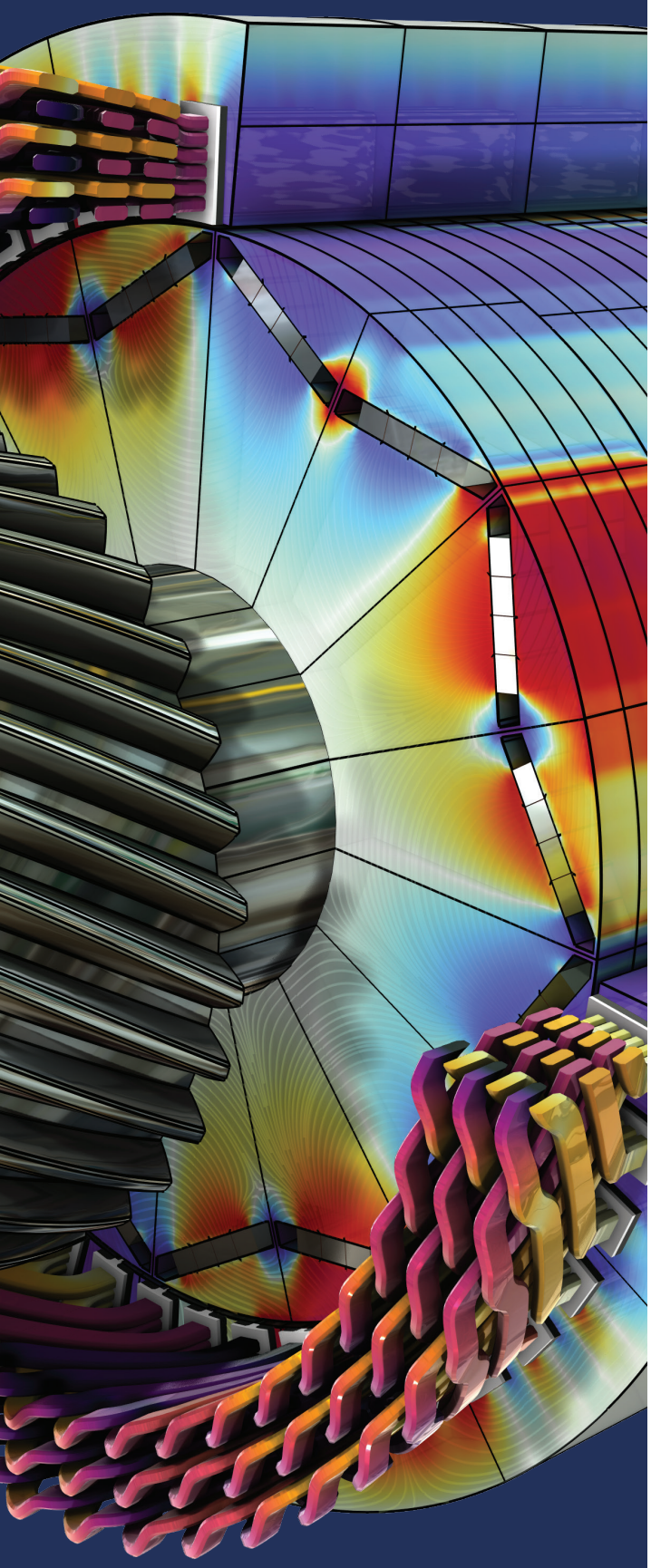
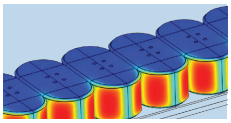


Automotive Design Innovation

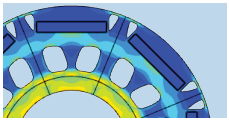
with COMSOL Multiphysics®

Modeling and simulation is useful for understanding and designing automotive components. This pamphlet highlights how the COMSOL Multiphysics® simulation software is being used in the research and development of electric vehicles (EVs).

