

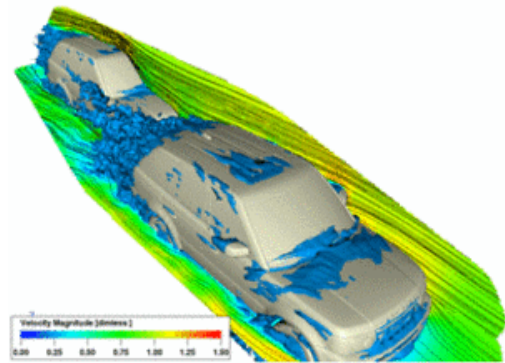
POWERFLOW FOR VEHICLE HANDLING



3DEXPERIENCE®

Applicable Industries: Automotive, Motorsports, & Trains

Beyond fuel efficiency, aerodynamics affects the driver experience of vehicle handling. The forces and moments on the vehicle affect the grip that the tires have on the road, response of the vehicle to steering inputs, and stability of the vehicle to changes in the road or wind conditions. Vehicle handling attributes are strongly driven by transient effects. The oncoming wind conditions can include transient gusts experienced by the moving vehicle due to prevailing crosswinds, obstacles, and topography near the road, in addition to wind disturbances caused by other vehicles. The vehicle aerodynamics might indicate sensitivities to certain timescales of transient onset conditions, and could be perceived by the driver as vibrations, undesirable roll and pitch motions, or lack of response to steering inputs. These problems increase significantly at high speeds and are a key design factor for high-performance or luxury vehicles.



Technical Challenges

Design for vehicle handling requires prediction of the aerodynamic lift on the front and rear tires where they contact the road, as well as the side loads and pitch, roll, and yaw moments that determine vehicle stability. These forces and moments are needed at a range of static crosswind conditions or under dynamic crosswind inputs. Under all conditions, these forces and moments are highly transient for most vehicles due to the strong sensitivities of the underbody and rear wake flow behavior to small fluctuations in pressure or onset flow.

Matching the true road conditions for high-performance vehicles is a major limitation of physical testing using wind tunnels. Realistic effects of vehicle motion and onset flow conditions cannot be included in a wind tunnel test. In a wind tunnel test, expensive moving-ground emulation systems consisting of belts and suction/blowing systems are used to approximate the effect of the vehicle motion on the road, and the effect of onset flow conditions is approximated by testing at a range of static crosswind (yaw) angles. However, wind tunnels are not equipped to accurately measure the transient aerodynamic loads that affect driver perception of vibration, response, and stability. These approximations create major limitations on the aerodynamic development of vehicles for optimizing handling attributes. Vehicle handling must then be assessed very late in the design process using road testing of final-stage prototypes.

The need for accurate prediction of transient forces and moments under dynamic onset conditions is also very challenging for traditional simulation tools. However, PowerFLOW is inherently transient and naturally handles these conditions. Time-accurate pressure fluctuations in the sensitive underbody and rear wake regions are simulated accurately, leading to prediction of transient response. The accuracy of PowerFLOW for handling attributes has been proven through industry validation compared to moving-ground wind tunnel tests with static crosswind conditions. Simulations can include dynamic onset conditions and the effect of other vehicles — conditions that cannot be produced in wind tunnels.

SIMULIA Solution

Automotive aerodynamic simulations for vehicle handling attributes are performed with PowerFLOW, including effects of dynamic onset conditions and a realistic road environment. The results are analyzed to compute the forces and moments, distributions of forces and moments, and contributions of each surface panel. You can use time graphs of transient forces and moments to show the transient response of the vehicle. Use transient flow visualizations to understand the flow structures and pressure fluctuations that contribute to the transient response. To further quantify transient effects, you can use PowerACOUSTICS to compute frequency-based analysis of the forces, moments, pressures, and flow structures. The output shows how loads in critical frequency ranges can excite the dynamic response of the vehicle suspension or affect driver perception.