NC State Research Drives Transportation Improvements

Even before Orville and Wilbur Wright made North Carolina “first in flight,” transportation played a vital role in the state’s history and development. With trade ships plying the coastal waters and railroads helping build a manufacturing economy, North Carolina was already a transportation hub. In the 21st century, “The Good Roads State” looks with pride at its aircraft and automotive component makers, logistics and technology centers, major highways, and air cargo and shipping ports. Meanwhile, officials plan for a high-speed rail line through the heart of the state.

NC State research has fueled the state’s growing transportation system for more than a century. From civil and construction engineering, mechanical and aerospace engineering, and electrical and computer engineering to composite fiber technology, industrial design, chemistry, and biochemistry, NC State researchers are moving North Carolina forward on land, through the air, and on sea.

NC State’s Advanced Transportation Energy Center (ATEC) and the Institute for Transportation Research and Education (ITRE), tackle applied research in a range of emerging transportation. ATEC concentrates on technologies that will allow commercial production of plug-in hybrid vehicles, such as powerful, lightweight batteries and a network of charging stations issues (see RESULTS, Summer 2008). Meanwhile, ITRE works with national, state, and local agencies on issues like efficient student transportation, mitigating environmental impacts of road projects, and planning for mass transit.

This issue of RESULTS highlights NC State’s research on vehicles, aircraft, and ships. It also brings to a close my role as Managing Editor. Over the past 10 years, it has been my privilege to cover NC State’s most noteworthy research efforts and the fascinating people behind the breakthroughs. I am especially indebted to the creative souls of editor Matthew Burns, designers Vicky Earp and Bob Witchger, and photographer Roger Winstead, whose excellence, patience, and humor have made this job more fun than work.

Jaine Place
Managing Editor

Inside a makeshift garage at the west end of the NC State campus, students move hurriedly around a stripped-down SUV, but always with a purpose. Under the leadership of graduate students Ali Seyam, Abram Harder, and Mike Joslin in the Department of Mechanical and Aerospace Engineering (MAE), the team is recreating the vehicle for the EcoCar Challenge to be more energy-efficient while retaining plenty of consumer appeal.

The EcoCar Challenge requires student teams to redesign an SUV to be more energy-efficient while retaining plenty of consumer appeal.

NC State is one of 16 universities participating in the three-year EcoCar competition, sponsored by the Department of Energy, Argonne National Laboratory, and General Motors. Students spent the first year designing their vehicle’s drive train and battery system, using computer simulations to refine their efforts. This year, hands-on work took center stage, as the team ripped apart a donated Saturn Vue, installed both a high-voltage battery and small diesel engine, and got the refurbished SUV on the road. In the final year, they will focus on optimizing all systems, from computer controls to emissions, and on outreach efforts to extol energy efficiency. “The competition really prepares our students to become the next generation of automotive engineers,” says Terry Gilbert, an MAE faculty member and EcoCar team adviser.

Team members chose to build a battery-powered car — the diesel engine drives a generator to recharge the battery — because it offered the best combination of low emissions and ability to handle distance driving. “We’re taking a pragmatic approach to everything,” says Seyam, who’s been fascinated by automotive electronics since childhood and who helped write the proposal a few years ago that got NC State into the competition. In another pragmatic move to reduce the vehicle’s weight, the team used composite materials instead of a metal box to house the battery in the back of the SUV.

The team’s safety precautions for working with high-voltage batteries have so impressed EcoCar organizers that they ordered all other competitors to follow NC State’s lead. “Safety is important in the competition, and the finished vehicle is supposed to be consumer-ready,” says Harder, who joined the team because he wanted to work with green technologies. Joslin, who signed up because he had experience with the software to design the control systems, says team members have confronted issues in a range of engineering disciplines, all of which prepare them better for their future careers. “After running so many simulations,” he says, “it’s nice to see the car actually work and to be able to drive it around.”
until recently,” Kim says, noting road crews often tested the quality of their work by kicking at the edges of new pavement. His research demonstrates lightweight aggregate and asphalt that contains a polymer emulsion to improve adhesion on the road surface, decreasing the likelihood that bits of aggregate will loosen and go flying as cars drive by. “We can now quantify the impact of different materials and find the best construction methods so chip-seal becomes more durable and can be used on roads with higher traffic volumes.”