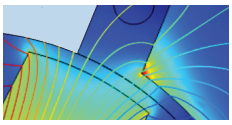
Developing fuel cell flow field plates



Designing and optimizing drivetrain components

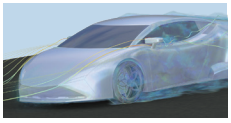


Creating simulation apps for evaluating rotor laminations

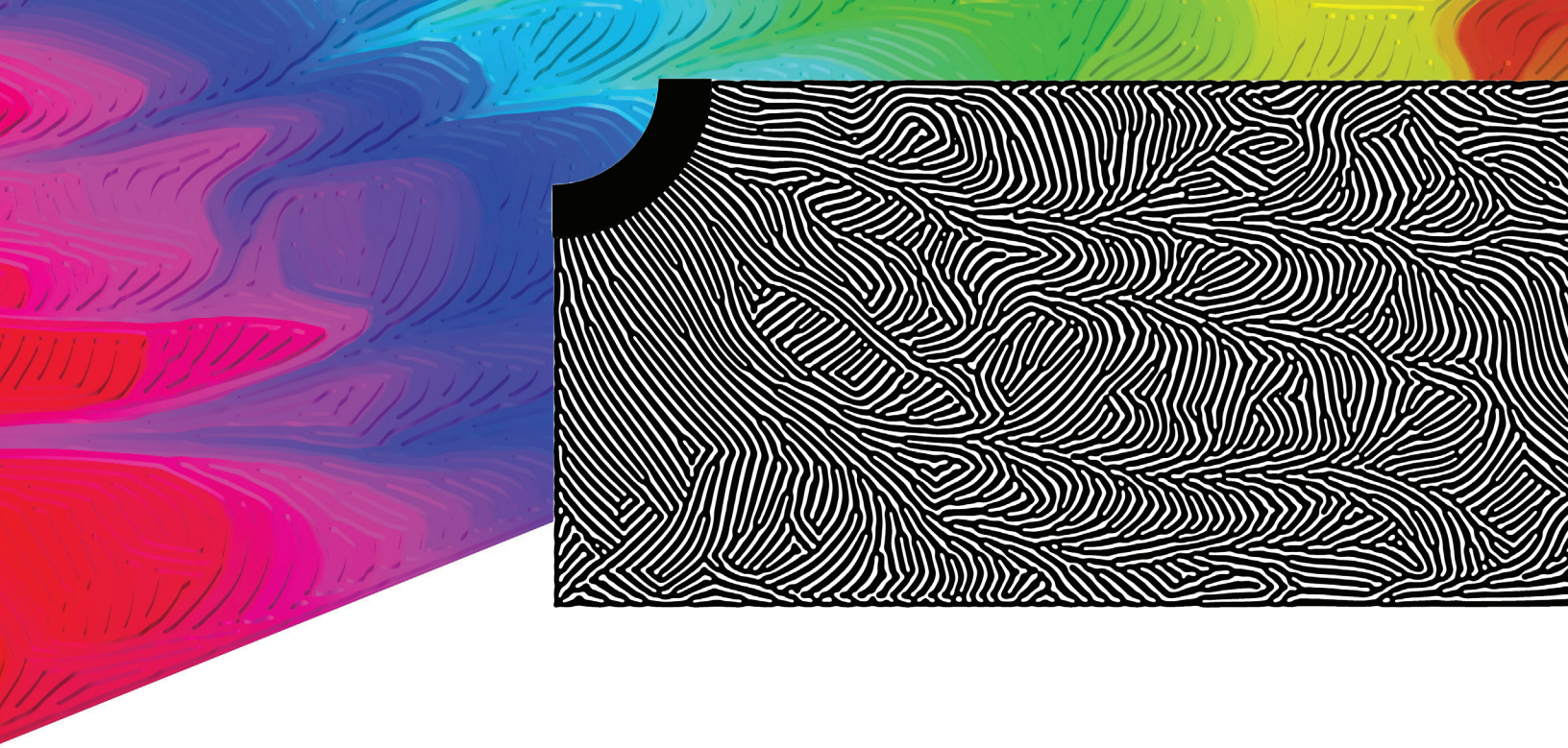


Analyzing EV applications via electromagnetics simulation

Understanding and optimizing batteries for EVs



