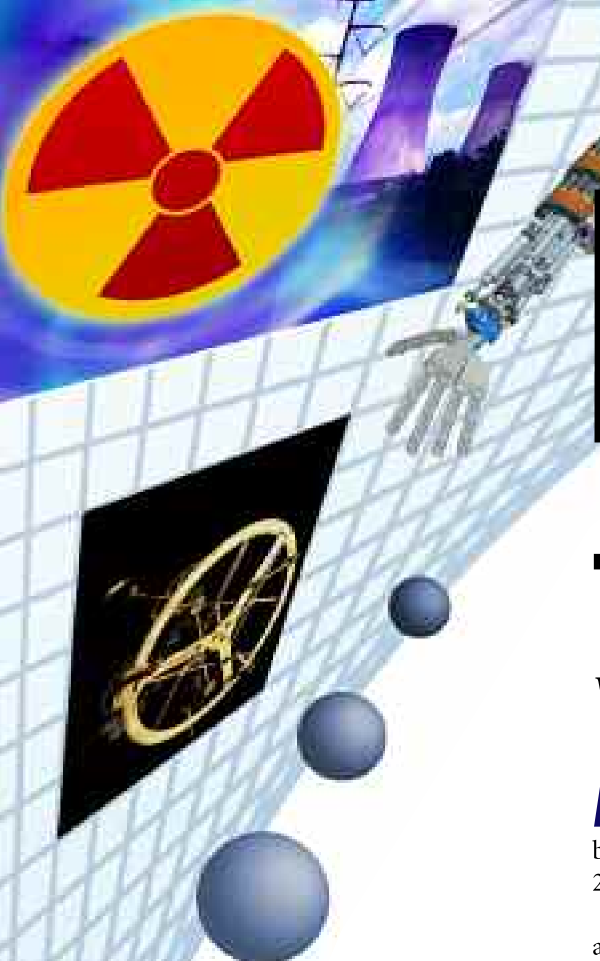
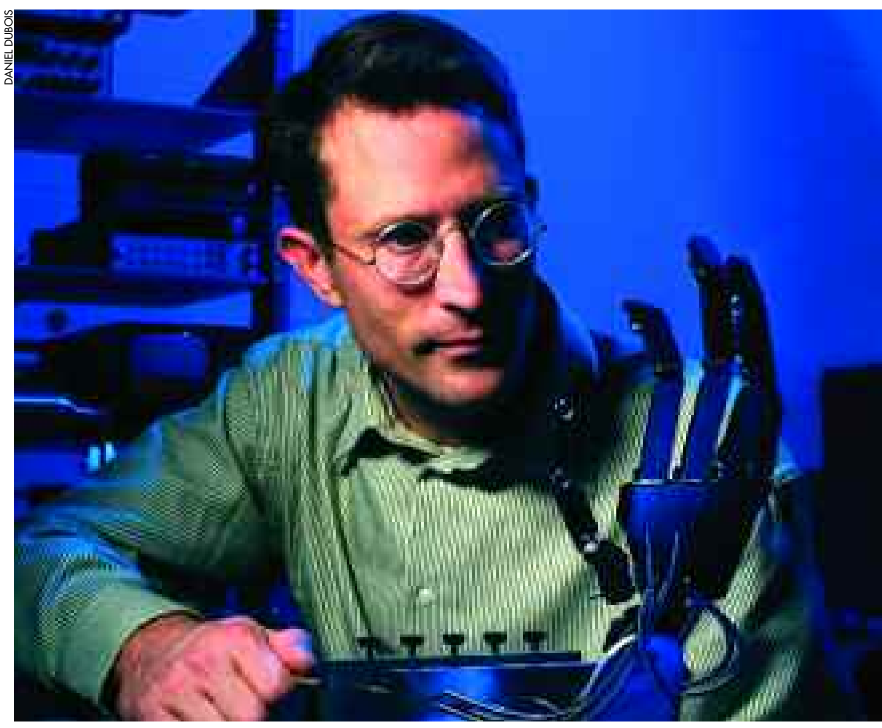


Volume 47, Number 2, 2006

ENGINEERING
VANDERBILT

The Future of Fluids

Vanderbilt researchers harness liquids and gases to power limbs, robots.



DANIEL DUBOIS

Professors Michael Goldfarb, above, and Eric Barth, bottom left, are developing power-supply and actuation systems for artificial limbs and human-scale robots.

Asimo would not be the robot of choice in a crisis. The Honda robot has good dance moves, but he runs out of juice in about 20 minutes.

In that respect, the dancing autonomous robot is not unusual; even its more essential cousins, such as rescue robots, suffer from the same limitation. For all their impressive technology, all unplugged robots today run out of power too quickly because of the constraints of batteries and motors.

Vanderbilt's Michael Goldfarb and Eric Barth are finding new ways to breathe life into rescue robots—as well as new devices to aid people with mobility impairments—by harnessing the power of fluids. Goldfarb, professor of mechanical engineering, and Barth, assistant professor of mechanical engineering, are part of the new national Engineering Research Center for Compact and Efficient Fluid Power.

Barth and Goldfarb will contribute by developing power supply and actuation systems that allow human-scale robots to move.

The center is funded by a $15 million, five-year grant from the National Science Foundation, and is augmented by $3 million from various industry partners. It is directed by the University of Minnesota.

Fluid-Fueled Robots

"This center will enable our research team at Vanderbilt to continue the efforts we have made over the past six years in advancing the state-of-the-art in human-scale robots," Goldfarb says. "We are pleased to have the opportunity and look forward to making the most of it."

Fluid-power technology, which includes hydraulic and pneumatic systems, uses liquids or gases to transmit power in the form of mechanical work or pressure. The $33 billion international fluid-power industry is involved in aerospace, agriculture, construction, health care, manufacturing, mining and transportation applications.

As part of the new center's research program, Goldfarb and Barth will also develop a rescue robot with legs to use the new power supply and movement system, which is expected to be capable of exerting considerably more force and power than current legged robots.