North Carolina Department of Transportation (NCDOT) road crews are probably the only people who have seen steam rising off asphalt more than Dr. Richard Kim. A professor in the Department of Civil, Construction and Environmental Engineering (CCEE), he has pioneered research on how to make pavement last longer, testing asphalt mixes from across the U.S., as well as Canada, China, and his native South Korea. In a basement lab in Mann Hall, Kim simulates traffic volume by repeatedly running tires over pavement samples and exposes the samples to extremes of hot and cold. As part of a Federal Highway Administration project, he is applying models to the test results to develop performance-related specifications for pavement. State highway agencies have traditionally used “recipes” for asphalt based on what worked elsewhere, because predicting pavement performance for a range of conditions was difficult. “We have developed models that reflect the mechanical behavior of the asphalt,” Kim says. “This will give contractors and highway agencies more confidence in using performance-based specifications.”

Kim also is helping NCDOT improve the pavement used on secondary roads statewide. “Chip-seal” involves spreading a layer of aggregate atop a thin layer of asphalt and compacting the layers. “There’s been no science behind it

A century ago, North Carolina became known as “The Good Roads State” because of its extensive system of state-maintained highways. Now, as increasing traffic volume strains the capacity and durability of state roads, NC State researchers are developing ways to make asphalt pavement last longer, predict maintenance needs on bridges, and redesign congested intersections to improve safety and efficiency. The efforts are done with an eye toward extending North Carolina’s reputation for quality transportation infrastructure well into the future.
Better Streets, Bridges

“but a visual inspection cannot tell you everything you need to know.”

Because the uniquely equipped, 20,000-square-foot CFL allows full-scale testing of structures like bridges, Rizkalla’s research team can use impact hammers and hydraulic jacks to vibrate and place loads on steel girders and concrete bridge decks. Sensors attached to test bridges each provide 10,000 readings per second to a computer model that scans the data for anomalies that might indicate damage, and provides an analysis of other problems that might result from such damage. A small crack in an I-beam, for example, could cause a chain-reaction that ends in a catastrophic failure elsewhere on the bridge.

“People think an annual bridge inspection is sufficient, but a visual inspection cannot tell you everything you need to know.”

The primary factor limiting the use of Rizkalla’s model is the paucity of bridges with fiber-optic sensors. Rizkalla says sensors are an easy item for states to delete from construction projects to save money, regardless of the potential for future savings in maintenance spending. Still, he says, it’s only a matter of time for them to become a common feature. “Civil engineering is slow to change,” he says. “Century-old bridges are exactly the same as those built today.”

Dr. Joe Hummer, a CCEE professor, is on a similar quest to convince traffic engineers to design so-called “superstreets” at complex intersections to improve safety and relieve congestion. Superstreets use a median to divide traffic on the main road and block through-traffic from a side street. Drivers who want to turn left onto the main road must turn right and then make a U-turn across the median. Hummer says superstreets can cut the number of points in an intersection at which vehicles cross paths — creating the potential for collisions or delays — by up to 75 percent.

“There are too many things going on in the middle of a conventional intersection,” he says. “With superstreets, drivers have only one thing to worry about at a time.”

The concept was developed in Alabama more than two decades ago, and Hummer became enamored with it as a variation of the specialized intersections he grew up using in Michigan. His research has optimized the superstreet design, testing factors like median width, signal timing, and accommodations for pedestrians and bicyclists. He also evaluates potential superstreet locations for NCDOT, which has installed 20 such intersections statewide — the most in any state. Hummer’s studies show that fewer collisions occur on superstreets and that traffic flows better because there are no green turn-arrow signals to wait through.