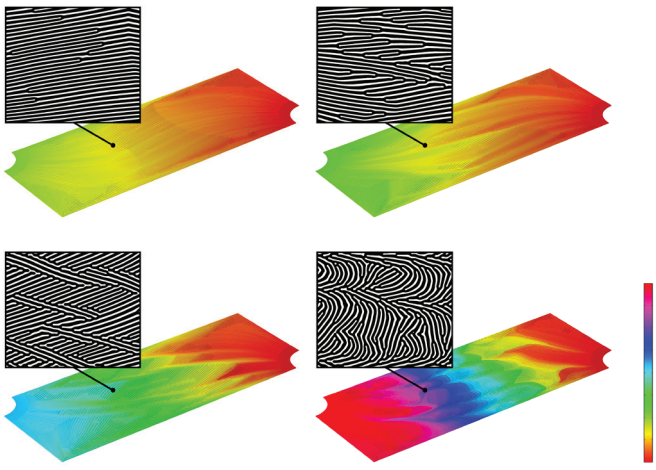
Plus: Example models to get started



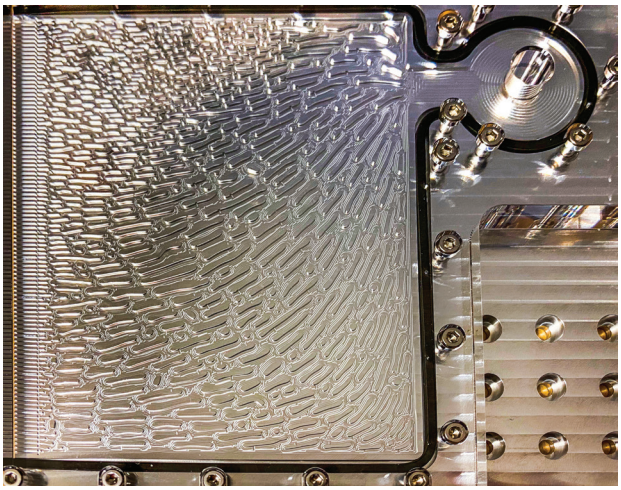
HYDROGEN FUEL CELL DEVELOPMENT

with **TOYOTA RESEARCH INSTITUTE OF NORTH AMERICA**

Toyota Research Institute of North America (TRINA) developed a simulation-driven generative design method for optimizing the design of fuel cell flow field plates.