The Vanderbilt researchers have already taken the fluid-power field several steps forward in developing a fluid-powered actuator that sends hydrogen peroxide through a screen coated with a catalyst to produce power in the form of steam. They developed this system to power and control a robotic exoskeleton, which is a strap-on lower-extremity device that warfighters can wear to help them carry heavy loads over long distances.

A Revolution in Artificial Limbs

The innovations they developed through that project, funded by the Defense Advanced Research Projects Agency (DARPA), have led the way to their participation in a new DARPA project to create an artificial arm that functions and looks very much like the real thing.

Goldfarb and Barth are working on the hand and below-elbow part of the arm, which when finished will allow the wearer to feel and control objects much as that person would with a native hand. The four-year Revolutionizing Prosthetics 2009 program will devote $30.4 million to the development of the new prosthesis, $2.7 million of which will go to Vanderbilt.

DARPA expects the technology to be ready for clinical trials in only four years. The lead institution, Johns Hopkins University's Applied Physics Laboratory, selected Vanderbilt to join its team because Goldfarb and Barth already had decades of experience in developing prosthetic devices.

"We will leverage some of the actuation technology we have already developed for the design of the artificial arm," says Goldfarb. "Our goal is to develop a biomimetic prosthesis that has 22 degrees of freedom, and the strength and power approaching an intact human arm."

Their device will use a liquid-fueled gas generator, similar to devices used in satellite thrusters, to power the pneumatically actuated prosthesis. Their design will be merged with neural-implant technologies developed by other team members, such that the final device will be hardwired into and controlled directly by the human nervous system.

"At DARPA we envision a future in which a soldier who has lost an extremity in battle will regain full use of that limb again," says Col. Geoff Ling, DARPA program manager for the Revolutionizing Prosthetics program.

At present, the state-of-the-art in myoelectric arms generally provides two degrees of freedom (one elbow and one hand, which is essentially a pincher that looks like a hand). The user controls the device by flexing muscles in the upper arm, which controls either the elbow or hand at any given time, as selected by the user.

The new device will represent a major leap forward for the prosthetics industry, since it will provide 22 degrees of freedom that will be controlled simultaneously by electrodes implanted into the nervous system. "This is a very exciting problem for us to work on," says Goldfarb, "because it is extremely challenging as an engineering problem and it provides a prime opportunity for us to use a unique technology developed by our group at Vanderbilt to improve the lives of other people."

—*Vivian F. Cooper*

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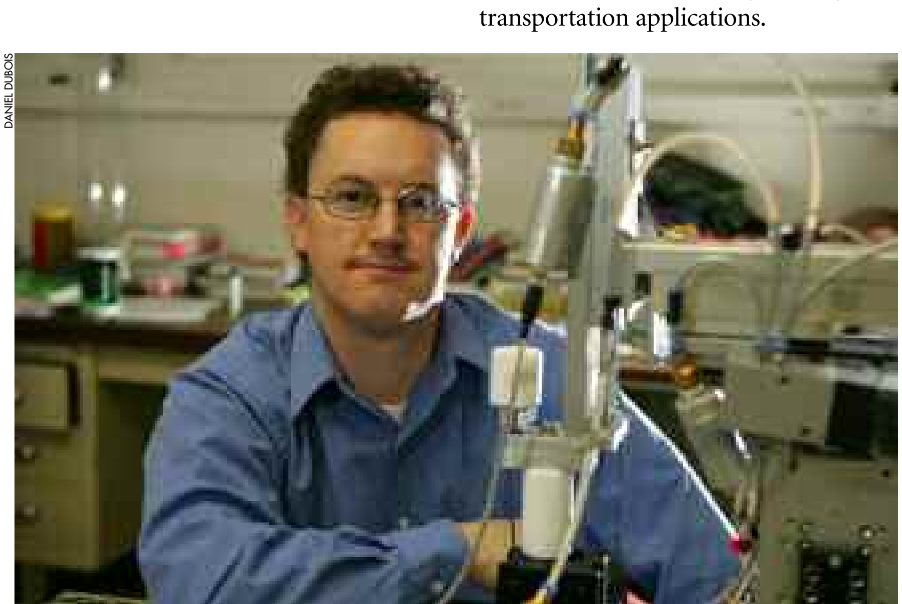

DANIEL DUBOIS

DANIEL DUBOIS

Dean Kenneth F. Galloway

New Frontiers: Taking the Initiative in American Competitiveness

In his latest State of the Union address, President Bush called for a sharpening of America's competitiveness and highlighted the need to pick up the pace of innovation in order to thrive on the playing field of global commerce.

The president touched on it, but recent books (e.g., *The World Is Flat*) and national reports (e.g., "Rising Above the Gathering Storm") have been more explicit on the challenge: The world is catching up with the U.S. in engineering, science and information technology—areas that directly impact economic competitiveness. In recent decades we have watched as our nation's manufacturing base has eroded and many operations, along with thousands of jobs, have migrated to foreign countries with cheaper labor. We have tolerated this, encouraging workers to retrain for the new information economy and to obtain more education to keep up with the changes.

As the dean of engineering at Vanderbilt, I am a great believer in education—particularly education in science, technology, engineering and mathematics (STEM). But now we are seeing significant international competition at some of the highest levels, with international firms hiring engineers from other countries at lower salaries than they must pay U.S. engineers. Is getting a strong education and specialized technical training enough for the next generation to secure their future?

Indeed, that would be a significant start! A disturbing fact is that the number of U.S. students capable of and interested in pursuing careers in engineering, science and technology is flat or dropping. These are the students who will invent the new products, create future innovations, and make us competitive in the global economy. Meanwhile, in many other nations the STEM numbers are growing. There is no question that bringing our K–12 students up to speed in math and science is a vitally important component of any strategy to enhance our economic competitiveness in the world.

