STEERING TOWARD THE FUTURE

Faced with rising fuel prices and growing environmental concerns, the automotive industry is re-inventing itself — and simulation is playing a critical role.

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The global automotive industry faces incredible pressures today. The skyrocketing costs of traditional fuels — along with worldwide supply uncertainties — are forcing automakers to not only increase the efficiency of current fuels, but to explore new fuel sources and engine designs that will drive increased efficiency. Last year, in an agreement with U.S. President Barack Obama, 13 leading automakers pledged to increase the average fuel economy of their fleets to 54.5 miles per gallon (mpg) by the 2025 model year. With today's average rate in the United States at 25 mpg, this is a very ambitious target.

Growing awareness of auto emissions' environmental impact is forcing the industry to rethink engineering design. Next-generation engine and exhaust system technologies are needed to minimize emissions and other environmental consequences, while still delivering the high levels of performance consumers have come to expect.

These dual pressures, while imposing, are just the beginning. Consumers are demanding cars, trucks and other vehicles that are smarter and safer than ever before. Incorporating innovative, interactive infotainment systems, wireless communications technologies, collision-avoidance systems and navigational devices is changing the way cars are designed, manufactured and used by consumers. Today, 30 percent of the value in the average passenger car lies in its electronic systems — and this percentage will increase as designers imagine new automotive functionalities to capture the imaginations of consumers worldwide.

DRIVEN TO INNOVATE

While these multi-faceted pressures may be daunting, they create an extremely exciting opportunity for automotive engineers and designers. There is a research-and-development boom in this industry that is unmatched in its 125-year-plus history.

Automakers have an amazing chance to reconceive and re-invent the most basic technologies that have driven the design of engines, powertrains, fuel systems, exhaust systems and other components since the earliest days of the industry. In this clean-sheet design environment, no idea is too outlandish — and no component or system can escape scrutiny. Everything is open to re-imagination and re-invention.

Though this represents an energizing and thrilling environment for designers, it presents practical challenges. How can engineers design, test and verify new elements quickly enough to meet the 2025 fuel-efficiency mandate? How can they keep engineering and testing costs low, while still ensuring the high level of product integrity required to protect consumers in real-world applications?

The answer, of course, lies in engineering simulation. Few other industries face the same daunting challenges; perhaps this is why the global automotive sector has been among the quickest to embrace the promise of engineering simulation. Since simulation technologies were introduced more than four decades ago, automakers have been at the forefront in understanding the value of these solutions and applying them to solve their most complex design challenges.

Today, manufacturers are using simulation to design new electric powertrains, reduce overall vehicle weight, create high-speed wireless communications systems, optimize the software that controls vehicles, and engineer new radar-based collision-avoidance systems. There is a host of practical challenges when designing such advanced systems. For example, how can wireless systems reliably eliminate interference and crosstalk? How do on-board computers decide which information is critical enough to transmit to drivers? When human safety is at stake, products must perform reliably the first time, every time.

GET THERE FASTER, WITH GREATER CONFIDENCE

The challenges automotive engineers face are incredibly complex. The good news is that recent technology advancements have enabled engineering simulation solutions that rapidly and reliably answer even the most sophisticated challenges.

Robust design features in ANSYS software impart confidence that automotive designs will perform as expected in the most demanding real-world conditions. While it might be impossible to test the actual performance of a physical component, such as a powertrain or muffler, in every condition — from rough roads to highways, from cold climates to deserts — simulation opens up this possibility. Typically, automakers can afford to test physical prototypes under only a few limited conditions, but simulation can ensure product integrity across a broad spectrum of conditions, for a fraction of the time and cost investment involved in physical testing.

Magneti Marelli is one industry pacesetter evaluating many virtual prototypes in the time that would be required to build a single physical prototype. An article in this issue describes their success at developing innovative engine components that run on renewable biofuels — by modeling the complete engine cycle.

Today's high-performance computing (HPC) environments enable rapid and seamless solutions of numerically large simulations, as complex problems are distributed across thousands of computer clusters. ANSYS software is specifically designed to be compatible with auto industry HPC environments. R&D teams can dramatically cut total time to solve, without sacrificing fidelity or scale. Engineers can test multiple scenarios quickly and efficiently by taking advantage of parametric analysis, distributed solve and other features of ANSYS software that harness the power of today's HPC engineering environments.