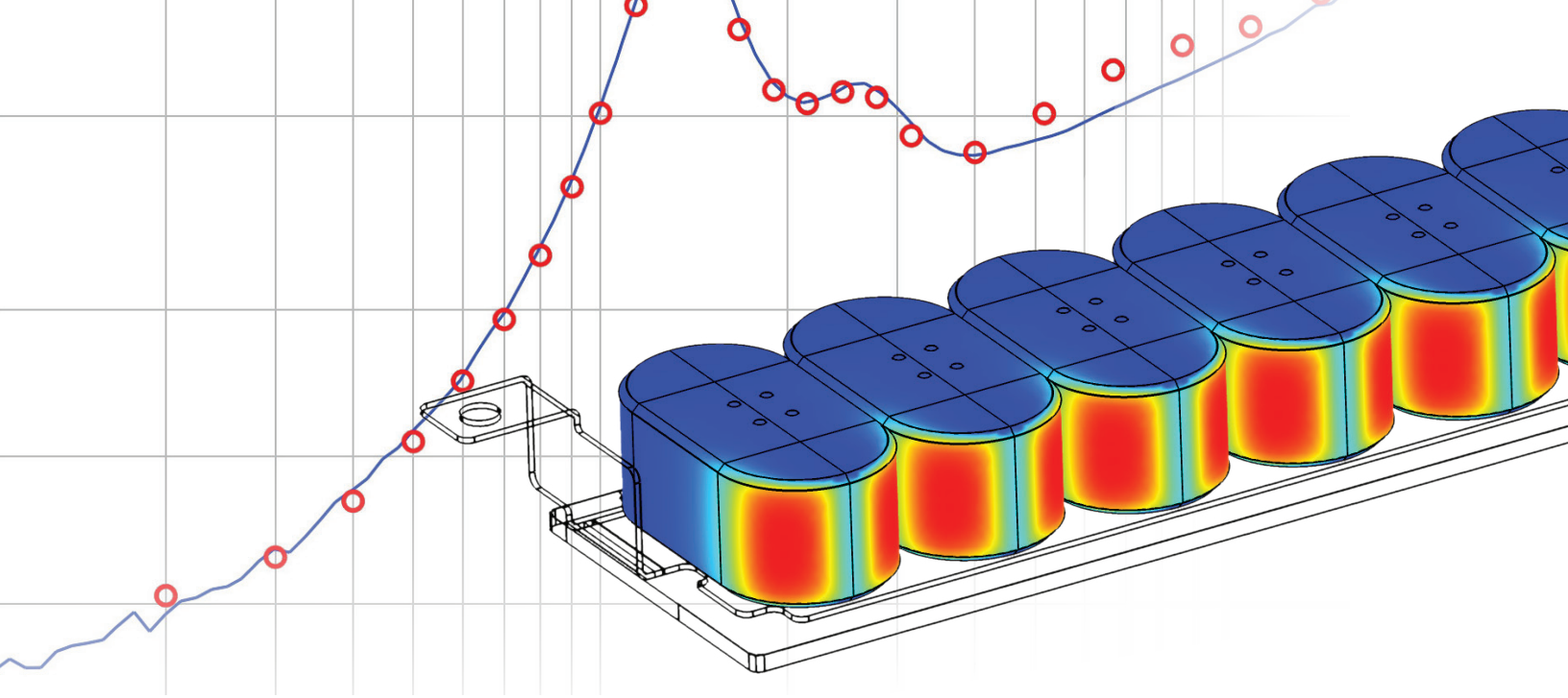
Applying this process resulted in four distinctive microchannel designs, all of which outperform baseline conventional designs across key reaction-fluid performance metrics.



The simulation-enabled process generated high-performing designs that resemble natural fluid reactant-distributing structures, such as leaves, lungs, and blood vessels.

Testing of a fabricated prototype showed enhanced fluid distribution and reaction uniformity, leading to increased power output from the fuel cell.

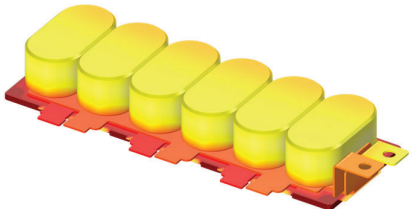
Read the full story at comsol.com/story/hydrogen

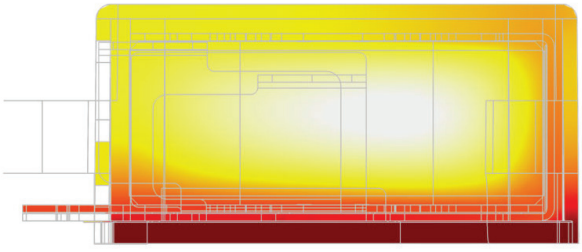


ELECTRIC DRIVETRAIN COMPONENT R&D

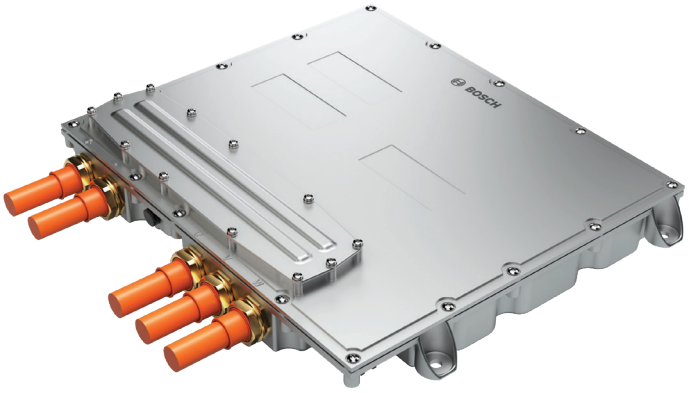
with **BOSCH**

Bosch supplies electrical systems and components to automakers worldwide, including DC link capacitors for EVs. The Bosch team uses multiphysics modeling for the optimization of these capacitors.