It is vitally important that our government understand that innovative breakthroughs come largely from science and engineering research, and that this research is well worth the investment of federal dollars.

Adventure in Innovation

But I believe we have to do more. The best way to keep jobs here in the U.S. is to show that we can get the job done better; we must do as Nashville Mayor Bill Purcell (or Larry, the Cable Guy) says: "Git-R-Done!" While attracting more STEM students and better preparing them are essential, they can't do the job alone. As Sen. Lamar Alexander has stressed, we also need to make significant investments in science and engineering research. These investments must be both in money and in national willpower.

To tackle these issues successfully, we must leverage both our technical expertise and our characteristically American ability to sweep aside conventional thinking and traditional, limited mindsets. As a nation we are all about frontiers. This new phase of world development is a new frontier. We must approach this mission of keeping our economy healthy and thriving as the challenge of a new frontier and as an adventure rather than some dire emergency. We will need a spirit of adventure to deal not only with foreign competition but with the increasingly unwieldy complexity in our world.

At Vanderbilt we have grappled for some time with the problem of managing the knowledge explosion in all the science and engineering disciplines. We have recognized that in order to solve the technological challenges that confront us—whether they be in energy, the environment, medicine, national security or industrial production—we must build cross-disciplinary teams. We truly have come a long way in learning how to break down traditional barriers between academic disciplines so we can attack these problems and create better solutions. It is vitally important that our government understand that innovative breakthroughs come largely from science and engineering research, and that this research is well worth the investment of federal dollars.

We also have come far in developing ways to teach students to tackle big problems effectively and creatively. We use research about how people learn to develop a very different approach to teaching our students. And we are working now to make these teaching strategies available to K–12 teachers so that students' natural curiosity and interest about technology and science will be encouraged.

We need participation in the adventure of innovation from a new generation of scientists and engineers that includes the strength that comes from diversity. We want to ensure that a STEM education is both attractive to and within reach of many more of our students.

Americans are an inventive, resourceful people. We roll up our sleeves when it's clear there is a need. But we also can be complacent and not respond to danger until it's very nearly too late. My fervent hope is that the president's comments will encourage the Congress and the American people to address this multifaceted challenge and to embrace the adventure of innovation and the new frontier of global competitiveness.

—Kenneth F. Galloway, Dean

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Face to Face

The School of Engineering introduces alumni to two key members of the team charged with the critical work of advancing the mission and future of the school through fundraising and alumni involvement.

Jennifer Zehnder, director of major gifts, hails from Lexington, Ky., and graduated from Xavier University in Cincinnati before embarking on a professional singing career. Several years and countless performances later, her love for music brought her to Nashville where she discovered a new passion: educational advancement at Vanderbilt. She has now called Nashville home for four years.

Emily Borders, associate director of development and alumni relations, was born and raised in Music City where, in high school, she realized her love for the French language. She then majored in French and business at Baylor University in Texas. During her junior year at Baylor, a course in nonprofit marketing sparked her interest in the nonprofit sector, ultimately bringing her to Vanderbilt.

Both women began their Vanderbilt careers in the office directing the university's current Shape the Future Campaign, where they had the opportunity to interact with staff in all areas of Development and Alumni Relations at Vanderbilt. Eventually, they both joined the team led by David M. Bass, the School of Engineering's associate dean for development and alumni relations.

"My favorite part of the job is getting to know our engineering alumni, parents and friends who have the desire to change lives through their generosity," says Zehnder. "These wonderful people truly make an extraordinary difference at the school. I love being a part of that."

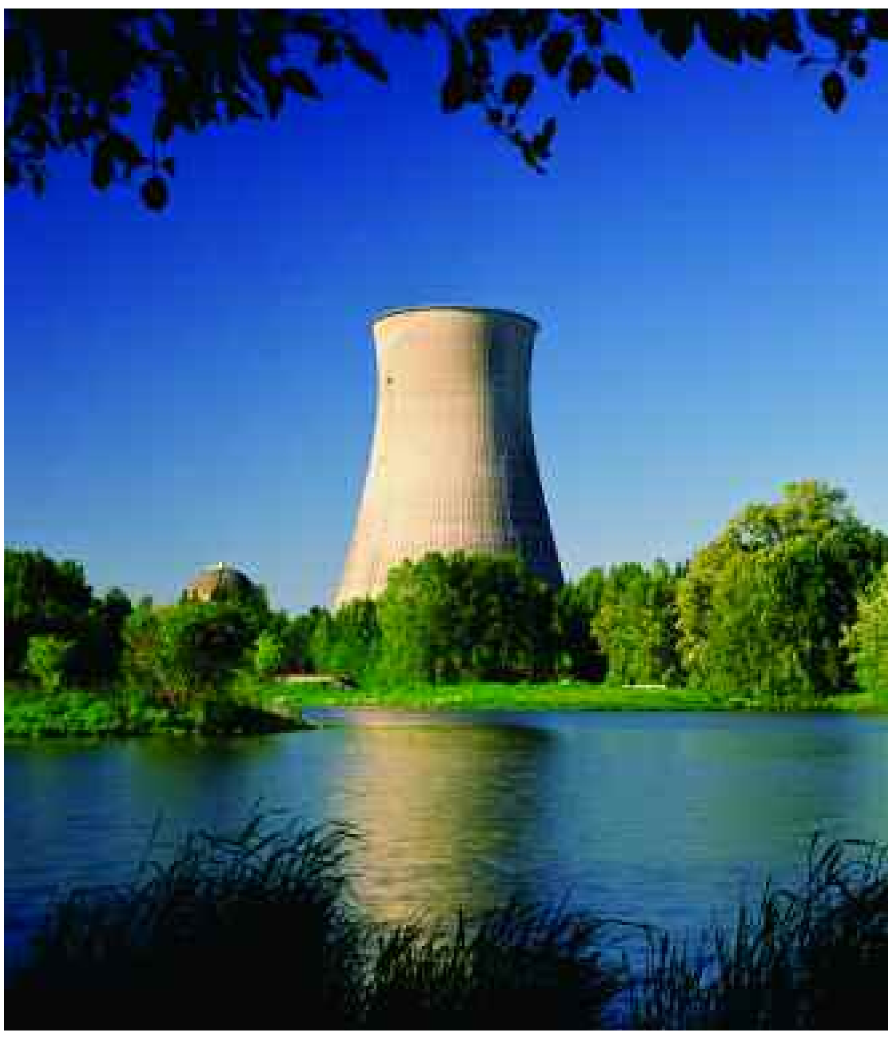
Jennifer Zehnder, left, and Emily Borders

