MSC Software

CASE STUDY

MSC Software: Case Study - Polestar Racing/Volvo

Racing to Win

Polestars Achievements Result in Top Standings

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Polestar Racing is a Swedish motorsport team, affiliated with Volvo Car Corp., currently competing in the Scandinavian Touring Car Championship and World Touring Car Championship. In this highly competitive environment, Polestar engineers spend months over the winter offseason struggling to squeeze a few extra tenths of a second per lap out of their cars. One of their most valuable tools is MSC Software's Adams/Car which they use to evaluate different vehicle designs in critical areas of the track such as the corners.

"With Adams/Car we can very accurately simulate the performance of any particular vehicle configuration in a corner and by simulating many configurations we can determine which one is the best for a particular track," said Per Blomberg, Manager Chassis Development at Polestar Racing. "We have one of the most advanced simulation capabilities on the racing circuit and this is one of the factors that helped us win the team championships twice the last three years and finish second the third year."

Polestar was founded in 1996 in collaboration with Volvo Car Corporation in order to drive forward Volvo´s investment in racing. Since then, Polestar has competed with the 850, S40, S60 and now the C30 Volvo models. The Scandinavian Touring Car Championship car was totally designed and developed in-house by Polestar in accordance with FIA S2000 regulations. The engine runs on Bioethanol (E85) and components from Volvo's DRIVe line of stock vehicles play a vital role. Polestar has had a stellar record, winning the Swedish Touring Car Championship team championship in 2009 and 2010 and placing second in its successor, the Scandinavian Touring Car Championship, in 2011.

Key Highlights:

Industry

Automotive

Challenge

To accurately simulate the performance of any particular vehicle configuration in a corner.

MSC Software Solutions

Adams/Car to predict the performance of a prospective design of the complete vehicle.

Benefits

- Quickly Build & Test Virtual Prototypes
- Analyze Events
- Evaluate Small-Scale Improvements

Tommy Rustad at STCC Premiere

"Before we used Adams/Car we found that only 40% to 50% of what we tried at the test track turned out to be effective. Since we began using Adams/Car, 80% to 90% of the ideas that we try on the track succeed."

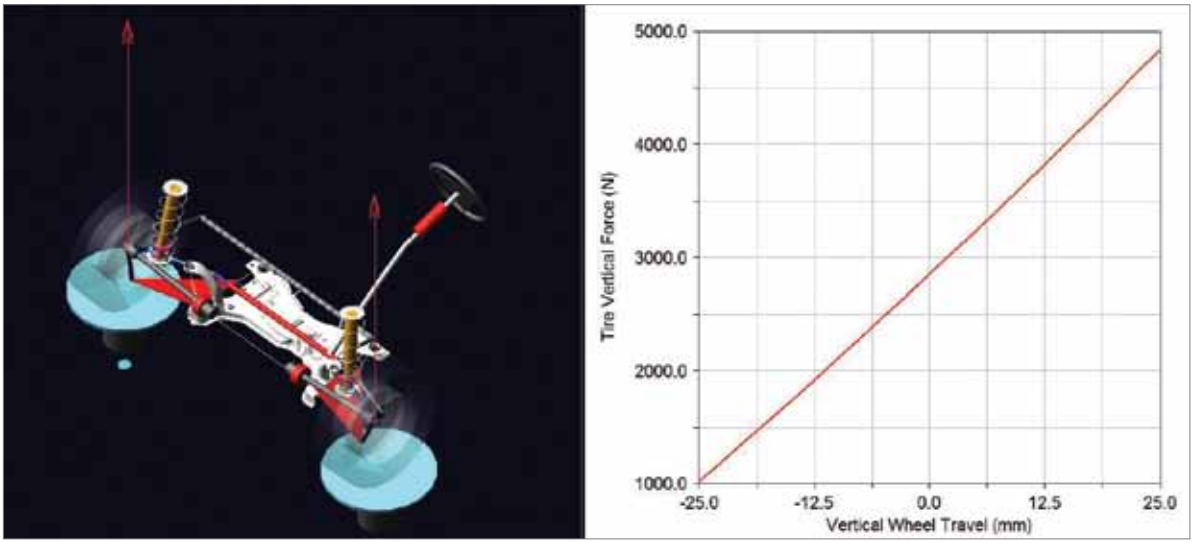
Per Blomberg, Manager Chassis Development, Polestar Racing