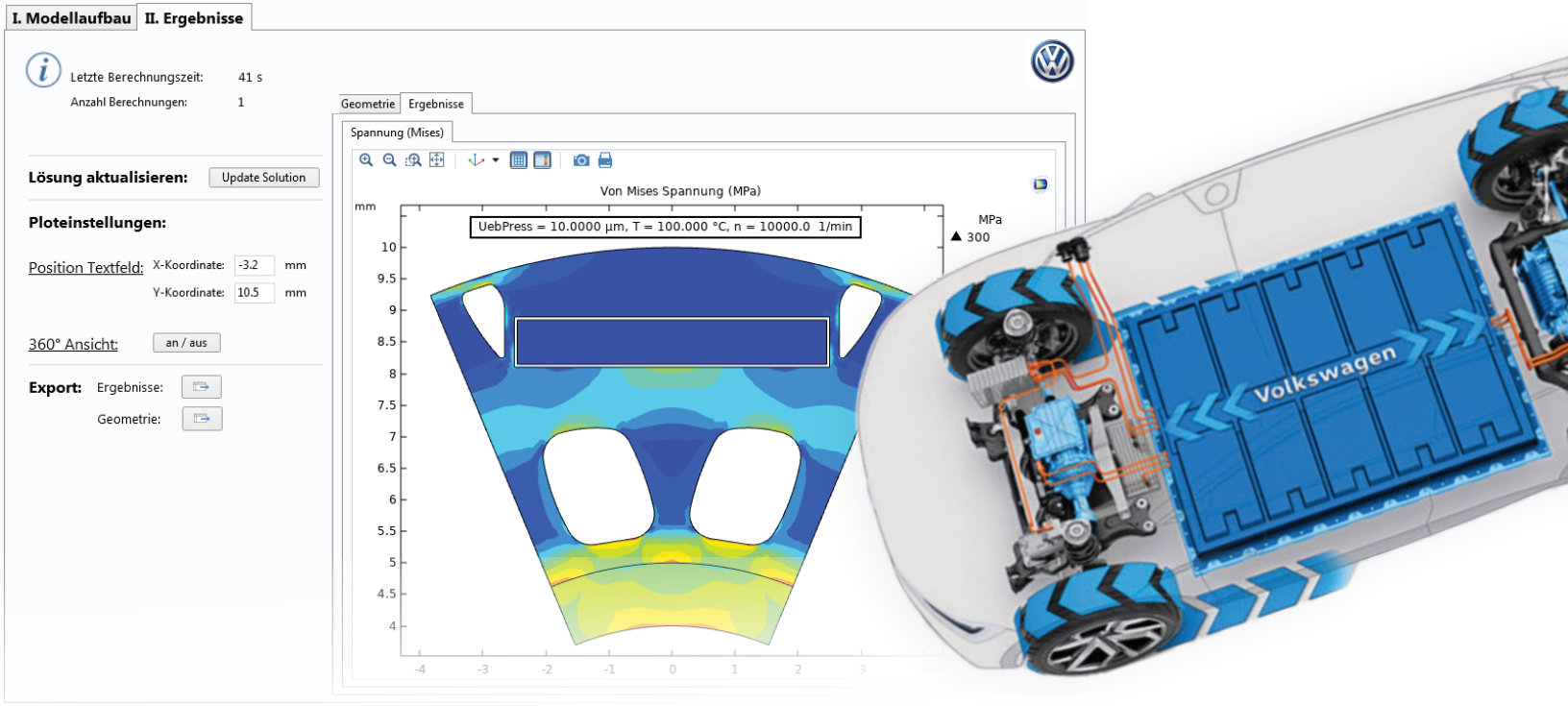


Modeling DC link capacitors has enabled the team to identify potential "hot spots" early in the development process, making it easier to avoid the failure that can result from too-high heat.



"I do think that the number of products that require new capacitor designs will keep expanding," says Martin Kessler, senior expert for automotive electronics at Bosch. "With our simulation-driven development methods, we are confident that we can keep up with this growth."