Borders says she enjoys being a part of the School of Engineering team and meeting the school's alumni, parents and friends. When she's not at work, you can find her spending time with her family and friends, listening to live music, or volunteering for Sweet Sleep, an organization dedicated to helping Moldovan orphans.

Meserve Says U.S. Headed for a "Nuclear Renaissance"

About two weeks after Sept. 11, the special secure telephone rang in Richard A. Meserve's office. As chair of the U.S. Nuclear Regulatory Commission, he had reason to steel himself, and he prepared to hear that his worst nightmare had come true: a terrorist attack on one of the nation's 103 nuclear power plants.

Luckily, it was just a Costco customer who had dialed the wrong number.



Currently president of the Carnegie Institution in Washington, D.C., Meserve told a few such anecdotes from his 1999–2003 stint as NRC chair as he delivered the John R. and Donna S. Hall Engineering Lecture at the School of Engineering on March 13.

Despite the sometimes-harrowing challenges of steering the NRC through difficult straits after Sept. 11, Meserve said he emerged from the experience with his confidence in the nuclear-power infrastructure intact. Not only are nuclear power plants better protected from terrorist attack than any other public infrastructure, he said, but the nation's need for nuclear power will continue to intensify.

"I truly believe we are on the edge of a nuclear renaissance in the United States," he said.

Meserve said the growing demand for electrical power, which the U.S. Energy Information Agency projects will increase by about 50 percent between now and 2025, is one factor. The other compelling reason, he said, is that nuclear power plants are better for the environment.

"We have a pressing need for an energy supply that does not involve greenhouse gases," Meserve said. Coal-fired power plants, which currently produce more than half the nation's electrical power, are responsible for about 37 percent of carbon-dioxide emissions in the United States. Nuclear power plants produce about 20 percent of the nation's electrical power.

"The cheapest plants [to operate] on the grid today—other than hydro—are nuclear power plants," Meserve said. On the other hand, he continued, several significant, though surmountable, obstacles to building new nuclear power plants exist—including the fact that they're expensive to build.

"There's also a particular problem in meeting human-resources needs," Meserve explained. Over the last several years, the number of nuclear engineers has declined significantly. Also, there are few highly skilled crafts people who can build to the sophisticated codes required, or manufacturers to build the complex equipment. If the nuclear renaissance does occur, then these problems eventually will be resolved over time, he said.

STEVE GREEN

Richard Meserve, the 2006 Hall lecturer, says nuclear power plants are better protected from terrorist attack than any other public infrastructure.

Meserve also discussed the international dimension of nuclear policy issues. "We have a nested set of problems that involve proliferation," he said. While nuclear power plants do not pose a proliferation risk because the fuel is not weapons grade, uranium-enrichment technology can produce weapons-grade uranium. For that reason he recommends that the United States participate in the full international fuel cycle, including enrichment and reprocessing.

"We can't influence it if we're not part of the game," he said.

—*Vivian F. Cooper*

Faculty Notes

George E. Cook, professor of electrical engineering, retired at the end of the 2005–06 academic year and was bestowed the title "emeritus" during May Commencement ceremonies. The former associate dean for research and graduate studies joined the Vanderbilt faculty in 1963.

Lawrence W. Dowdy, professor of computer science and computer engineering, received the 2006 Edward J. White Engineering Faculty Award for Excellence in Service from Vanderbilt School of Engineering Dean Kenneth F. Galloway during a May 9 ceremony.

School of Engineering **Dean Kenneth F. Galloway** has been elected to a second two-year term on the executive board of the American Society for Engineering Education's Engineering Deans Council. He served on the board from 2003 to 2005 and is chair of the EDC Public Policy Committee.

Sanjiv Gokhale, associate professor of the practice of civil and environmental engineering, has received the 2006 North American Society for Trenchless Technology 15th Anniversary Industry Achievement Award, recognizing his contributions to the development and support of trenchless technology during the past 15 years. "Trenchless technology" refers to techniques used to install, replace and repair utility lines with minimum excavation from the ground surface.

Duco Jansen, associate professor of biomedical engineering, received the 2006 Vanderbilt School of Engineering Award for Excellence in Teaching from Dean Kenneth F. Galloway during a May 9 ceremony.

Donald L. Kinser, professor of mechanical engineering and professor of materials science and engineering, retired at the end of the 2005–06 academic year after 38 years at Vanderbilt and was bestowed the title "emeritus" during May Commencement ceremonies. He is best known for his contributions to the design of space-system windows and optics through his research into the behavior of glasses in hostile radiation and space environments.

T. John Koo, assistant professor of computer engineering, co-chaired the Workshop on Hybrid and Embedded Systems: Technologies and Applications, held Feb. 21–22 in Hong Kong. He and Vanderbilt colleagues Gábor Karsai, associate professor of electrical engineering and computer engineering, and Janos Sztipanovits, E. Bronson Ingram Distinguished Professor of Engineering, gave invited lectures at the workshop.

David S. Kosson, professor of civil and environmental engineering and chair of the department, has received the first School of Engineering Medal of Excellence for Alumni Achievement in Academia from Rutgers, the State University of New Jersey.

