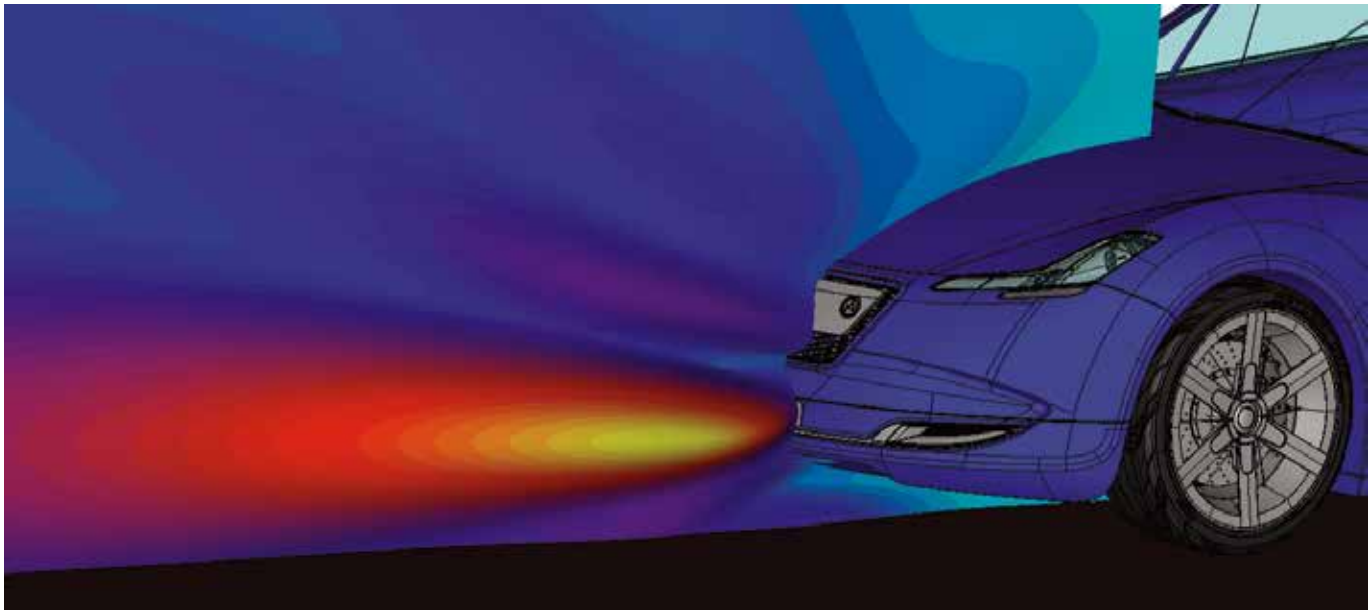

Figure 1. Electric field from a radar sensor on the front of a car.

SIMULATING AUTONOMOUS AND CONNECTED MOBILITY

Innovation has always been key to success in the automotive industry. Every aspect of vehicle design is being constantly optimized and new technologies regularly emerge that revolutionize what a car can do.

Right now, many of the trends in vehicle design are converging towards intelligent electronic systems. These include increasingly integrated onboard computers, advanced driver-assistance systems (ADAS), vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) systems for monitoring and negotiating with the environment, autonomous driving and electric drive.

Integrating these technologies into a vehicle affects every area of the design and requires multiphysics simulation. Replacing the engine, usually mounted at the front, with batteries and motors slung under the body changes the vehicle's center of gravity, affecting the performance of the chassis and suspension, and the removal of the front radiator grille changes the aerodynamics and affects heating, ventilation and air conditioning (HVAC) of the passenger cabin.

To fully model an electric car, the engineer needs multibody, mechanical, vibro-acoustic, fluid dynamics and electromagnetic (EM) simulation tools, all of which can be found on the **3D**EXPERIENCE platform. This article focuses on the latter, and highlights some of the areas of modern vehicle design where EM simulation with CST STUDIO SUITE can reduce design time, optimize performance, and identify and mitigate concerns about health, safety and interference regulations.

CONNECTED VEHICLE DESIGN AND ADAS

One of the most important lessons taught to any learner driver is to always be aware of your surroundings. Communication, navigation and ADAS systems supplement what the human eye can see and help keep drivers informed about where they are, what the road ahead is like, and what other drivers are doing around them. Antennas are the eyes and ears of these systems, transmitting and receiving signals such as radio, mobile telephony, GPS and radar.

The performance of an antenna is affected by where it is placed on the vehicle, as the metal body reflects, blocks or conducts signals in ways that are hard to predict without simulation. Avoiding blind spots in a radar, for instance, is safety-critical (Figure 1). Where there are multiple antenna systems close together, there is also a risk of co-site interference between them. To model this risk, CST STUDIO SUITE offers a Co-Site Interference workflow that takes the properties of all the different transmitter systems into account to calculate the interference risk.