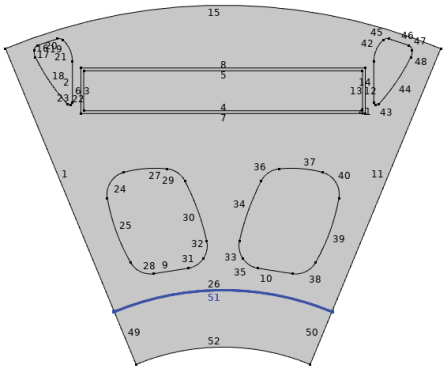
Read the full story at comsol.com/story/EV-components



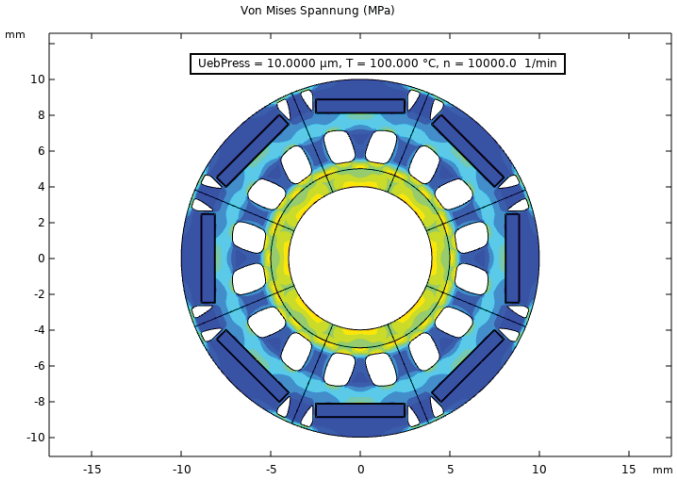
ELECTRIC VEHICLE MOTOR DEVELOPMENT WITH APPS

with **VOLKSWAGEN KASSEL**

The VW Kassel plant produces 150 electric and 300 hybrid drives daily. Balancing dual requirements, such as torque, or power, with durability can be challenging.



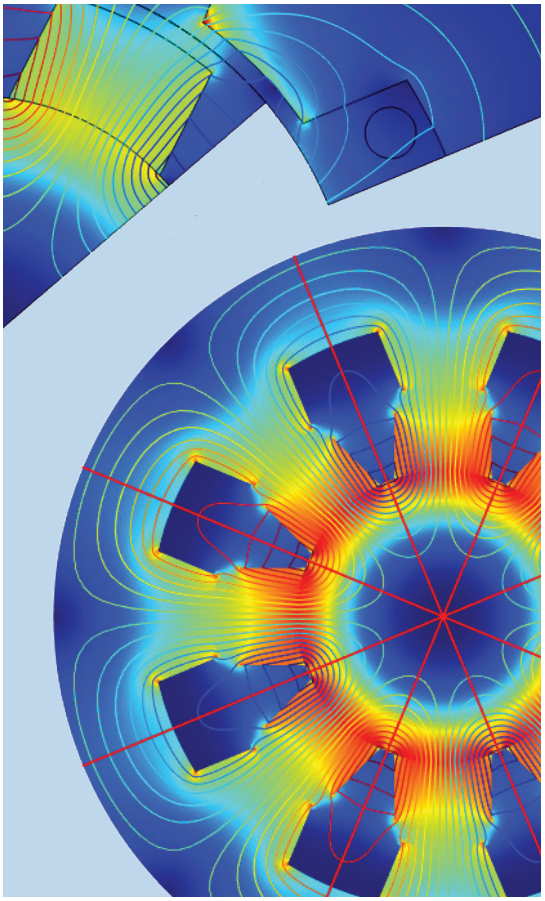
The simulation experts model electric drive designs to address requirements early on in the development process, greatly reducing the number of variants. From there, they build simulation applications.



By using a simulation app based on the model, designers can quickly and easily benchmark different variants.

The test process for evaluating the strength of rotor laminations has been automated through simulation apps — further reducing development costs and increasing product quality.