For example, automotive engineers can leverage morphing, advanced computational fluid dynamics, solver numerics, HPC environments and process automaters to simulate 50 shape variants of a vehicle, with high-fidelity

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CFD simulations that use a computational mesh of 50 million cells for simulating each design point, in a total elapsed time of 50 hours after initial case setup. Partnerships with processing leaders, such as Intel, have helped ANSYS to bring this kind of speed and power to auto engineers around the world.

ANSYS multiphysics technologies span the breadth of automotive engineering challenges — from the chip level to an entire system, such as a sophisticated electric powertrain. Automotive design encompasses fluid dynamics, structural mechanics, electromagnetics and thermal transfer; ANSYS delivers technology leadership in each of these individual physics. Furthermore, and perhaps more critical, ANSYS solutions support the systems-level approach that will help automotive designers meet the aggressive timetable established for truly re-inventing cars, trucks and other vehicles.

Only by looking at vehicles as connected systems — instead of as isolated components — can auto designers arrive at a new generation of products that meet the diverse needs of consumers, environmental groups and government regulators. Particularly for the new smart cars of the future, designers must ensure that computer chips, circuit boards and antennas interact reliably with such critical components as brake and steering systems — ensuring product integrity and passenger safety.

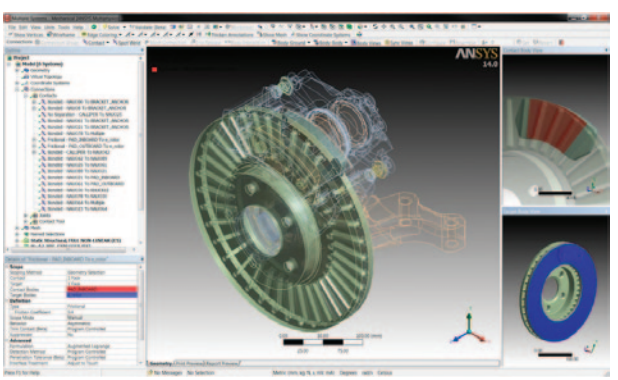
GREATER PRODUCTIVITY

Perhaps more than in any other industry, automotive engineers are racing toward the future of their product lines. Engineering simulation is helping organizations to amplify their resources and win the race — by making rapid progress at a lower overall investment.

Another article in this issue details how General Motors doubled the productivity of its engineering team working on an electric vehicle traction motor, combining an HPC environment with the power of ANSYS electromagnetic field simulation software. By performing simulations across 16 computers, with 32 cores, General Motors reduced its overall solution time by a factor of 16 — from 72 hours to just 4.5 hours.

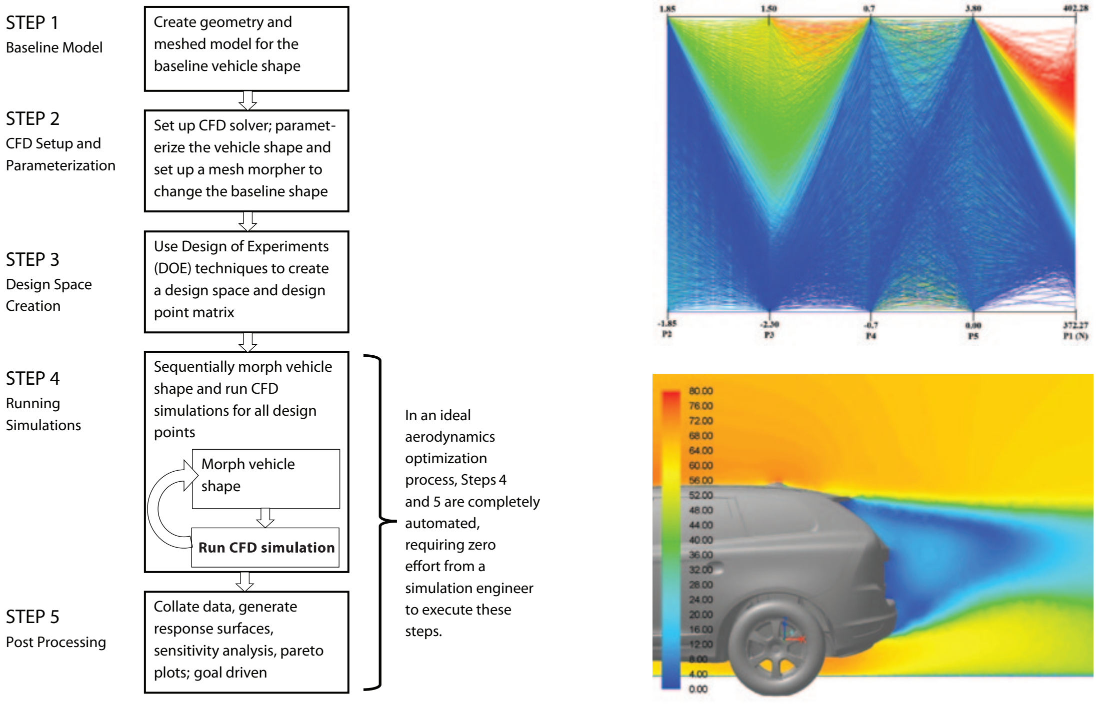
ANSYS software is designed to be easy and intuitive to use, enabling the democratization of auto engineering, as more diverse employee teams work toward a common goal. Software features such as engineering knowledge management and the industry-standard ANSYS Workbench platform enable automotive teams — including OEMs and multi-tier suppliers — to collaborate in a powerful manner, sharing workflows and simulation data.

