



Example of responses (black, blue and red) for a vehicle with three different values of a perturbed parameter.



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# Volvo Cars: Active Safety

Safety continues to play a prominent role in the development of Volvo cars. Traditional development and testing of active safety technologies is important from a real-life perspective. On the other hand, computer testing is both time and cost efficient. As part of its continuous strive to improve the overall safety of its cars, Volvo Cars is adopting model-based approaches to active safety system development.

**P**reventive actions play an increasingly important role in vehicle safety. Real life testing in combination with computer testing, which is both time and cost efficient, enables Volvo Cars to enhance its safety knowledge. To what extent, then, can modelling and simulation replace testing in the active safety system development process? "If you can represent the vehicle behaviour with a mathematical model, you have a great platform for active safety system development", says Per Ola Fuxin, Manager, Active Safety Functions at Volvo Cars. "However, a model must not just be valid in the sense that

*The test vehicle is equipped with car body levelling sensors, a steering robot, torque measuring wheels and a gyro platform.*



it captures the results of already tested scenarios and parameterisations. It must also be able to predict the effects of new scenarios, parameters and configurations", he continues.

## VALID MODELLING APPROACH

To address this, an important part is to show that by having valid subsystem and component models, the resulting vehicle model shall also be valid. The work is conducted in Dymola with models built from Modelon's VehicleDynamics Library, implemented in Modelica. These models are hierarchically built-up where each subsystem is easily replaced by another. The subsystems are parameterised individually from construction data or isolated tests before they are assembled to form the complete vehicle model. The vehicle model is then simulated and the results are compared to the corresponding real-life tests for validation.

A further advantage with the modelling approach is that this hierarchy continues down to the component level where the Modelica code can be viewed and modified. "In this respect, the Modelica approach is appropriate. The openness

## More about Modelon

Modelon is a Dynasim Partner that specializes in Model-Based Systems and Control Design, and is the premier provider of Modelica-related consulting and products. Modelon's portfolio includes model libraries for air conditioning, vehicle dynamics, hydraulics, and pneumatics among others. [www.modelon.se](http://www.modelon.se)

of the code essentially gives us the advantages of an in-house tool without having to have a software development team in-house", says Mats Beckman, Tyre Specialist at Volvo Cars. A particular case where a model-based approach is valuable is when we want to learn the effects of parametric uncertainties; these can, for example, occur from different road conditions, load cases and tyre pressures. "Zooming in on the details to study how each component or subsystem influences the entire vehicle behaviour is the key to an efficient and systematic analysis", says Bengt Jacobson, Technical Specialist, Vehicle Control Architecture at Volvo Cars. "Understanding how different parameter changes affect the vehicle allows us to adapt sensors, estimators, and controllers in an efficient way to continue to improve safety", he concludes.

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