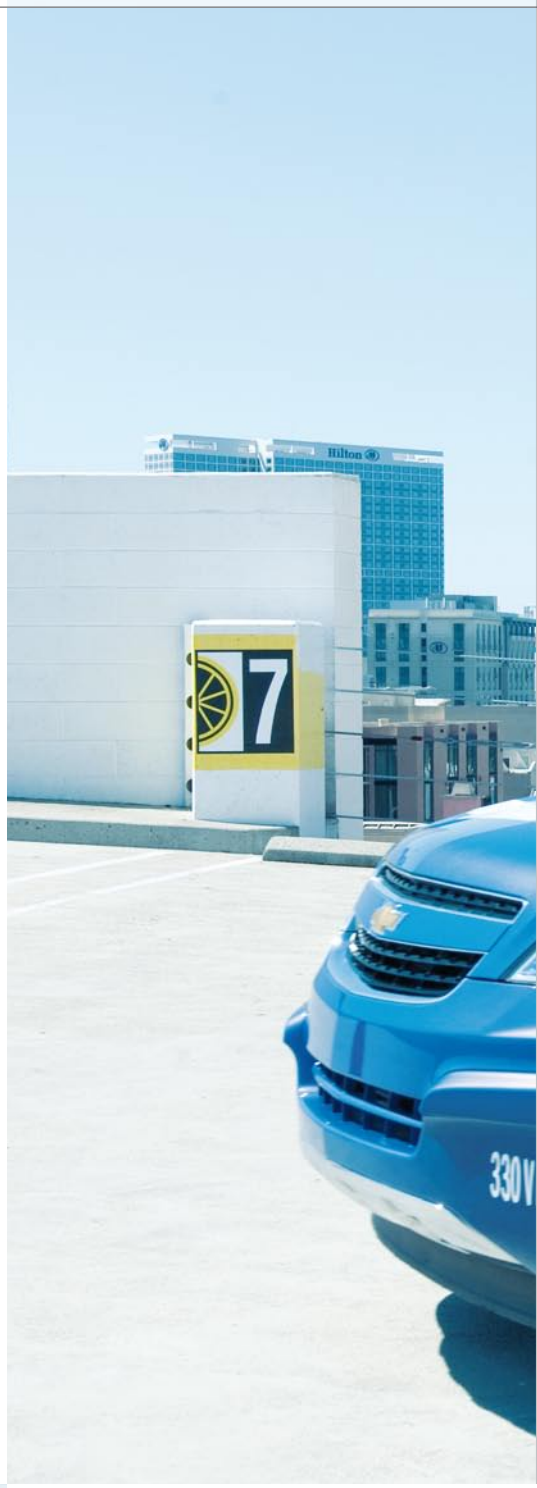
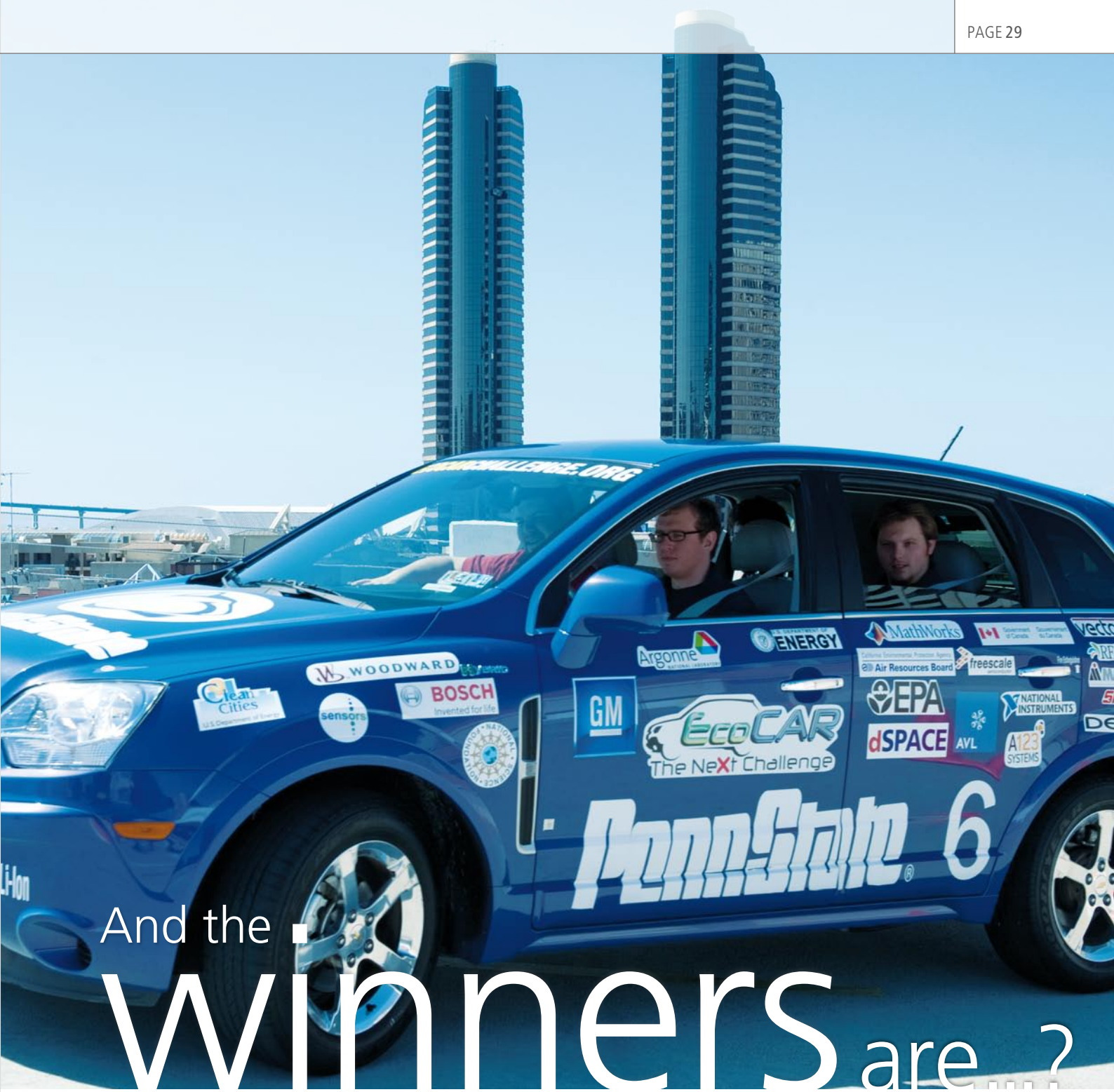
The final year of the EcoCar Challenge ended with an impressive show of the young engineers' green vehicle technologies, which included extended-range, hybrid, plug-in and fuel-cell electric vehicles. 16 North American universities were challenged to design and construct a near-production prototype vehicle with the goal of improving fuel economy and lowering greenhouse gas emissions, while retaining consumer acceptability in the areas of performance, utility and safety.