Sharon Lowe, administrative assistant for the Vanderbilt School of Engineering Dean's Office, received the School Award for Professionalism in Staff Service from Dean Kenneth F. Galloway during a May 9 ceremony, in recognition of her exceptional service to the School's faculty and staff.

Sankaran Mahadevan, professor of civil and environmental engineering and professor of mechanical engineering, received Vanderbilt's Joe B. Wyatt Distinguished University Professor Award in April. The award, which includes a $2,500 cash prize, recognizes a full-time faculty member "for the development of significant new knowledge from research or exemplary innovations in teaching." For one year Mahadevan will carry the title "Joe B. Wyatt Distinguished University Professor." He is director of the doctoral program in multidisciplinary reliability and risk engineering and management—the first such program in the world.

Richard E. Speece, Centennial Professor of Civil and Environmental Engineering, emeritus, is the first donor of time and lectures to donatehour.com, a Chinese charity Web site. The Web site posts people's needs, and volunteers may sign up to contribute in various ways.

Reuse and Recycle

Doug Schmidt likes to come up with easy-to-remember acronyms for the software packages developed by his research group in the Institute for Software Integrated Systems at Vanderbilt.

ACE and TAO, for example.

Their short, simple names fit what they're all about: making software so intuitive you won't need an army of programmers on your speed dial to use it.

With ACE, TAO, and an alphabet-soup bowl full of other acronyms, the associate chair of computer science and engineering and professor of computer science is carving out an impressive niche focusing on software that is reusable, high quality, and intuitively easy to use. He first saw a need when he observed programmers spending countless hours writing software from scratch for their applications, even though most of the software functions shared common features that weren't being exploited.

The solution is middleware, a set of programming instructions sandwiched between the network, hardware and operating system on the bottom and the application on top. Each layer "converses" with the other to achieve the end result of the application, say, navigating a fighter airplane or transmitting a medical image.

"The buzzword is *reuse*," Schmidt says. "The approach is a way to avoid busywork and redundancy."

Schmidt's graduate students are working on a variety of middleware projects as part of their research. James Hill, for example, is developing a tool called CUTS (Component Workload Emulator Utilization Test Suite) for his graduate research project, which is funded by systems-integrator giants Raytheon and Lockheed Martin.

"It can take months for a system to go from development to implementation, and you have to wait for other people who are building other parts," Hill says. "As you're developing the system, you don't know if it will fulfill its performance objectives. We're trying to shorten the integration phase. CUTS lets programmers run, on the target architecture, a replica of the system they're developing."

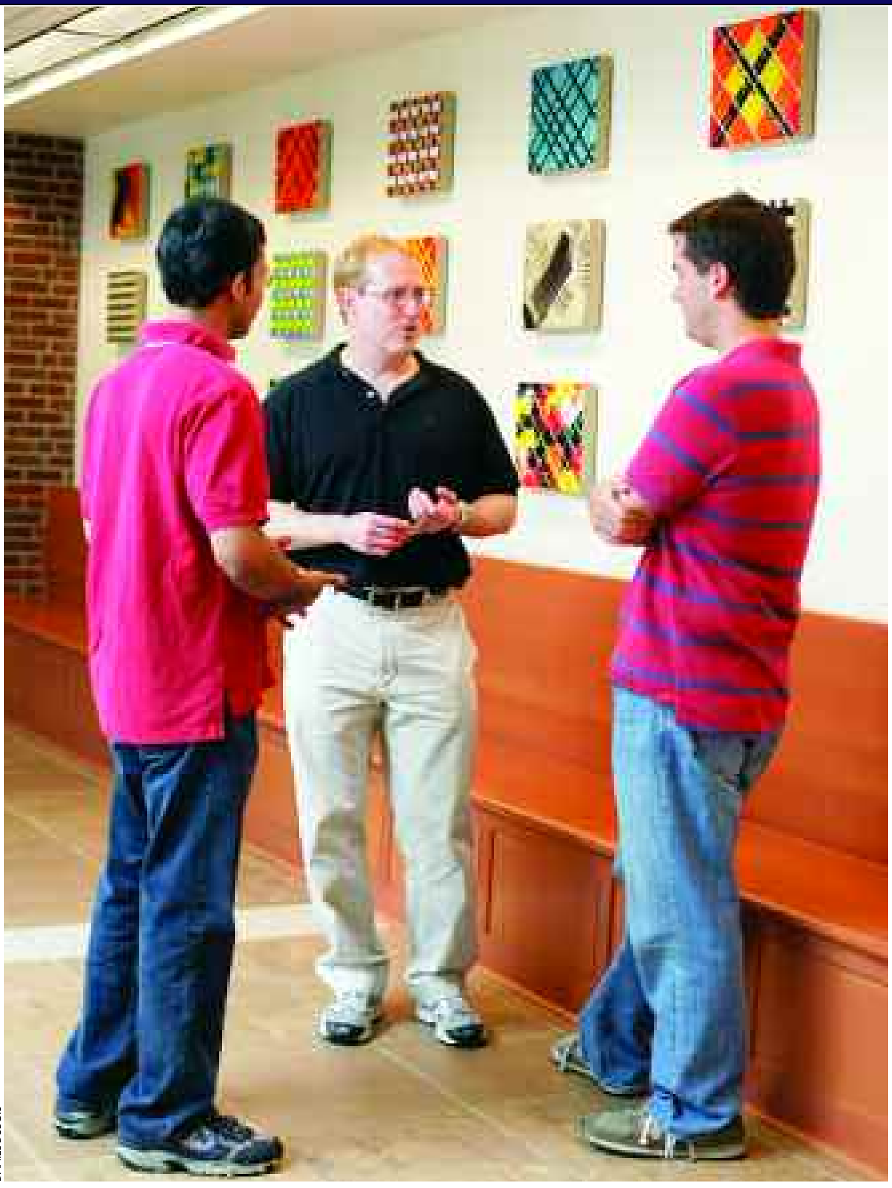
Programmers evaluate how well the "faux" component expresses different actions. If the replica works well, it's replaced with the real component when ready.