Read the full story at comsol.com/story/EVs



KEYNOTE VIDEO

MODELING STRATEGIES FOR ELECTRIC VEHICLE APPLICATIONS

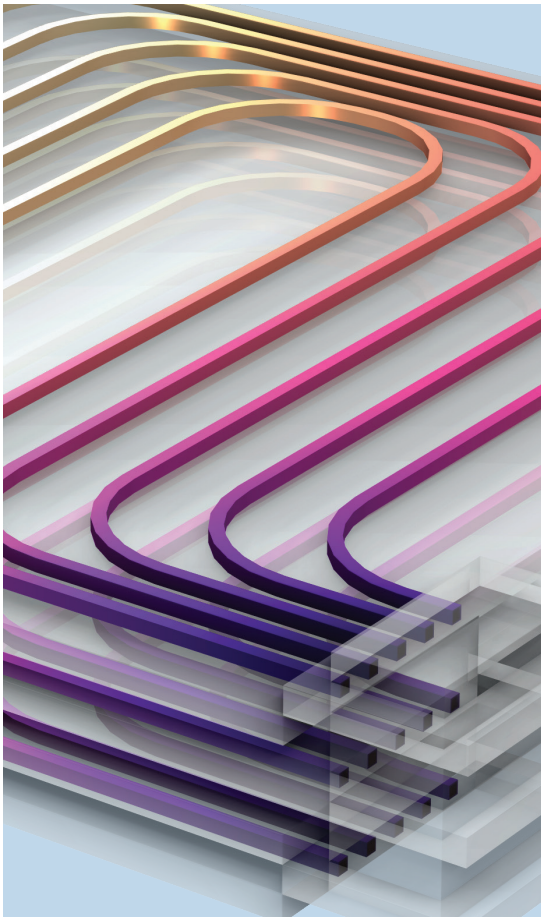
Fabian Scheuren, the founder of Scheuren Simulation & Consulting GmbH, explains how multiphysics simulation can be used to keep up with the fast-paced development cycles of the automotive industry.

During the talk, Scheuren presents on the use of electromagnetics simulation for analyzing EV applications. He shares advice for meshing model geometries, using boundary conditions, modeling exterior boundaries, and selecting study types.

Watch the keynote at comsol.com/video/20451

KEYNOTE VIDEO

HOW FAST-CHARGING XNO™ BATTERIES COULD TRANSFORM E-MOBILITY



Maurits Houck, a PhD student at the University of Cambridge who studies batteries in collaboration with Echion Technologies Ltd, discusses how to use multiphysics simulation to optimize complex battery designs.

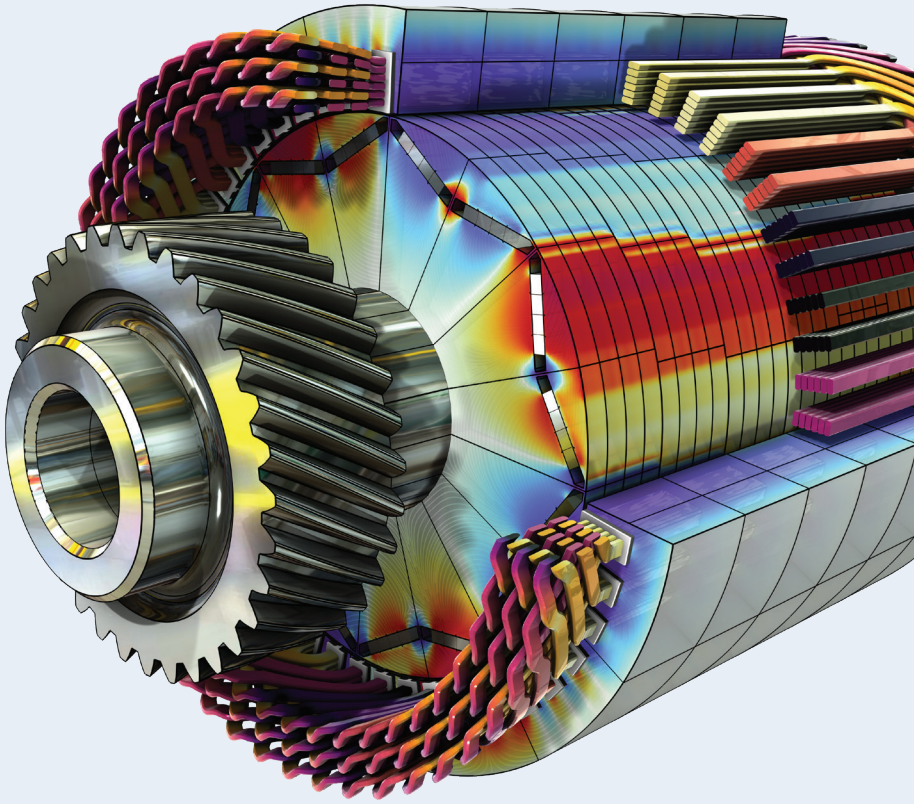
During the talk, Houck goes over the setup of a Newman pseudo-two-dimensional (P2D) model of a battery cell, which can be used to predict its final experimental performance. It also provides insight into what happens inside the cell, which is difficult to measure experimentally. A 3D battery model is also explored.