“Engineers usually have to trade efficiency for safety, but this is the rare case where we can improve both,” he says. Still, Hummer says, many drivers dislike making multiple turns to get where they want to go, even if it’s a safer route. “Safety is a hard sell in our profession,” he says. “Nobody thinks he’s going to be the next statistic.”
Sensors Detect Unseen Aircraft Damage

Peters says. Metal fatigue usually begins as cracks in rivets, making it easy for mechanics to spot. “The problem with composites is that they dissipate the energy of impacts internally,” she says. “The damage spreads inside out.” Aircraft mechanics occasionally use imaging scans to look into composite parts, but Peters says fiber-optic sensors would improve monitoring. Hundreds of sensors could be placed on a single fiber and embedded inside the composite material. A monitor attached to the strand could then alert the flight crew or maintenance personnel to anomalies that indicate damage, so it could be repaired quickly. “If the monitoring shows nothing is wrong,” she says, “you wouldn’t need to park a plane as often for scheduled maintenance.”

With funding from the Air Force, Peters is trying to optimize the sensor technology. While additional sensors provide more information, they also disrupt the structure of the composite material. “If you have enough sensors in there, you could produce an earlier failure in the part,” she says. So, in her lab, she bangs on composites that contain various densities of optical fibers to see how much they can handle before they fail. That data is then used in computer simulations to determine the best layout for fatigue sensors in aircraft components.

Peters also is developing “healing mechanisms” within the composite parts, as part of a National Science Foundation grant, so damage can be repaired once sensors have identified it. She inserts resin that isn’t fully cured in different regions of the composite matrix to determine whether chemically activating the resin would allow it to fill cracks and harden, preventing the damage from spreading. She also is working with Brigham Young University on ways to collect data from sensors faster, which would help with real-time monitoring. “As material systems change,” she says, “we have to change how we inspect aircraft to ensure travelers’ safety.”

“Commercial jets log hundreds, even thousands, of miles every day, and the relentless schedule of takeoff, touchdown, and turn around to do it again takes a toll on the aircraft. Airlines regularly perform spot maintenance checks, and every year or so, planes are taken out of service for extensive component testing. Dr. Kara Peters, associate professor in the Department of Mechanical and Aerospace Engineering, says the need for such scheduled maintenance would be less if aircraft were designed so the structural integrity of the fuselage and wings could be continuously monitored.

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Such real-time monitoring is more difficult as planes switch from metallic bodies to parts made of carbon composites.
Two Northwest Airlines pilots caused a nationwide stir last fall when they became so engrossed in discussion that they ignored cockpit alerts and calls from air-traffic controllers, overshooting the Minneapolis airport by 150 miles.

Dr. David Kaber, a professor in NC State’s Edward P. Fitts Department of Industrial and Systems Engineering, says such cockpit complacency has occurred more frequently as aircraft controls have become more automated. He’s been working on a three-year study for NASA Ames Research Center to determine what factors cause performance problems for pilots so manufacturers can better design next-generation avionics.

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Some flight management systems contain up to 17 levels of automation to set an aircraft’s trajectory and air speed at various points of a flight. Kaber says that sometimes leaves pilots “out of the loop” as to what aspects of flying they still need to monitor. “The automation is so reliable that there can be a loss of situational awareness,” he says. On the other hand, he says, low levels of automation force pilots to remember more items, make quick calculations, and manually input flight-control data, leaving them little time to make critical decisions, possibly leading to errors. “It’s definitely a two-edged sword,” Kaber says. “It’s very pilot-specific as to how much automation is too much or too little.”

The issue becomes more vital as the Federal Aviation Administration develops a next-generation system that will cut the distance between planes during takeoffs and landings to improve the flow of air traffic. Under the new system, pilots will receive clearance earlier to make straight-line descents into airports instead of the current stair-step method. Kaber’s research team tested pilots to determine whether they could reset the flight management system within a specified time to perform a straight-line descent.