Jules White's effort to keep large programs from getting too complex for programmers and the experts who use them comes with a downside. "Every time you make it easier for programmers, they're inclined to build bigger programs," he says.

The trend is to have several big programs work together as one, not as stand-alones, so users can move among them effortlessly to accomplish their tasks—say, managing their checking, savings and investment accounts, for example. Making this possible, White says, are visual tools called "domain-specific modeling language," which allow final users to have more control of their programming.

"Integrating all these systems takes so much work and has so many details that even a team of programmers can't do it easily," says White, whose research is funded by IBM and Siemens.

His second focus is to have the computer do more of the actual programming, making it possible for programmers to work at a higher level.



DANIEL DUBOIS

Professor Doug Schmidt, center, advises numerous graduate students who are writing software called "middleware." Two of these students are Nishanth Shankaran, left, and Will Otte.

"The computer can also analyze the programming better and tell you if it will work or not.

"Working for Doug's group is the golden job with the ultimate group," White says. "It's exceeded my expectations a hundredfold."

William Otte is working with middleware called DAnCE (Deployment and Configuration Engine), middleware that links several components so they all work together, even if one or more of them goes down.

"A modern navy cruiser or destroyer, for example, has computers all over the place, running everything from radar to defense mode and attack mode," Otte says. "At present, if a missile takes out part of your computer system, you can't change those deployments on the fly, because they're hard-wired in." Otte's research, funded by Lockheed Martin Advanced Technology Center, involves control software for satellites.

Nishanth Shankaran is working on software projects also funded by Lockheed Martin Advanced Technology Center that will help NASA plan missions for its satellites that collect atmospheric and earth-surface data.

The biggest challenge faced by Shankaran is that of striking a balance between power and safety or, as he says, "figuring out how to get the maximum performance without the system running out of power."

—Robert Ross

NEIL BRAKE

Top Scholar

Michael Osborne, left, is presented the School of Engineering Founder's Medal during Commencement ceremonies May 12 by Dean Kenneth F. Galloway. The Founder's Medal recognizes the leading scholar in each undergraduate and professional school. Osborne, a native of Louisville, Ky., participated in several research projects at Vanderbilt, including the designing of a mask to be worn in conjunction with a foam-based fire-extinguishing system for skyscrapers.

Alumnus, Student Receive Prestigious Scholarships

Michael Cannamela, a 2006 graduate in mechanical engineering and German from Boise, Idaho, is one of 11 Vanderbilt students named Fulbright Scholars for 2006–07. He is currently conducting research on ways to even out thickness in sheet-metal formation distribution optimization in incremental sheet forming at the Rheinisch-Westfaelishe Technische Hochschule in Aachen, Germany. Following his year in Germany, he hopes to continue his studies in mechanical engineering in graduate school.

The Fulbright U.S. Student Program is sponsored by the U.S. Department of State's Bureau of Educational and Cultural Affairs.

Jacob J. Hughey, a senior from Manhattan, Kan., with a double major in biomedical engineering and mathematics, has won a prestigious Barry M. Goldwater Scholarship. He was selected on the basis of academic merit from a field of 1,081 mathematics, science and engineering students nominated by the faculties of colleges and universities nationwide. The Barry M. Goldwater Scholarship and Excellence in Education Program, established by the U.S. Congress in 1986, covers the cost of tuition, fees, books, and room and board up to a maximum of $7,500 per year.

Hughey's career goal is to explore the use of microelectronic mechanical systems and microfluidics to understand biological problems.

Good Sports

Playing Division I college sports is no walk in the park at any school. But it takes an outstanding student and athlete to combine the challenges of superior athletic competition with the rigors of a Vanderbilt engineering education. Nevertheless, 35 engineering students are currently choosing to meet that challenge with grace and a lot of hard work.

NEIL BRAKE

Ted Skuchas

Basketball player Edward Alva "Ted" Skuchas is one of those exceptional students. Last May, Skuchas was awarded his B.E. degree in computer engineering. Because "Skuch"—his Commodore nickname—was redshirted his freshman year, he still has a year of playing eligibility left. This fall he is enrolling in graduate school at Peabody College. After obtaining his master's degree in organizational leadership, he hopes to pursue a career in engineering project management.

One of the last things Skuchas did before graduation was to join with six fellow engineering students to design and implement a point-of-sale system for the University Club of Nashville as their senior design project. According to Andrew Dozier, professor of the practice of electrical engineering, the project was impressive.

"It required specification of the hardware, development of software and, most important, definition of the system requirements," Dozier says. "This required the students to interview the [University Club staff] and review the specified requirements with them before implementing the system. They also deployed the system at the University Club and trained the staff." Dozier reports the University Club welcomed the new system with enthusiasm.

Skuchas was born in Philadelphia and attended Germantown Academy in nearby Auburn, Pa. At 6 feet 11 inches, he is head and shoulders above other students, perhaps because his father and mother met through a tall person's club. Skuchas is following a family tradition of playing basketball, wearing the same number on his jersey that his father did when playing for Lafayette College.

Striking a Balance

As a member of the Commodore women's golf team, Kristen Svicarovich finds that balancing sports and her engineering education is often quite challenging. A senior majoring in civil engineering, she has made the Dean's List several times. She hopes to continue her education next year by earning her master's degree in transportation engineering, perhaps at Vanderbilt.

Svicarovich was born Thanksgiving Day in Hillsboro, Ore., 20 miles west of Portland. Like Skuchas, her family heritage is Eastern European: hers from Yugoslavia, his from Lithuania and Poland.

Her father introduced Svicarovich to golf, his favorite game, when she was 11 years old. She also played softball at Glencoe High School, where she was valedictorian.

Svicarovich says studying engineering is tough work, but she relishes it. Combining her studies with the 20 hours the NCAA allows for sports, however, is a balancing act.