And the winners are ...?

Final round of the three-year competition EcoCAR:
The NeXt Challenge

The Winners

After three years of intensive work and a steep learning curve, three teams beat tough competition to become the winners of EcoCAR: The NeXt Challenge 2011. The top finisher was Virginia Tech University, followed by the Ohio State University and the University of Waterloo. The teams received their awards at a ceremony held in Washington D.C, USA on June 16, 2011.

Today's Tools for Tomorrow's Engineers

The university students used a real-world engineering process to design and integrate their advanced technology solutions into a General Motors (GM) vehicle. During year one, each team set goals for their vehicle and used design and simulation tools to develop an advanced powertrain architecture that would accomplish those goals. During year two, teams procured components and constructed mule vehicles of their chosen designs. Finally, during year three, teams tested and refined their vehicles to optimize the system. This process employed a wide variety of software and hardware tools and products to bring the advanced powertrain designs to life. In addition to developing and building an advanced vehicle architecture, teams were also required to demonstrate smooth, reliable vehicle operation.

dSPACE's Contribution

dSPACE Inc. is a platinum sponsor of the EcoCAR Challenge and supplies tools for the teams to develop and test their vehicle architectures and control strategies, including MicroAutoBox prototyping units, hardware-in-the-loop (HIL) simulators, as well as top-notch training, technical support and mentoring. Here, three of the teams – the Ohio State University, the University of Victoria and the University of Water-

> "We relied on dSPACE hardware and software through all the phases of the three-year challenge. They really made a difference to our progress, from modeling and simulation to prototype development."
>
> *Eric Schacht, Ohio State University*

loo – report on how they used dSPACE products to solve the tough issues that they faced.

Advanced Learning Effect for Ohio State

For the Ohio State University (OSU), dSPACE hardware and software were integral to their automotive development through all three years of the EcoCAR Challenge.

