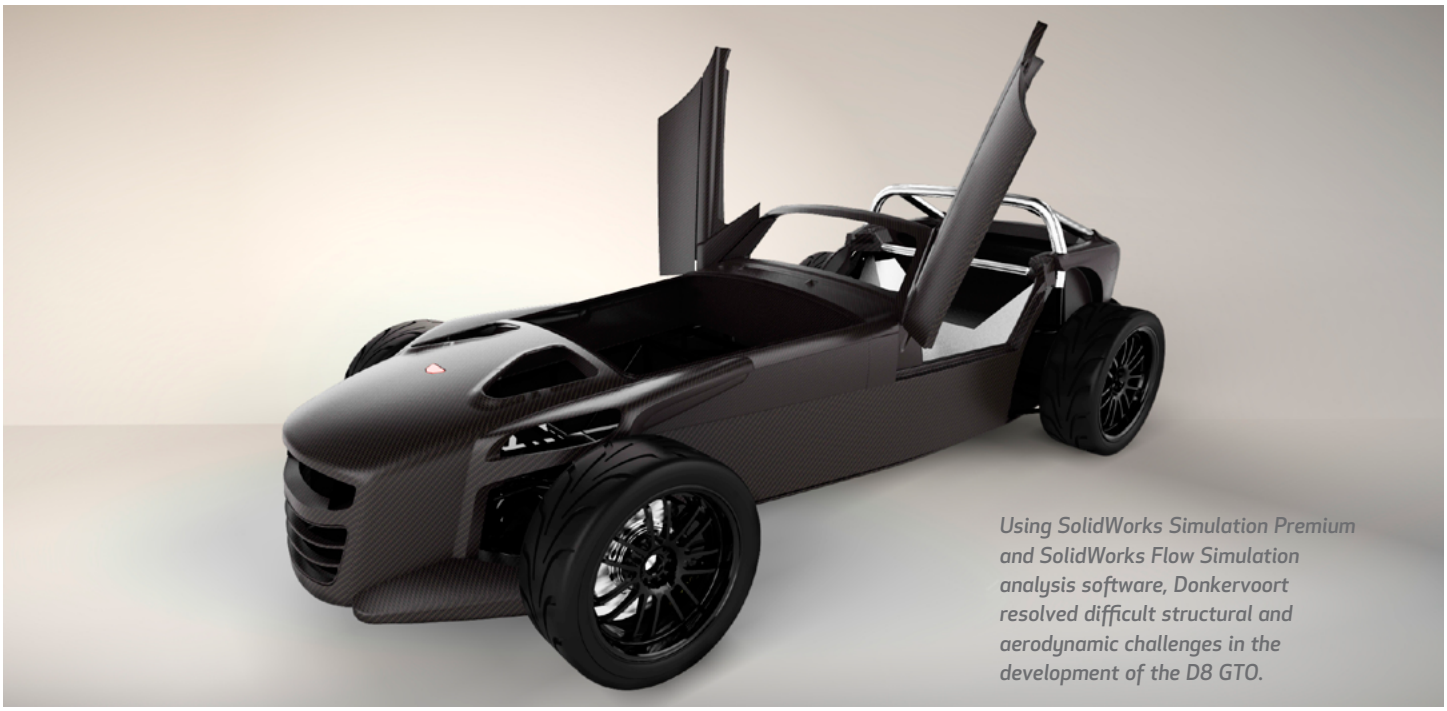
DONKERVOORT AUTOMOBIELEN BV

Advancing high-performance sports car design with SolidWorks Simulation



Using SolidWorks Simulation Premium and SolidWorks Flow Simulation analysis software, Donkervoort resolved difficult structural and aerodynamic challenges in the development of the D8 GTO.

The search for perfection in quality, technology, styling, and design has driven Donkervoort Automobielen BV since Joop Donkervoort founded the sports car manufacturer in 1978. Donkervoort's combination of appealing styling, ultralight weight, high-power output, and fantastic road-tracking agility has produced sports cars that behave like racecars, to the delight of driving enthusiasts around the world.

Every Donkervoort automobile is built by hand, and the company produces roughly 50 cars annually. Donkervoort's quest to produce the perfect sports car has increasingly relied on advanced design and simulation tools, according to Head of Design and Engineering Jordi Wiersma.

"We push the boundaries of what is possible, increasing horsepower while maintaining the light vehicle weight that is critical for enhanced maneuverability," Wiersma says. "In essence, we create cars that behave like Formula One racers, but with the aesthetic attributes of a classic roadster. To do this, we need engineering tools that help us develop workable designs quickly and cost-effectively."

Until recently, Donkervoort used 3D CAD software—first IronCAD®, then SolidWorks®—for design, and outsourced its aerodynamic and structural simulation work. The quickening pace of sports car development led the engineering staff to seek its own internal simulation capabilities.

