

# POWERFLOW FOR AERODYNAMIC EFFICIENCY



**3DEXPERIENCE®**

## Striving for efficiency

In today's economic environment, consumer demand for fuel-efficient vehicles has never been higher. Vehicle aerodynamic design has a critical impact on fuel efficiency, through reducing wind resistance of the vehicle's exterior shape and reducing losses associated with requirements for cooling flow through the engine compartment. Aerodynamic design starts with the earliest concepts of the vehicle based on its shape and proportion to meet styling intent, passenger space, and component packaging needs. As the exterior shape is refined, the aerodynamic efficiency is driven by shape parameters such as angles, radii, and dimensions. Typically, you can make improvements in these parameters with minimal impact on the styling aesthetics. As the vehicle design progresses further, aerodynamic panels and devices such as spoilers, wheel deflectors, and underbody covers are sized and positioned mainly for aerodynamic benefit, in trade-off with the cost of parts and other constraints. Throughout these design stages, adequate cooling flow to the heat exchangers must be maintained while minimizing the associated wind resistance.

The challenge faced by vehicle manufacturers in each design stage is the urgent need for information about how to improve the design. Aerodynamic information can be costly and difficult to obtain, traditionally involving building a detailed model or prototype of the vehicle and testing it in a wind tunnel. Design iterations at this late stage of product development are time-consuming and costly because it is difficult to make large-scale changes to a model, or to change any surface features of a fully detailed prototype during a wind tunnel test. Prototype testing for aerodynamics is a major contributor to vehicle development costs and design cycle time.

## Technical Challenges

Aerodynamics simulation changes the vehicle development process, reducing both vehicle development costs and design cycle time. Because of its inherent advantages over physical testing methods, simulation can bring much more feedback about the design performance into each stage of development, improving the ability for designers and engineers to innovate in balancing design aesthetics with aerodynamics. Simulation is more accurate than physical testing because of its ability to capture small details that might not be present on a physical reduced-scale model during the early design stage, and its ability to duplicate actual road conditions without interference from the wind tunnel walls and floor. Physical testing can lead to costly mistakes and delays due to accuracy problems. Finally, simulation can reduce the cost of the final vehicle by revealing design improvements earlier in the design phase that do not require additional parts and expense. Simulation provides cost savings and improvement in the final design.

The need for accuracy and timely delivery of design feedback places a high demand on aerodynamics simulation quality. The simulation must account for many real-world effects, realistic high-fidelity geometry of the vehicle; reproducing realistic test conditions such as road effects, rotating wheels, and oncoming flow conditions such as turbulence and wind gusts; and realistic simulation of transient turbulent aerodynamics. PowerFLOW is uniquely designed to bring

realism into aerodynamics simulation. It is heavily validated across the entire ground transportation industry to bring the high accuracy and confidence required for design decisions.

## SIMULIA Solution

Aerodynamics is at the core of simulations with PowerFLOW, whose unique, inherently transient Lattice Boltzmann-based physics enables it to perform simulations that accurately predict real-world transient conditions on the most complex geometry. Each simulation brings time-accurate evolution of the airflow around the vehicle and through the engine bay and underbody. Wheel rotation for on-road configurations can be accomplished using true rotating geometry. Cooling fans can rotate to represent the correct cooling flow conditions. Heat exchangers provide the correct resistance to the flow and contribute to the flow losses affecting aerodynamic efficiency. Analysis of the results shows the overall aerodynamic drag, distribution of the drag from the nose to the tail of the vehicle, and surface drag contributions over each panel. You can use flow visualizations such as surface and flow streamlines to indicate cause-and-effect relationships between design changes and the aerodynamic drag.

PowerFLOW uniquely enables rapid multi-disciplinary trade-offs between aerodynamics, thermal management, and aeroacoustics. This is possible because PowerFLOW uses a single physics model for all types of analysis with a common, fully detailed geometry definition. PowerFLOW results have been validated against experiment as highly accurate for aerodynamics and many other applications.