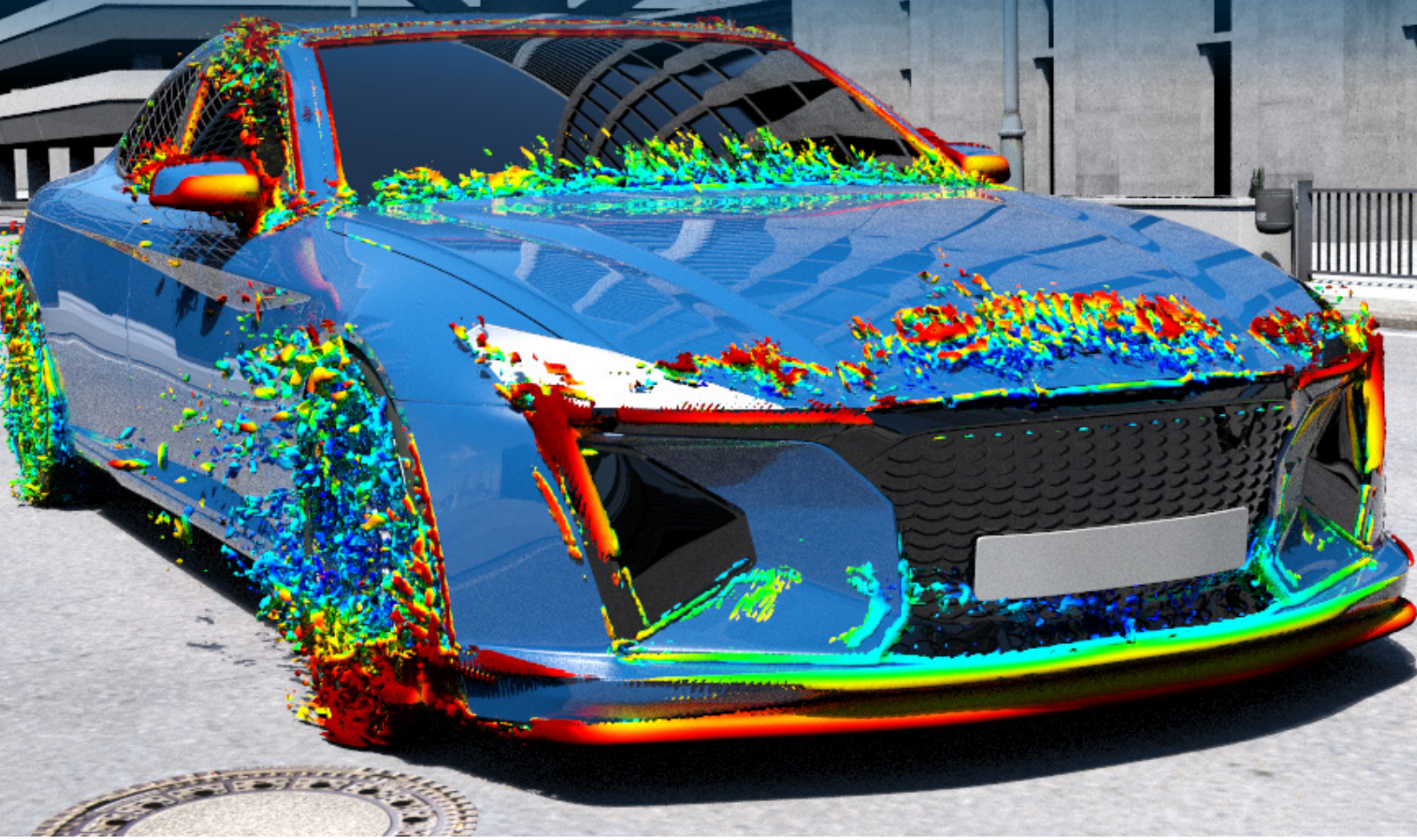
SIMULIA

3DEXPERIENCE®

VEHICLE STYLING FOR AERODYNAMIC PERFORMANCE, EFFICIENCY AND CERTIFICATION

SIMULIA's automotive fluid dynamics simulation solutions connect performance with design for optimal style and efficiency.