"On the D8 GTO (introduced in 2011), we moved from the Audi 1.8-liter turbo four-cylinder engine to the Audi 2.5-liter turbo five-cylinder engine," Wiersma explains. "This gave us more power—jumping from 270 to 400 horsepower—but also increased engine weight from 125 to 196 kilograms. To compensate for this weight gain, we had to redesign the vehicle and needed CFD (computational fluid dynamics) and advanced structural simulation tools to do it on time and within budget."

After evaluating CFD analysis packages, including SolidWorks Flow Simulation and FLUENT®, and nonlinear structural simulation systems, including SolidWorks Simulation Premium and ANSYS®, Donkervoort selected SolidWorks Simulation tools.

Challenge:

Advance world-class sports car design by increasing horsepower and improving aerodynamics, while simultaneously managing weight for agile maneuverability, airflow for smooth-running engines, and heat for top performance.

Solution:

Implement SolidWorks Flow Simulation computational fluid dynamics (CFD) analysis software to manage aerodynamics, airflow, and engine cooling, and SolidWorks Simulation Premium structural analysis software to validate innovative hybrid chassis designs using nonlinear analysis capabilities.

Results:

- Cut number of prototypes required by 50 percent
- Increased product sophistication
- Improved aerodynamics and performance
- Introduced structural innovation in sports car design

SOLIDWORKS

"We chose SolidWorks Simulation because it provided all of the analysis capabilities that we need in a single design environment," Wiersma recalls.

"CAD integration is a must," he adds. "We had experience working with outside consultants who used other analysis tools. We often spent more time integrating analysis results into our CAD system than we did applying those results to our designs. Working in a single environment enables us to more efficiently use simulation while we design and apply these insights to our design concepts in real time."

Optimizing intake manifolds

The first projects for which Donkervoort used SolidWorks Flow Simulation involved optimization of the car's intake manifolds and airflow around the engine. "The intake manifolds project was the most interesting," Wiersma notes. "Through flow simulations, we identified a pressure buildup in the intake manifolds that would inhibit air from reaching each cylinder evenly, resulting in rough idling.

"By making the surfaces spherical instead of flat, we achieved autonomous airflow to all cylinders and improved performance," Wiersma adds. "We also looked at how air flowed around the engine, leading to modifications. The benefit of addressing these issues in software is that we reduce the time and costs associated with prototypes. Using SolidWorks Simulation tools, we have cut the number of prototypes required in half."

Resolving open-wheel aerodynamic challenges

A trademark of Donkervoort cars is the open-wheel design—the wheels are positioned outside of the car body like a racecar. This contributes to the car's ultralight weight and tight cornering. However, it also presents aerodynamic challenges by creating additional drag.

"Rotation of the open wheel disturbs the airflow," Wiersma points out. "We used SolidWorks Flow Simulation to optimize the distance between the fenders and the wheels to reduce drag. We also added wings to the rear fenders of the D8 GT coupe to deflect airflow and positioned wings in the undertray/diffuser of the D8 GTO for increased down force."

Managing weight with innovative hybrid chassis

The most difficult D8 GTO challenge involved keeping the weight of the car near 700 kilograms when the larger engine alone increased the weight by 70 kilograms from the previous 650 kilogram model. "It wasn't just the increased engine weight that was an issue," Wiersma stresses. "The boost in horsepower required structural strengthening—a snowball effect that adds weight. This is where we needed simulation tools to help us increase the sophistication of the car."

Donkervoort engineers created a hybrid carbon fiber-tubular steel chassis to add strength while minimizing weight. Using SolidWorks Simulation Premium software, the company conducted nonlinear force, stiffness, crash, and impact tests on the innovative steel/composite chassis. Donkervoort also reduced engine weight by reconfiguring the "front end auxiliary drive", intake manifold, and clutch/flywheel assembly.

"The automobile industry is very competitive, and we need to use cutting-edge technology like SolidWorks Simulation and high-tech materials to continue to be successful," Wiersma says.

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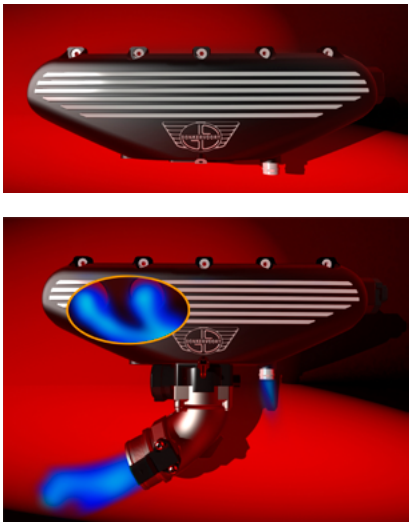

Donkervoort used SolidWorks Flow Simulation software to identify and address a pressure buildup in the D8 GTO's intake manifolds, improving engine performance.

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