- *Vehicle performance and fuel economy prediction:* Various simulation and development tools from dSPACE helped the OSU team predict performance capabilities. Specifically, the fuel efficiency measured by driving the final vehicle was quite similar to the estimated fuel efficiency found from simulation.
- *System integration:* dSPACE-sponsored hardware and software and HIL simulation contributed immeasurably to testing and validating the vehicle's performance and control strategy.
- *Real-world engineering experience:* Engineering students gained invaluable experience of the cutting-edge control development technologies used in industry.The OSU team won the dSPACE Embedded Success Award twice. The students had the unique opportunity to gain real-world, hands-on experience while working on a fun and engaging project.

University of Victoria Stays in the Loop

The University of Victoria team (UVic) developed an electric vehicle with independent four-wheel-drive propulsion that couples a GM

So that the students can gain real-world experience, they are given tools to use for everything from the simplest work steps to HIL testing.

> "Going through the entire modeling process and encountering real-world challenges is what makes EcoCAR such a great experience for engineering students. None of this would be possible, though, without the support and resources provided by dSPACE and our other tremendous competition sponsors."
>
> *Jeff Waldner, UVic EcoCAR's Team Leader*

2-mode transmission and a 2.4-liter LE9 EcoTEC engine to the front wheels, and a UQM PowerPhase 145-kW electric motor to the rear wheels. Electric power is supplied by a 21-kWh lithium-ion battery pack from A123 Systems that provides a range of up to 60 km.

Two of the major focuses of the EcoCAR Challenge were model-based design and HIL simulation. These techniques help teams to test everything from failures to fuel economy using a virtual vehicle model. They also help to ensure that a robust, reliable and safe control system makes its way into the car.

From Zero to 100 in 7.5 Seconds

Throughout one semester, several members of the UVic EcoCAR Controls Team worked diligently to improve their system, taking advantage of dSPACE Automotive Simulation Models (ASM). The mature model accurately represents the real vehicle, from the ignition and body roll right down to the frictional forces between the tires and the road. This work quickly paid dividends, allowing the team to accurately test their real-time optimization strategy before making any updates to the vehicle. The new model and preliminary on-road testing also confirmed

Everyone's a winner in the EcoCAR Challenge. All the teams had a lot of fun and gained plenty of experience.

In Brief

16 teams from North American universities each spent three years building their own production-close prototype of an ecological vehicle.
It was all part of the EcoCAR Challenge, in which the teams learned methods such as model-based design and hardware-in-the-loop (HIL) simulation, so they were able to test their systems with a virtual vehicle model. The methods also helped the teams make sure that their control systems were robust, safe and reliable when installed in a real vehicle. With all the experience gained, the students are ideally prepared for starting their careers.

that UVic's EcoCAR is capable of 0-100 km in about 7.5 seconds, as predicted back in year one.

dSPACE Tools for Rapid Development

The University of Waterloo Alternative Fuels Team (UWAFT) was faced with the question every designer asks: How do you speed up the development process without compromising safety and reliability? The team chose a complex powertrain and used the possibility to explore new methods and technology that significantly changed their vehicle development process. For example, they removed the vehicle's stock powertrain and replaced it with a hydrogen fuel cell plug-in hybrid electric powertrain. dSPACE provided its MicroAutoBox controller and its HIL simulator, which gave the students the ability to simulate various powertrain failures without damaging real-world components. dSPACE also provided fault insertion and interface software. With dSPACE's support, UWAFT was able to develop and implement its control system strategy with relative ease. After UWAFT's vehicle control strategy passed all the required tests in the simulator environment, the dSPACE MicroAutoBox controller was ready to be installed and tested in the actual vehicle.

Outlook: EcoCAR2

The 16 teams competing in EcoCAR2 will all be using HIL systems and simulation models (ASM) from dSPACE. Working closely with General Motors and A123 Systems, dSPACE has parameterized the ASM modeling suite so that the teams can perform highly precise testing and verification of their controller developments for powertrain and battery components from the very beginning. ■

Awards for the Best

dSPACE Inc. supported the following university teams:

- Georgia Tech
- Mississippi State University
- North Carolina State University
- Ohio State University
- Pennsylvania State University
- Texas Tech University
- University of Victoria
- University of Waterloo
- West Virginia University

Finally, dSPACE presented three teams with an additional award, the dSPACE Embedded Success Award 2011, in recognition of the most effective use of control engineering with dSPACE equipment. The first-place winner of the dSPACE Embedded Success Award was the University of Victoria. Second and third-place honors were presented to Ohio State University and Texas Tech University. dSPACE gave $750, $500, and $250 for first, second, and third place, respectively.