DASSAULT SYSTEMES

Vehicle manufacturers face challenges from all sides. As new competitors enter the industry the pressure is on to create stylish, differentiating vehicles and get them to market fast. But every vehicle must also pass stringent certification tests to satisfy regulators that it performs efficiently and meets emissions standards. When aggressive styling leads the design process it can compromise aerodynamic performance, causing delays as engineers have to spend extra time putting things right so the vehicle can be certified for sale. Electric and autonomous vehicles intensify the challenge, bringing big opportunities to experiment with form but also increased risk, as designers don't yet have tried and trusted data to tell them what has worked in the past. In addition, customers expect the experience of driving any new car to match the promises of its eye-catching style. Trade-offs between looks and performance are no longer acceptable and to avoid them, manufacturers need a rapid, robust process that brings styling and engineering together from the start.

The only way to meet all those requirements is by integrating modeling and simulation from the beginning of the design cycle. With simulation-driven design, stylists and analysts can create innovative concepts, refine details and meet performance targets. This whitepaper will explain how SIMULIA simulation solutions can be used to accelerate innovation and reduce the risk involved in developing new vehicle designs. As well as enabling right-first-time designs that meet performance targets, simulation can save time and money by enabling manufacturers to test and certify multiple configurations quickly, without having to build physical prototypes.

THE CHALLENGE OF DESIGNING FOR STYLE AND PERFORMANCE

First impressions count for a lot in the world's automotive markets. A vehicle's looks are a major driver in the decision to purchase, and manufacturers are under pressure to bring impactful styles quickly to market. But consumers, and regulators, also want a vehicle that performs well in terms of handling, comfort and, especially for electric vehicles, range. Designers are under pressure to innovate but also to get it right first time. If the aesthetic theme causes problems with aerodynamics, for instance, it's time-consuming, costly and sometimes not possible to rectify those issues later. As a result, designers need to be confident that as well as looking good, the vehicles they create will meet all performance targets.

Electric and autonomous vehicles up the ante even more when it comes to aerodynamic performance. Charging an electric vehicle (EV) battery takes much longer than filling the tank of an internal combustion engine (ICE) vehicle, so the range the car can travel on each charge is critically important to prospective buyers. As the most expensive part of an EV, the battery is also a natural focus for manufacturers looking to control costs. Better aerodynamic performance addresses both those issues, enabling greater range and making it possible to reduce the size—and cost—of the battery.

EVs also open a world of new style possibilities because unlike ICE vehicles, there's no need for an EV to have an engine upfront where it can be cooled. This gives stylists flexibility to create exciting shapes and layouts, but it's also new territory for vehicle design, with no prior examples to suggest what works and what doesn't. Being able to analyze the performance of these new shapes early on is critical to successful innovation in EV design.

Meeting regulatory standards is mandatory, but increasingly, consumers are also concerned about how the experience of driving their new vehicle matches up to the advertised performance, e.g. for the range of an electric vehicle. Physical testing for certification is done in ideal, controlled conditions because it has to be repeatable. But the traffic, crosswinds, rain and noise experienced by drivers on the highway are far from these ideal conditions. Worse, manufacturers often don't know exactly how the vehicle will perform in these uncertain conditions until they build it and test it around a track or city environment—by which time it's too late to fix any problems. As a result, drivers on the road typically experience much higher drag values than the ones evaluated during design and certification, and thus achieve much less vehicle range or worse fuel economy than advertised. To be sure the vehicle they create will live up to its promises, designers need fast, efficient and repeatable ways to understand how every style nuance will affect performance in everyday driving conditions.

BENEFITS OF A SIMULATION AND VIRTUAL TESTING APPROACH

Simulation allows designers and engineers to create and test virtual models of vehicles while avoiding the time and cost of building multiple physical prototypes. In general, simulation enables the final product to be built faster, to higher engineering standards, while reducing costs. This is especially important in a crowded automotive market where manufacturers are under pressure to expand their range and offer custom configurations. When it comes to those radical ideas for new EV designs, having simulation tools to give feedback on how untried vehicle shapes will perform is essential to move the industry forward.

A simulation and virtual testing approach allows for hundreds of design iterations and validates the best options to proceed quickly.