"Traveling and trying to stay on top of homework is the biggest challenge," she says. Fortunately, say Svicarovich and Skuchas, Vanderbilt engineering faculty members have been very flexible in allowing them to take tests before or after their road games.

NEIL BRAKE

Kristen Svicarovich

These Vanderbilt engineering student-athletes continue to uphold the highest values of the university's proud traditions in both academics and athletics. They wouldn't have it any other way.

—Joanne L. Beckham

DANIEL DUBOIS

Engines and Robot Mice

Engineering seniors presented posters and demonstrations of their yearlong projects during April's Senior Design Day. Here team leaders Nur Adila Faruk Senan (mechanical engineering), Jake Ware (mechanical engineering), and Jonathan Lindsey (computer engineering) present their project, the engine/dynamometer-lab facility. The system they developed serves both as an internal combustion-engine lab experiment for mechanical engineering seniors and as an engine test facility for the VU Motorsports Formula-SAE racing team. A wide range of engineering designs was displayed and demonstrated during Senior Design Day, ranging from a "micromouse" robot to race through a maze, to an automatic system to guide surgeons in deploying gastric band balloons for obesity management. Design projects were implemented by teams of seniors in biomedical engineering, civil engineering, electrical engineering, computer engineering and mechanical engineering.

Dirty-Bomb Detection

Doctoral candidate Janos Sallai waits for the signal from engineers in the press box of Vanderbilt Stadium to begin walking randomly around the stadium to test the new "dirty bomb" detection system developed by the Vanderbilt Institute for Software Integrated Systems and the Oak Ridge National Laboratory. Their system, which was demonstrated April 20 to the Fifth International Conference on Information Processing in Sensor Networks, can track the position of people or objects even in the presence of large crowds, with a precision of one meter, compared to the 10-meter resolution typical of GPS. In a crowded stadium, that translates into an area of about 10 seats, as compared to 700.

NEIL BRAKE

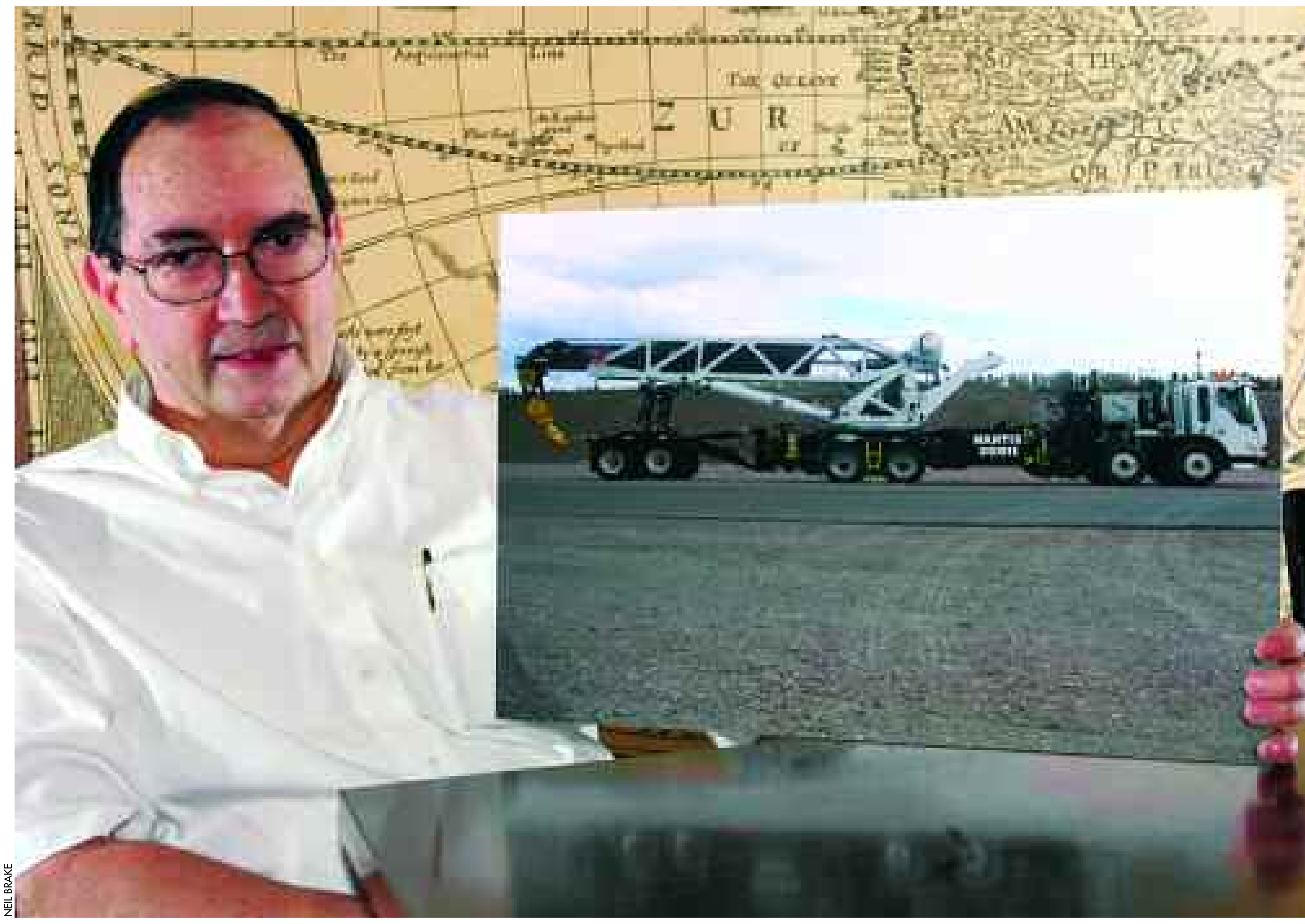
Niche-Market Cranes

Alumnus Bill Mitchell has taken the crane-manufacturing industry to new heights.