Watch the keynote at comsol.com/video/19461

comsol.com/models

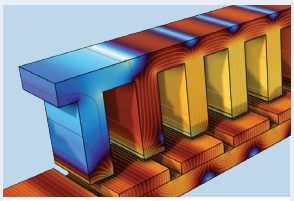
Electric Machine Modeling

APPLICATION ID: 110261



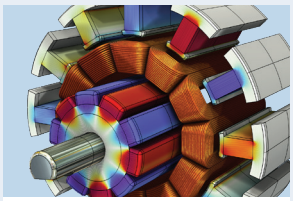
A series of models that demonstrate advanced electric machine modeling in COMSOL Multiphysics® — in 2D, 2.5D, and full 3D, including end effects. It shows how to investigate the performance of a permanent magnet synchronous motor, which is often used in modern EVs.

Additional COMSOL Models for Download



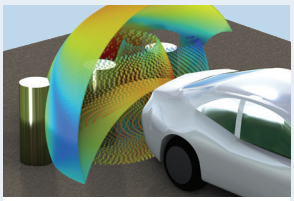
Linear Motor
Application ID: 102731

Moving mesh and periodic conditions for a periodic part of a complete motor.



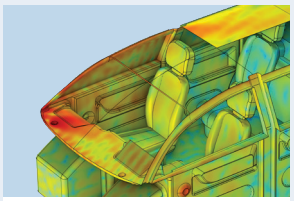
Permanent Magnet Motor
Application ID: 47621

Eddy current losses in the magnets.



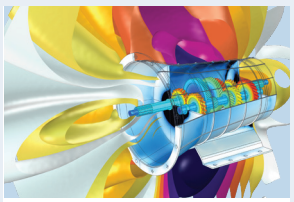
Ultrasonic Car Parking Sensor
Application ID: 68041

Coupling FEM with ray tracing to compute the transducer response.



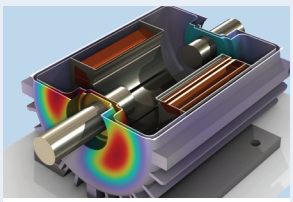
Car Cabin Acoustics
Application ID: 15013

Analysis of a car cabin to study the performance of a sound system in the low- to midfrequency range.



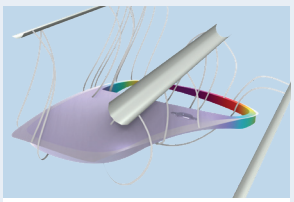
Gearbox Vibration
Application ID: 103211

Transient multibody analysis for computing gearbox vibration.



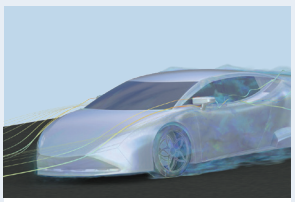
Vibration in an Induction Motor
Application ID: 47871

Electromechanical analysis of a three-phase induction motor.



Electrocoating of a Car Door
Application ID: 16171

Electrocoating of paint onto a car door in a time-dependent simulation.



Fluid–Structure Interaction
Application ID: 99871

FSI analysis of a sports car side door and side rear-view mirror.