To create a model of pilot behavior, the researchers videotaped a former military pilot operating a flight simulator. He described what he did and why he made certain decisions at particular junctures. The team then brought in commercial pilots to validate the model, having the pilots and the model run the same flight scenario. Both the simulations and the model showed that the automated system for straight-line descents needs further development. “Pilots can’t make effective decisions fast enough with current automation,” Kaber says. The computer model will allow the FAA and manufacturers to refine the automation without the time and expense of having commercial pilots test it in a simulator, he says. “We can now predict problems with flight management systems in advance and design systems that will be safer.”
The Highway Patrol in enforcing regulations on big rigs. The tools grew out of a statewide database of wrecks involving tractor-trailers. “We’ve evolved from a focus on crashes to a focus on freight,” Hughes says, noting that freight tonnage moving through North Carolina is expected to double by 2020. As the trucking industry moves toward “more productive” vehicles — longer and often heavier — the concern for safety on rural roads increases. Rural roads are more susceptible to pavement damage from overweight trucks, he says, and the risk of fatal crashes can be two to three times higher than on an interstate.

Hughes’ team overlays the crash data — it’s broken down by time of day and day of week as well as location — with an array of other GIS information, such as the locations of smaller bridges, where and when troopers stopped rigs for inspections, and the frequency of citations for driving or weight violations. The Highway Patrol officers can use the information to see how their enforcement efforts match the needs in their region. The ITRE researchers are using risk analysis to pinpoint “hot spots” that have statistically significant clusters of wrecks and are aligning their data with GPS devices in troopers’ cars for more precise mapping. “There are only 300 troopers in North Carolina to handle motor carrier enforcement,” Hughes says. “We’re trying to help them be more effective at keeping our roads safe.”

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The work done by Jeff Tsai and ITRE’s Pupil Transportation Group helps North Carolina school districts use school buses more efficiently. Officials used to map their bus routes by sticking pushpins in a map to show where students lived and then running a string from one pin to the

Where Rubber Meets Road in Research
The research team also used funding from the National Institutes of Health to develop an automated yield-detection system that uses a combination of video cameras and a computer algorithm to determine when cars have slowed enough entering or exiting a roundabout for a pedestrian to cross. The system is activated when someone pushes a button at the crosswalk, and it provides a voice signal when the path is clear. "The yield-detection system allows pedestrians to take advantage of natural opportunities in the traffic flow to cross," Rouphail says. Students at the Governor Morehead School for the Blind in Raleigh were enlisted to test the system at a roundabout on NC State’s campus, and the researchers found that they crossed about 30 percent more often with the system telling them that cars had slowed for them. "ITRE addresses many needs," Rouphail says. "We are literally where the rubber meets the road in terms of research."

ITRE has developed other applications for GIS data, including helping districts set attendance zones and find sites for new schools. Wake County school officials, for example, asked the institute to help determine their construction needs for a $1 billion bond issue in 2007. Researchers used mathematical models and decision-science tools to map growth projections and showed officials areas where schools would be needed in the future. ITRE is now doing similar growth forecasts for more than 30 school districts statewide and for districts in South Carolina and Mississippi. "Once you know where students live, it’s easy to grow from just transportation into efficient planning," Tsai says. "There are hundreds of ways to draw school maps, so you look at data layer by layer to make your decisions."

Concerned about the ability of people with disabilities to navigate complex intersections, Rouphail is leading an ITRE team trying to make decisions easier for visually impaired pedestrians at intersections with roundabouts. The configuration of such intersections makes it difficult for pedestrians to judge by sound when it is safe to cross, but installing traffic signals would defeat a roundabout’s ability to keep traffic moving. So the ITRE researchers have examined a variety of solutions, from raised crosswalks that force drivers to slow down to rumble strips that provide an auditory signal to blind pedestrians that a vehicle is approaching. "If we slow vehicles down," Rouphail says, "the propensity of drivers to yield increases without stopping and delaying traffic."