Preparing for the Next Season

Blomberg said that the race team's greatest use of Adams/Car is during the winter months when it is preparing its cars for the next season. "We have many different ideas to improve race performance," Blomberg said. "But we can only spend four or five days every six weeks at the test track in southern Spain. We have a very intense schedule and the number of vehicle configurations that we are able to test is strictly limited." The team performs around 3,000 kilometers of track testing each winter with the new car compared to the 150 kilometers or so that each driver covers in the course of a normal race weekend. Polestar also uses Adams/Car during the race season to analyze events that have occurred in earlier events and evaluate small-scale improvements that are implemented during the racing season.

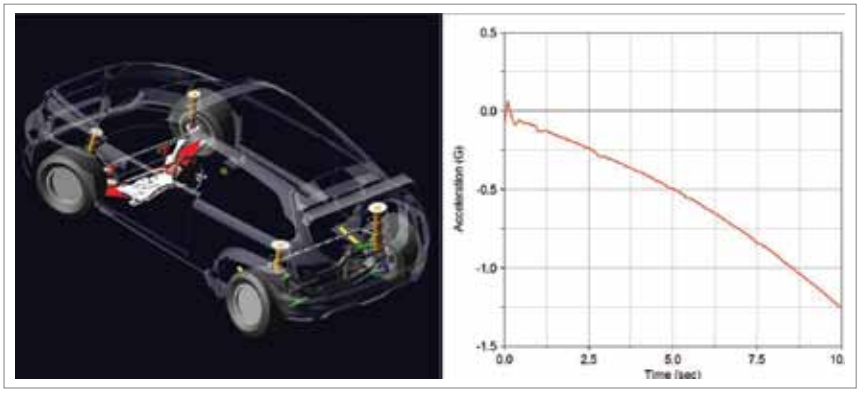
In the past Polestar used hand calculations and spreadsheets to perform some very rough estimates of vehicle performance to attempt to select the best designs for testing. "These tools provide some value in sharing knowledge but contribute little towards predicting the performance of a prospective design," Blomberg said. "We have long used simulation at the component level to, for example, evaluate stress and deformation in suspension components, but we were not aware of the possibility of predicting the performance of the complete vehicle until the MSC representative introduced us to Adams/Car."

Adams/Car is designed to enable engineering teams to quickly build and test functional virtual prototypes of complete vehicles and vehicle subsystems. Working in the Adams/Car environment, automotive engineering teams can exercise their vehicle designs under road conditions, performing the same tests they normally run in a test lab or on a test track, but in a fraction of the time. "With front wheel drive cars the front tires are responsible for steering, breaking and powering the vehicle while the rear tires simply follow," Blomberg said. "It's a continuous struggle to find enough friction with the front tires and this is the area where Adams/Car makes its greatest contribution."



Polestar Volvo C30

Robert Dahlgren WTCC in Curitiba



Polestar Volvo C30

Modeling the Vehicle Configuration

Engineers create a model of the vehicle in Adams/Car to match a configuration that they are interested in evaluating. One of the key aspects of the vehicle is the pickup points in the suspension, the points where the suspension link arms attach to the chassis. The front end of Polestar's current vehicle has a Macpherson strut with a damper that attaches to the body under the hood and a lower link arm that attaches to the hub. The rear end uses a multilink suspension. The locations of the pickup points are limited by the rules of the racing series. Polestar sometimes simulates vehicles outside these limits in order to get a better understanding of the sensitivity of the vehicle performance with respect to certain design parameters. Other parameters whose impact is evaluated during simulation include the spring thickness, anti-roll bar thickness, camber angles, tire properties and weight distribution in the vehicle.

Polestar obtains data on the mechanical properties of the tires from the tire manufacturers and incorporates them into the Adams/Tire module that models the forces and torques that act on the tire. Polestar engineers take data recordings from measurement systems in the car such as the steering, breaks, and accelerator and export these channels to Adams/Car. The data is taken from critical sections of a race course such as three different types of 180 degree turns. The slow turn is normally taken at 60 kmh, the medium turn is taken at 100 kmh and the fast turn is taken at 170 kmh. This data is used to generate the driver control file that Adams /Car uses to simulate the input of driver. In most cases the driver provides little active control during the turn – the car goes through the turn so quickly that there is no time to react.