As user needs in the auto industry (and other sectors) have become more complex, ANSYS has responded by making significant R&D investments that allow engineers to arrive at faster, higher fidelity, more accurate results without increasing their human resources and other product development costs. Product integrity can still be assured, even as companies slash the engineering



CAD MODEL COURTESY TRW AUTOMOTIVE.

Friction-induced squeal in automotive brakes is an increasing source of customer complaints. An integrated approach to brake squeal prediction incorporates bidirectional computer-aided design (CAD) connectivity, automated meshing and connectivity, flexibility to use a linear and/or a nonlinear solver, parametric and sensitivity studies, and a wide range of graphical outputs. This method substantially reduces setup time, correlates well with physical testing, maintains in-sync models with production and the supply chain, and makes it possible to automatically evaluate a large number of design alternatives to quickly identify the optimal design.



Aerodynamics development is all about trade-offs. Typically, R&D teams analyze up to 500 different vehicle shape variants in the time available for aerodynamics development. The analysis results shed considerable light on the impact of styling choices on aerodynamics performance, but they do not come close to achieving the potential of simulation to identify the best possible design that meets the various constraints and trade-offs involved in the project. A new approach, the 50:50:50 method, simulates 50 design points with high-fidelity CFD simulations that use a computational mesh of 50 million cells for each design point in a total elapsed time of 50 hours after baseline problem setup. By enabling full exploration of a large design space, the technique can lead to more informed trade-offs and choices in the early stage of the development process.

cycle time to arrive at revolutionary new designs before the rest of the industry.

WINNING THE RACE

In this issue of *ANSYS Advantage*, we showcase still other automotive leaders who are leveraging the power of simulation to amplify their resources, turbocharge their product design efforts, make products safer, and contribute to saving the planet.

In the hybrid electric vehicle sector, General Motors has enlisted a team (which includes ANSYS) to develop commercial battery software tools, expecting to accelerate development of next-generation cars. With funding from the National Renewable Energy Laboratory, the project is focused on breaking the industry's expensive and time-consuming process of design–build–test–break for prototyping and manufacturing lithium-ion batteries.

Complex structures, such as vehicles, are never 100 percent compliant in the real world. When a design does not take this into account, structures can distribute loads that lead to significant — and even catastrophic — consequences. A manager at John Deere developed a new approach to structural analysis that considers the effects of weld noncompliance.

Dallara Automobili is known for its accomplishments on the race track, but a significant portion of its business is through its consultancy practice. CEO and General Manager Andrea Pontremoli discusses the role that engineering simulation plays in fostering innovation, staying competitive and reducing prototyping.

These companies, and other ANSYS customers in the auto industry, are leading the way to the next generation of automotive design. There is no doubt that the results of our customers' innovative engineering efforts will be visible on highways and in off-road applications within the next few years, serving as an example of what can be accomplished through innovative engineering.

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