"We’re now looking at possibilities in high-speed rail and next-generation air transportation."

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More Fiber for Auto Bodies

The fabric of your life could one day be the fiber of your ride, according to Dr. Abdel-Fattah Seyam. A professor in the Department of Textile and Apparel Technology and Management, Seyam is testing various fibers to see if they could provide a strong, lightweight alternative to using steel and aluminum in automotive parts. “Reducing vehicle weight is one way to dramatically improve fuel efficiency,” he says. “Still, we cannot sacrifice safety for lower gas consumption.”

Using a three-dimensional weaving process developed by College of Textiles Professor Emeritus Mansour Mohamed, Seyam’s research team is creating fabrics of glass fibers that can be molded into any shape, from a chassis to a fender, and then infused with a resin to harden. With funding from the National Textile Center, the researchers run the composite materials through a battery of tests to determine if they can match the performance of metal parts in terms of impact resistance, tensile strength, and ability to withstand shear forces. “The composites dissipate energy better than metal, so they would hold up well in a collision,” Seyam says, adding that the glass fiber-resin combination also would provide corrosion resistance to vehicles.

To optimize the performance of the composite materials, the NC State researchers are experimenting with various weave patterns, glass fiber thicknesses, and layers of fabric. Seyam also is working with the University of Massachusetts at Dartmouth to determine whether short, recycled fibers dispersed throughout the 3D weave can boost the composite’s strength. The researchers either mix the short fibers with the resin or use electrostatic forces to arrange the short fibers in the vertical plane, where Seyam says they can reinforce the resin-rich areas. “If you have fiber within the resin, it can stop cracks from propagating,” he says.

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Recycling short fibers isn’t the only sustainable initiative Seyam is pursuing. His research team is looking at “green composites” for greener alternatives to glass and epoxy resin. “We’re looking for something that is 100 percent natural,” he says. “We are using materials that aren’t petroleum-based, which reduces costs and limits the environmental impact.” The researchers have found that some flax fibers perform as well as glass, and they also plan to test jute, rice straw, and even cotton. Instead of epoxy, they are studying whether soybean-based resin could be used to harden the fabrics. “With natural fibers and resins and 3D weaving technology,” Seyam says, “we see intriguing possibilities for the future of automobiles.”
New Wrinkle to Keeping Hulls Shipshape

From sailboats to cruise ships to aircraft carriers, most ships gleam as they sit in harbor or cut through the open water. Below the water line, however, the picture often isn’t as pretty. Algae, barnacles, and other organisms can latch onto a ship’s hull and create an uneven surface that reduces maneuverability and increases drag. Such biofouling can increase fuel consumption by as much as 30 percent.

Until recently, the Navy coated ship hulls with copper- and tin-based materials, which poisoned the attached organisms to shed the unwanted growth, but environmental concerns brought an end to that practice. The Office of Naval Research has tapped Dr. Jan Genzer and others to find a greener solution to biofouling. The NC State research group led by Genzer, Celanese Professor of Chemical and Biomolecular Engineering, believed it could create a dense coating of molecules that would repel organisms by bombarding a stretched piece of rubber with reactive oxygen and letting the rubber snap back to its normal size. In a bit of serendipity, the process works, but not as originally intended.

When the NC State team examined the treated rubber, they found it was wrinkled. In fact, it had layers of different-sized wrinkles atop each other, Genzer says, because the oxygen created an ultra-thin layer of a silica-like material that crumpled when the stretched rubber was released. Surfaces with periodic roughness naturally tend to be better than smooth ones at remaining free of unwanted debris, and tests in the U.S. and the U.K. have shown that, even after months in the water, surfaces with the wrinkled coating had little organic buildup. “You have so many organisms of different size in the ocean,” Genzer says, “so having wrinkles of various sizes works.”

Algae, barnacles, and other organisms can latch onto a ship’s hull and create an uneven surface that reduces maneuverability and increases drag.