Adams/Car then simulates the vehicle traveling through the turn. The driver enters the turn at the outer edge of the track, steers into the corner to the inside edge of the track at the center of the turn, then exits the turn at the outside of the track. The margin, the distance between the vehicle and the outer edge of the turn, is one of the most critical outputs of the simulation because the existence of margin indicates that the driver can increase the speed of the vehicle through the turn. Polestar engineers often run the simulation several times at different speeds in order to find the speed where the margin is zero. This is the maximum speed that the vehicle configuration under consideration can be driven through the corner.

The simulation also provides detailed information on the behavior of every aspect of the car that is included in the model. This information is often used by engineers to understand the reasons why one design performed better than another. It's important to note that simulation provides much more diagnostic information than can be obtained from physical testing which is limited by the relatively small number of sensors that can be positioned on the vehicle.

Accuracy to Second or Third Decimal Place

"The correlation between Adams/Car simulation and physical testing is very good," Blomberg said. "When we compare simulated to measured roll angle or lateral or longitudinal acceleration the results match up to the second or third decimal place. Our biggest challenge in making further improvements in simulation accuracy is getting accurate material information from the tire manufacturers.

"Adams/Car helps us decide which ideas we should go to the test track with and which ones we should forget about," Blomberg said. "Before we used Adams/Car we found that only 40% to 50% of what we tried at the test track turned out to be effective. Since we began using Adams/Car, 80% to 90% of the ideas that we try on the track succeed. By enabling us to try out our ideas on the computer first, we can evaluate many more ideas than in the past and spend our scarce time at the track just on ideas that we are nearly certain will work."

As an example, the Swedish Touring Car Championship changed tire suppliers a few years ago. All of the teams scrambled to better understand the behavior of the new tires. Polestar used Adams/Car to explore the effect of variables that influence the behavior of the tire on the full vehicle performance. Polestar discovered that vehicle performance was optimized at two very different combinations of tire pressure and camber. Both of these combinations were equally fast but there were major differences in the way the vehicle handled, particularly in the degree of over-steering and under-steering. After noticing this phenomenon in simulation, Polestar engineers tested it out on the track and found that it was accurate. They used this knowledge to select one set of conditions or the other depending on which type of behavior was best suited for a particular track. On several conditions they even changed the conditions in midrace.

Blomberg concluded that Polestar's experience with and intensive use of Adams/Car provides a significant competitive advantage and has played a significant role in the team's success. "To win a race, you must understand the car," Blomberg said. "Adams/Car supports our success by enabling us to simulate the car for every vehicle configuration and track condition we can imagine."

About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit: www.mscsoftware.com.

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About Adams

Multibody Dynamics Simulation

Adams is the most widely used multibody dynamics and motion analysis software in the world. Adams helps engineers to study the dynamics of moving parts, how loads and forces are distributed throughout mechanical systems, and to improve and optimize the performance of their products.

Traditional "build and test" design methods are now too expensive, too time consuming, and sometimes even impossible to do. CAD-based tools help to evaluate things like interference between parts, and basic kinematic motion, but neglect the true physics-based dynamics of complex mechanical systems. FEA is perfect for studying linear vibration and transient dynamics, but way too inefficient to analyze the large rotations and other highly nonlinear motion of full mechanical systems.

Adams multibody dynamics software enables engineers to easily create and test virtual prototypes of mechanical systems in a fraction of the time and cost required for physical build and test. Unlike most CAD embedded tools, Adams incorporates real physics by simultaneously solving equations for kinematics, statics, quasi-statics, and dynamics. Utilizing multibody dynamics solution technology, Adams also runs nonlinear dynamics in a tiny fraction of the time required by FEA solutions. Loads and forces computed by Adams simulations improve the accuracy of FEA by providing better assessment of how they vary throughout a full range of motion and operating environments. Please visit adams.mscsoftware.com to learn more.

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