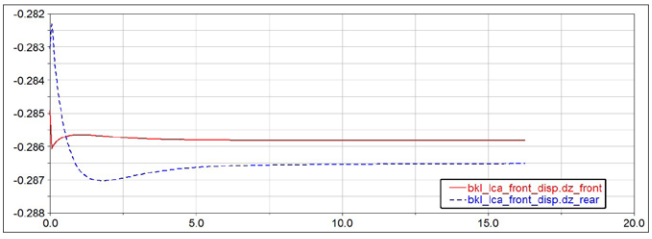
Solution: Simulation and evaluation on virtual test stand

Individual items were quickly checked and optimized to reach the desired vehicle behavior. When the team modified the suspension to use air springs instead of steel springs, they quickly found out at which stroke the spring element would have the best performance. The diffuser was optimized accordingly.

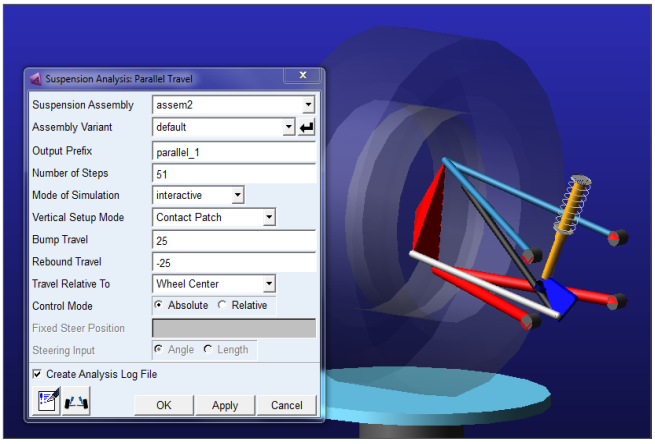
In order to reach the ambitious weight target of 30 percent reduction, many parts – such as the wheel carriers – were optimized with the help of strength analyses, with the objective of minimizing weight. Simulation brought the confidence to test the limits. On the other hand, weak points were identified in time: “If simulation shows me that a control arm is insufficiently dimensioned, I need not even test it in reality,” reports Frank Meyer. “This saves cost and is particularly important for a small, young team.”



Spring stroke: The postprocessing plot shows the desired linear relation between spring deflection at the wheel and spring stroke



Bar forces: Full vehicle simulation allows the calculation of bearing and reaction forces



Suspension: Only a few hub points are connecting suspension and frame

Virtual vehicle test stand gives the team a head start

The whole vehicle was tested under different road conditions on the virtual test stand. The latter was not only devised for the different Formula Student classes – combustion engines, electric drives, autonomous driving – but also for the different competitions.

Electric vehicles are ranked based on points in four tests: acceleration, cornering on a skid pad, autocross, and durability. "Virtual tests show the problem and at the same time the reasons for the respective vehicle behaviour," says Frank Meyer. "Whereas in test drives with the real vehicle, the reasons often remain hidden."

The students had about three months to simulate and optimize the suspension. The weight was reduced to 260 kg, compared to 379 kg in its predecessor. This meant that the weight target of 30 percent reduction was achieved.

Bonnie accelerates to 100 km / h in 3.5 seconds. Also, the new vehicle is about 10 cm shorter and 25 cm slimmer. "Soon we will see what advantages this brings on the racetrack," says Frank Meyer. "There you have to find the best course, and most of all, keep your nerve."

Qualified for the future

To qualify for one of the 30 spots for Varano de´ Melegari – among 170 candidates, the team had to pass an extensive "quiz": "This was pure exam stress," reports Frank Meyer. They have post-race plans as well: "We want to continue improving and learning; that's why we want to apply the aerodynamic simulation packages too." However, that's not all: The purchased electric motor shall be replaced with one developed in-house by 2020 – electric mobility has a great future ahead!

About HofSpannung

HofSpannung Motorsport e.V. is the Formula Student team of the University of Applied Sciences Hof. The team was founded in 2012 and is currently building the fourth model for the Formula Student Electric competition.

For more information about HofSpannung, please visit: www.hofspannung.de

Frank Meyer: Head of suspension and braking system, analyzing the suspension for possible weaknesses with the help of Adams

Juergen Theilmann: As a master student in simulation technology, the mechanical engineer feels at home with Adams

For more information on Adams and for additional Case Studies, please visit: **www.mscsoftware.com/adams**

FHS*2019JUL*CS