The researchers are now trying to attach various molecules and polymers to the silica-like layer to determine if chemistry can aid topography in keeping ship hulls clean. “The more we work on biofouling, the more we realize that we have more work to do,” Genzer says. “There’s a sweet spot in there for controlling buildup, and we need to find it.”
Smarter Vehicles,

Dr. Wesley Snyder has developed a "seeing" car that can keep the vehicle in its lane. Full-scale demonstrations will need more computing power to move at higher speeds.

North Carolina has the tenth highest rate of traffic fatalities in the United States, according to the National Highway Traffic Safety Administration. More than 1,400 people died on state roads in 2008, the most recent year for which figures are available. That's roughly the same number who died in wrecks 15 years earlier, even though traffic fatalities had dropped 8 percent nationwide. NC State researchers are trying to improve those grim statistics, studying ways to help drivers stay in their lanes and avoid crashes or cushion the impact if a collision does occur.

The DARPA Grand Challenge, a Department of Defense competition to build driverless vehicles, got Dr. Wesley Snyder thinking a few years back about ways to build cars that use human-like vision. The professor in the Department of Electrical and Computer Engineering (ECE) didn't participate in the contest, but he used his expertise in robotics to take a step toward the goal of a “seeing” car by designing a system to keep a vehicle in its lane of traffic. Such a system could be crucial if a driver has a heart attack, seizure, or other medical condition that would cause a loss of control.

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Snyder developed algorithms to mimic some of the biology believed to be behind the way people see. His research team then placed a video camera on the hood of a toy jeep and hooked it up to a laptop computer on the back of the jeep. The camera sends images of the road ahead to the computer, where the algorithms recognize lane markers, stop signs, tail lights of other vehicles, and traffic lights. The curvature of the road helps the computer infer the jeep's speed and distance from other objects as the vehicle moves. Snyder is now working on boosting computing power because the laptop can process only two images each second, limiting the jeep to a snail's pace. "We've got part of it solved, but we still have more work to do," he says. "Driving in tight traffic at high speeds is a very tough problem."

Dr. Mo-Yuen Chow, Snyder's ECE colleague, is taking a different tack to try to solve that problem. Using the concept of “intelligent space,” or the control of distributed networks, he is working on a system to turn future vehicles into the equivalent of planes being tracked by air-traffic control. State transportation departments already have improved in-car GPS systems, above, would warn drivers of the need to take quick action.
control centers to monitor traffic in metro areas, and Chow says global-positioning system (GPS) devices could one day beam information collected from various vehicle sensors to the control centers and receive real-time warnings not only about traffic congestion ahead, but also when the driver needs to take quick action to avoid a collision.

Using biological names to describe his work, Chow compares the overall project to an immune system for vehicles and says the first step is to create a “gene library” of situations a driver might face. Factors like vehicle speed, weather conditions, the curve of the road, and traffic combine in different ways to produce a range of outcomes, he says, much like genes do in humans. Eventually, human factors like driver age and fatigue will be in the gene library, too. As vehicle information is fed into traffic control centers from numerous GPS devices, a program will run through the database to assess the risk that two or more vehicles are headed for a collision and will alert them as needed to take corrective action. “This isn’t like air traffic, where you have miles between planes,” Chow says. “We need to process data in real time for split-second decisions.”

For instances where a collision is unavoidable, Dr. Afsaneh Rabiei has patented a metallic foam that, when used behind bumpers and in other automotive body parts, could transform crashes into the vehicular equivalent of pillow fights. The associate professor in the Department of Mechanical and Aerospace Engineering was convinced she could devise a stronger metal foam than those made by simply injecting air bubbles into molten metal. “There’s no control over the internal structure and properties of those foams,” she says. “The lack of structural uniformity causes the cells to buckle and fail prematurely.”

