

POWERFLOW FOR SOILING AND WATER MANAGEMENT



3DEXPERIENCE®

Tracking Particles

Air is not the only medium encountered by a vehicle on the road. Vehicles must be designed to handle the sometimes harsh natural conditions found on the road, where water, snow, ice, dirt, rocks, and other particles of debris are kicked up off the road by tires or wind, or are present due to weather conditions. The small size of these particles dictates that they will be strongly influenced by vehicle aerodynamics. The exterior airflow around a moving vehicle drives the motion of particles around the vehicle until they hit the surface or are ingested into an air intake or other opening.

Many critical safety, performance, and quality features of the vehicle are determined by how the airflow manages these particles.

- **Road spray:** For solid particles like dirt and rocks, the impact of these particles on the vehicle must be managed to avoid damage to the vehicle finish and components, while keeping all passenger glass, exterior mirrors, exterior cameras, and lights as clear of material as possible. The regions around the wheels are designed to control the path of road spray water droplets that carry dirt, to reduce dirt deposition in critical areas on the vehicle body.
- **Wheels and brakes:** For the wheels and brakes, the brake disk surfaces should be kept clear of dirt and water. In addition, tiny brake dust particles are created during use of the brakes and can create unsightly deposition patterns on the wheel rims. To alleviate these problems, you can use the wheel rim shape, splash shields, and airflow guides to help control particle deposition.
- **Snow accumulation:** When driving in snow conditions, the accumulation of snow particles is determined to a large degree by the vehicle aerodynamics. Flow disruptions such as small separations can enable particles to accumulate in certain regions, which can then block air intakes, block visibility of the glass or exterior mirrors, cover vehicle exterior lamps, or affect windshield wiper performance. You can adjust the vehicle shape to smooth these flow disruptions and discourage snow accumulation.
- **Engine bay particle ingestion and soiling:** The water and dirt kicked up by the vehicle wheels and other vehicles on the road, as well as water, snow, and dust in the air can degrade performance of the engine and underhood systems. In particular, air intakes are designed to draw in clean air, and minimize the pressure losses associated with filtering or separating particles from the incoming flow. Similarly, particle deposition can affect the performance of moving parts in the engine bay (such as belts and fans). Airflow management for controlling particle deposition and ingestion affects the design of the grille, underbody, engine bay components, and component layout.

Technical Challenges

The vehicle aerodynamic and aeroacoustic performance are considered simultaneously with water management when considering the shape of the A-pillar, side mirror, and other aspects of the vehicle shape. Performance related to management of water, dirt, snow, brake dust, and other

foreign particles is dependent on the small details of the vehicle surface and component design. Typically, evaluating this type of performance requires fully detailed prototypes — which are available only at the end of the design process. Fixing problems at this late stage of design is very costly in terms of engineering effort, retooling, and additional parts for the vehicle. Information about the primary performance drivers for particle management (such as exterior surface shape and engine bay layout) is needed earlier in the design process. Effects of detailed component design such as rain gutters and air intakes need to be understood before fully detailed physical prototypes are available, so the vehicle can be designed to meet performance and safety targets.

Aerodynamics simulations can provide these insights, but are also challenging. Geometry details that affect particle flows in the air and on the surface are needed. Particles flows are very sensitive to transient, turbulent flow effects, and accurate simulation of the airflow and particle trajectories is required.

SIMULIA Solution

PowerFLOW provides solutions for the simulation of aerodynamics and particle flows to assess vehicle design goals. Airflow simulations are performed using PowerFLOW. Using the airflow results with PowerVIZ, you can dynamically release particles into the airflow and compute the particle trajectories until impingement on the surface. Particle hit points and densities are recorded for accumulation analysis. In addition, you can define surface properties so particles can reflect off surfaces and create complex flow paths through the engine bay or on the vehicle surface. In a particle simulation, you can realistically capture particles as they flow through screens or heat exchangers. This combined functionality enables you to investigate a wide range of soiling and water management phenomena.