ELECTRONIC EQUIPMENT DESIGN

Automotive electronics encompasses the chips themselves, the packaging, printed circuit boards (PCBs) and connectors that carry signals. Electromagnetic compatibility (EMC) between electronic systems and signal and power integrity (SI/PI) within systems are all crucial here. EMC relates to how much interference, in the form of radiated and conducted emissions, a device produces. SI concerns how well an electronic channel conducts signals without degradation, and PI is about ensuring that the power supplied to a component is clean, without voltage spikes or drops that might affect performance.

Not only are there legal regulations on the interference a device may produce, OEMs specify strict limits to their suppliers in order to ensure the reliability and integrity of the car as a whole. This means that EMC and SI/PI compliance is crucial at all points in the automotive supply chain. CST STUDIO SUITE

includes a range of specialized tools for identifying potential EMC and SI/PI issues from the earliest stages of design.

Thermal management is another important factor in automotive electronics, particularly in the high current parts of electric vehicles. Airflow significantly affects how hot a device becomes in use, and so a multiphysics simulation approach—combining EM, thermal and fluid dynamics technology—is the only way to accurately model the cooling systems.

3D WIRE HARNESS ENGINEERING

An extra topic of electronics, which is especially important to vehicles, is the wiring. Cars need a complex tree of cables linking all their components, and these are bundled together into harnesses to save space. The close proximity of wires in a cable harness can cause interference, but adding shielding to every cable would add significant weight and bulk to the vehicle. Hybrid simulation allows even very complicated cable harnesses to be simulated in a realistic environment in order to analyze performance and find the right balance between weight and shielding.

ELECTRICAL DRIVETRAIN ENGINEERING

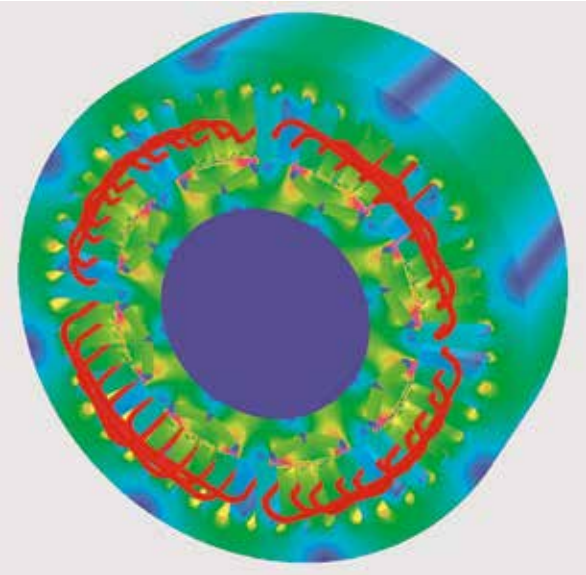

Figure 2: Cross-section of a motor, showing the electric field within.

Electric mobility poses a range of new questions to automotive engineers. How much space is required for the batteries and motor? Are the high-voltage, high-current systems safe? Is the motor design efficient enough? These questions can be answered with simulation.

Automatically optimizing motor geometry (Figure 2) through simulation can quickly improve the performance and power consumption. Equally important is understanding how the efficiency of the motor changes at different speeds. CST STUDIO SUITE can automatically calculate the efficiency map—a plot of efficiency for all torques and speeds—which can be used to find the optimal configuration.

Wireless charging systems are another application. Similar to the charging mat technology used with some phones, but on a much larger scale, wireless charging is expected to make electric vehicles more convenient by allowing them to recharge their batteries in car parks, bus stops and warehouses. The technology is based on transmitting power between two coils, a primary one buried in the road and a secondary one in the vehicle, which need to be placed as centric as possible to each other. Engineers need to know how many wires are needed in the coils, which materials the coils should be made from, what the best design and coil configuration for perfect power transfer is, and how much shielding is needed to meet safety regulations while also limiting weight.

ELECTROMAGNETIC COMPATIBILITY

One thing that all the systems listed above have in common is the risk of interference. EMC is a legal requirement and indispensable if individual systems are combined into a vehicle. Components ranging from the power electronics that control the motors to the passenger's phone can all produce interference, and cables, vents and seams can leak and allow EM fields to couple to unexpected parts of the vehicle. Full system simulation, using multiple 3D and circuit simulation techniques, is crucial to analyzing the EMC performance of the vehicle before committing to constructing a full prototype, and the ability to visualize EM fields in 3D allows designers to easily find and deal with the causes of interference.

In addition, high-power electric fields—particularly from wireless charging—are limited by health and safety regulations. The exposure of the human body to transmitted EM energy is measured in terms of specific absorption rate (SAR). CST STUDIO SUITE includes realistic human body models, and calculates both the SAR and the actual heating caused by EM field exposure.

SUMMARY

Electronics is transforming the automotive industry. Due to the high complexity and sheer number of electronic systems, electromagnetic simulation is key in the entire development process. Virtual prototyping and simulation of all product variants is essential in the ever shorter development process and will be the next big step in the automotive industry. The success of vehicle design relies on the mastery of many areas of physics, and the addition of EM to the range of simulation tools available on the **3DEXPERIENCE** platform makes SIMULIA's portfolio for automotive simulation even more comprehensive.

For More Information

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