Rabiei eventually hit upon the idea of mixing hollow steel spheres into molten steel or aluminum. The resulting composite material, which looks like a silvery sponge, can absorb seven to eight times the energy of other metal foams and 70 to 80 times that of solid steel or aluminum. “The foam sacrifices itself, so passengers don’t have to take a hit in an accident,” she says. Tests have shown that bumpers with Rabiei’s metal foam would make a 28-mile-per-hour collision feel like a bump at 5 miles per hour to a vehicle’s occupants.

“The metal foam sacrifices itself so passengers don’t have to take a hit in an accident.”

Through her research, she customized the steel spheres, similar to tiny ball bearings, so the diameter and wall thickness provided the optimal strength. The spheres bond together well in the metallic matrix so they can be compressed up to 80 percent — as might occur in a wreck — without cracking or bulging. “Our mission here is to save lives,” she says. “If my metal foam lets someone walk away from a crash, then I’ve done my job.”
Combining personal experience with engineering skill and creative flair, NC State students won four of five awards in the World Traffic Safety Symposium’s Design for Safety Competition at the New York International Auto Show in April. “We’re always looking for something that nobody’s thought of before, something that will give us a chance,” said Dr. Bong-Il Jin, a professor in the Department of Industrial Design who worked with the students as they developed their ideas. This year, they stole the show.

Graduate student Kathryn Asad, the first-place winner, found that spray from a tractor-trailer’s tires on a rain-slicked highway obscured her vision of the road during a trip last year, and she wanted to minimize that risk for other drivers. So, she devised “CurtAir,” which uses a vehicle’s compressor to feed a series of nozzles inside each wheel well that blast jets of air onto the tires. The air flow then creates an invisible curtain that deflects the spray off the tires toward the roadway.

Taking second place, senior Alex Bodnarchuk drew from his experience of skidding on black ice for his “SlipVision” idea. He says Jin encouraged him to combine his plans for black ice sensors on a car with his idea of using bioluminescent paint on roads without street lights. The result involves mixing quinine or other material that glows under black light with asphalt when paving roads and then using ultraviolet LEDs on cars or roadsides to illuminate the quinine and reveal patches of black ice.

Lance Cassidy, a graduate student who finished third in the competition, leveraged his undergraduate work in aerospace engineering to design an external airbag for cars. During an internship at NASA’s Langley Research Center, he got a firsthand look at the airbags developed to protect the Mars Rover landing craft and theorized the same sensor-activated technology could be used to cushion cars in collisions. “The point of the contest is to push technology in ways engineers aren’t going to think of,” Cassidy says.

Fifth-place winner Ali Sutton-Settemi, a senior, also relied on a background in engineering to design “Flex Heat,” a solar-powered mat that can be bonded to asphalt on bridges to generate heat to melt ice and snow. “Engineers are very convergent thinkers. They have to bring all their ideas down to one equation or one solution,” Sutton-Settemi says. “Designers are divergent thinkers. We think of as many possibilities as possible, even if they’re crazy, to come up with something new.”
Students Steal Show in Traffic Safety Contest

Sean Coleman's dream came true in March when he got to climb behind the wheel of a car he designed. A graduate student in industrial design, Coleman won the 2010 Shell Eco-Marathon Americas competition to design a fuel-efficient car for urban commuting. “To see something go from your imagination to real life,” he says, “is pretty amazing.”

“The design process is heavily research-based. Jin says he would examine the latest technologies, composite materials for the auto body, and trends in interior, fashion, and color. He also watched and read a fair bit of science-fiction for a futuristic vision while poring over market research to determine what current consumers wanted. “You have to try to match people’s subconscious expectations,” Jin says. “You take current models and then use styling and a different paradigm to improve on them.”

Coleman says his industry experience now helps him prepare students like Coleman for careers in automotive design. “We try to match their imagination with what can be mass produced,” he says. “The designs should be more advanced than recent cars.” Coleman says the Shell competition taught him the importance of research in design and has helped him adapt to rapidly changing situations. He plans to design another eco-friendly car for his master’s thesis and — who knows? — it might wind up being what people are driving in a few years.