As well as eliminating the need to build physical prototypes during the design process, a simulation approach can minimize the number of prototypes needed for certification. Worldwide Harmonized Light Vehicle Test Procedure (WLTP) certification, for instance, must be carried out for every possible configuration of the vehicle, but it only requires physical prototypes of the lowest and highest performing variants. All the hundreds of variants in between can be certified digitally using simulation, reducing the number of physical tests by an order of magnitude.

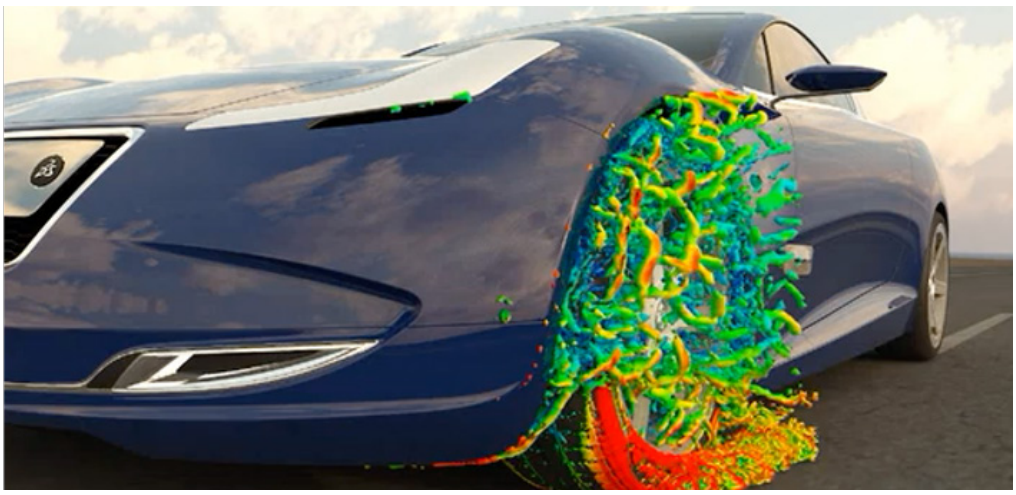
When simulation connects consumer demands, performance goals and regulatory requirements it can minimize the need for trade-offs between these areas. By combining modeling with simulation from the very start of the design cycle, designers and analysts can identify innovative concepts, refine details and meet performance targets while creating styles that inspire their consumer base.

THE SIMULIA SOLUTION

All the challenges listed above can be addressed through a simulation approach that helps designers and engineers connect the geometry between performance analysis and styling, while managing complexity across the entire development process. SIMULIA has solutions to do that. Powered by the **3D**EXPERIENCE® platform, it delivers realistic simulation applications that simplify the management of data associated with thousands of different vehicle configurations. Crucially, it enables vehicle designers to interactively explore the impact of design changes on performance early in the design cycle. As a result, manufacturers can simulate and certify designs without having to build hundreds of different prototypes.

PowerFLOW®

PowerFLOW is SIMULIA's computational fluid dynamics solution that simulates fluid flow over the vehicle with full time accuracy. Unlike many fluid dynamics solutions which show only the average drag or condition of the flow field, PowerFLOW provides transient aerodynamic simulations using either ideal, uniform flow conditions or a realistic wind environment. Every element of the vehicle can be analyzed, enabling designers and engineers to quickly evaluate vehicle performance and drag, whether in ideal conditions similar to a wind tunnel or in the fluctuating conditions drivers will experience on the road. When this information is available early in the design cycle, it can be used to inform style decisions to ensure that great style does not mean compromises on performance. In fact, multiple vehicle manufacturers have already received approval for digital certification under WLTP using SIMULIA PowerFLOW.



Using PowerFLOW to simulate the motion of rotating tire treads, identify the best tire brand for aerodynamic performance and provide certification values on how different tires will affect drag.

DesignGUIDE®

DesignGUIDE, introduced in the 2020 release of PowerFLOW, empowers vehicle manufacturers to interactively explore the impact of design changes on performance. It provides feedback that connects performance to design in a graphical, intuitive way that gives stylists the freedom to craft appealing aesthetics while also achieving performance targets.

Using a color-coded surface map, DesignGUIDE provides a 3D representation of the vehicle which tells the stylist, designer or engineer how moving a surface in a given direction will affect aerodynamic performance. Colored areas indicate, for example, that pulling a certain surface outward will make the drag worse while pushing it in will improve it. It also provides vital information on the areas where designers can make styling choices that will have zero impact on the vehicle's performance. This intuitive guidance leaves creative decisions firmly in the hands of designers, providing them with the information they need to combine aerodynamic performance with the aesthetics consumers want.

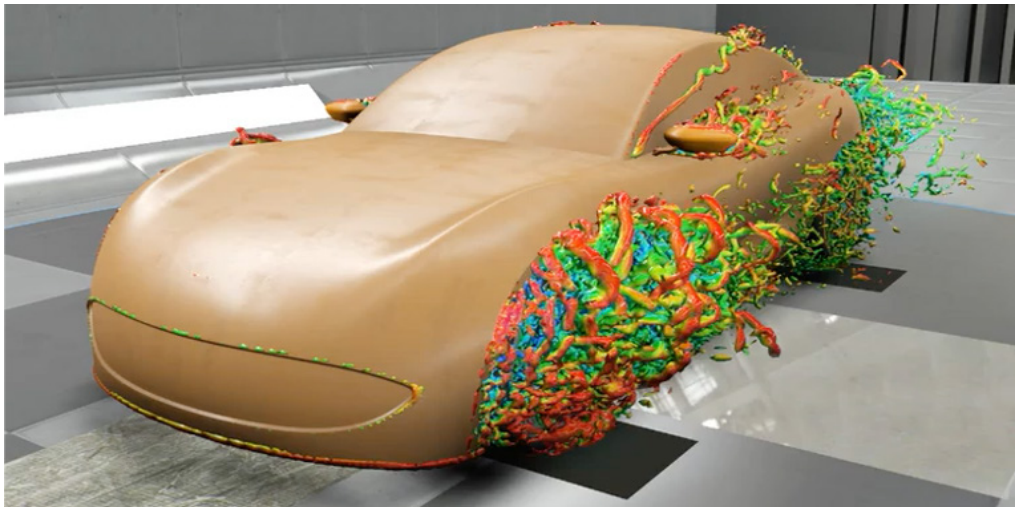
DesignGUIDE connects performance to design using interactive, color-coded surface maps to indicate how style decisions will affect elements such as aerodynamic performance, water management and wind noise.

Crucially, by marrying creative freedom with the ability to optimize aerodynamic performance from the start of the design process, DesignGUIDE can rapidly accelerate vehicle development. Better communication between engineering and design teams, coupled with intuitive guidance, speed up the process of creating right-first-time designs that combine aesthetic with aerodynamic performance.

As the design matures and different parts of the vehicle develop at different rates, the **3D**EXPERIENCE platform provides a single environment to manage the complexity of the development process. It seamlessly incorporates new or carry-over production-level components or assemblies with fresh exterior surfaces from the design studio, accelerating overall vehicle development.

Once it is time to certify the vehicle for sale, the same process can be used to identify and evaluate all the different vehicle combinations. This avoids the costly and time-consuming process of acquiring and testing physical prototypes and reduces the risk of launch delays due to testing bottlenecks or missed performance targets. Certification is also faster. When all the different variants have been simulated during the design process, they can be digitally certified before the vehicle is built, removing the need to procure and physically test each one.

SIMULIA tools are available on the **3D**EXPERIENCE platform, which allows designers and engineers to collaborate seamlessly across disciplines and different teams throughout the organization. Breaking down silos increases the potential for innovative solutions that improve vehicle performance while freeing designers to create exciting new concepts. In addition, manufacturers and suppliers can share data easily and build accurate simulation models.



Simulation allows vehicle aerodynamic performance to be evaluated early in the design process, providing stylists insight to make design decisions without compromises.

CONCLUSION

In a competitive and rapidly changing global automotive industry, manufacturers need to be able to create stunning new vehicle designs that meet stringent certification requirements and deliver a superb driving experience on the road. With the solutions offered by SIMULIA, they can bring design and engineering decisions together from the very start of the design cycle, reducing the risk associated with new styling elements by providing intuitive guidance on how design decisions will affect aerodynamic performance. Integrating engineering insights into the design process gives vehicle stylists the freedom to create innovative, aesthetically pleasing new vehicles while ensuring they meet and exceed performance goals from the start. Virtual prototyping and testing of every variant also reduces the number of physical tests required, speeding up the certification process so manufacturers can get exciting new models to market faster.

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