In the business of building cranes for the general construction marketplace, there are many manufacturers, but none with greater flair for specialization than Mantis.

Mantis cranes—dubbed "the Swiss Army knives of cranes" because of their versatility and reliability—are produced by SpanDeck Inc. of Franklin, Tenn. SpanDeck's chairman, Bill Mitchell, BE'59, says the line of cranes he first created in the 1970s is tailored to meet customers' needs. Equipped with telescopic booms for pick-and-carry capabilities and mounted on crawler chassis, Mantis cranes are the tools of choice when low ground pressure must be maintained and workspace is confined or terrain is rough.

Case in point: The company designed maintenance-of-way cranes for the New York City Transit Authority that had to cope with tunnels, high-tension electrical lines and other difficulties to replace worn or damaged rails. And for the "Big Dig," the colossal multibillion-dollar, eight- to 10-lane underground expressway project in Boston, SpanDeck custom fitted cranes with very short heavy lift booms to accommodate work underground.



NEIL BRAKE

Bill Mitchell, BE'59, is chairman of SpanDeck Inc., which manufactures Mantis cranes, the nation's leading line in custom-designed telescopic-boom crawler cranes. Mitchell holds a photo representing a recent design of the Mantis 30011, a heavy-lift crane manufactured for the Burlington Northern Santa Fe Railroad. This particular crane is superior in aiding train derailments because it can travel by road to the nearest railroad/highway crossing, rapidly convert itself from road-bound to rail-bound, and then proceed by rail to the derailment site.

"One of our first jobs was for a crane to use in construction in Antarctica," says Mitchell. That meant manufacturing a crane customized with materials and hydraulics that could operate in 80-degree-below-zero windchill conditions. "We've always been a niche player, and it's the right place for us," he says. It was a philosophy Mitchell developed after working two years with International Harvester just after graduating from Vanderbilt.

"They had 3,000 people in the engineering department," Mitchell recalls. "When you went into their offices, it looked like there ought to have been cobwebs from the engineers' heads to the bookshelves, like nobody had moved in 20 years. That wasn't for me. I followed my nose."

His nose led the Nashville native back to Middle Tennessee where he became the second employee at SpanDeck Inc., for which he designed the equipment for a newly patented prestressed concrete technology that ultimately was franchised worldwide.

Specializing in Specialization

By 1969 he was president of the company and looking for new challenges. When a neighboring company approached him for telescopic-boom crawler cranes for its storage tank-building business, Mitchell said, "Why not?" He credits his mentors at Vanderbilt with helping him cultivate the application of engineering principles to his ardor for heavy equipment.

The SpanDeck line includes shipboard pedestal, power line/pipeline, foundation cranes and rerailing wrecker cranes. The government is a major customer, with the Army Corps of Engineers tapping Mantis for rail-mounted cranes for lock and dam maintenance, and the U.S. Navy for cargo-handling cranes. Specialization means typically manufacturing more than 50 cranes per year with specific capabilities for demanding customers. That penchant for meeting customers' exact needs is what has set Mantis apart, says Mitchell.

Today SpanDeck sells seven crane models ranging in capacity from 18 to 70 tons. Two new models will come on line late this year, one with a 100-ton capacity.

Although Mitchell, 73, is no longer involved in day-to-day company activities, much of his family is. His son Bill, for one, is president/CEO (and a 1994 Vanderbilt Owen School graduate). But Mitchell keeps a sharp eye on the company and its operations. And while he set the design parameters and business practices for SpanDeck early on, Mitchell is modest about his work.

"I haven't built the world from a bucket of mud," he shrugs. "All I've tried to do is build a successful company. It all boils down to that."

—Mardy Fones

Ask the Faculty

STEVE GREEN

G. Kane Jennings is an assistant professor of chemical engineering. He earned his master's and doctoral degrees from the Massachusetts Institute of Technology and joined the Vanderbilt faculty in 1998.

What is on the near horizon for solar energy?

Two key challenges in converting sunlight into usable electricity by photovoltaic solar cells are to greatly reduce the cost of preparing these materials and to increase their efficiencies. Traditional photovoltaics are made from silicon, are expensive to fabricate, and offer only modest efficiencies. New approaches that I expect to gain momentum in the next few years include hybrid organic/inorganic systems where conducting polymers are combined with inorganic nanostructures; natural photosynthetic systems, in which the actual components that drive photosynthesis in plants are removed from the plant and integrated with conducting and/or semiconducting materials; and biomimetic systems where molecules are synthesized to effectively integrate light absorption, charge separation and electron transport. In each approach, new nanostructured architectures and components that allow absorption of broad wavelengths of solar radiation are needed to boost efficiency. Rapid and affordable processing of these materials through self-assembly and cutting-edge technologies in micro/nanofabrication should further reduce cost.

How are Vanderbilt engineering researchers contributing to the future of the field?

Vanderbilt chemistry professor David Cliffel and I are leading a team of student researchers toward the preparation of photoelectrochemical cells that contain Photosystem I (PSI) biological nanostructures. PSI is a nanoscale protein complex found in green plants, algae and cyanobacteria. PSI drives photosynthesis by capturing photons of sunlight. To prepare a photoelectrochemical cell from PSI, we first extract the protein from spinach and allow it to self-assemble on electrode surfaces. By modifying the electrode surface, we can entrap the protein within a thin film that mimics its natural environment in the plant. By shining light on this surface, we can achieve measurable current from a single monolayer of PSI. In the near future, we seek to greatly amplify this current by assembling PSI onto nanoporous electrodes with high surface area. Our work is currently supported by the U.S. Department of Agriculture and was initially funded by a Vanderbilt University Discovery Grant.

After the Storm

Six months into her appointment as chief of staff at a Gulf Coast hospital, Dr. Kathryn McClure-Ruiz faced the greatest challenge of her career: Hurricane Katrina.

A passion for logic—it's the common thread that led Dr. Kathryn McClure-Ruiz, BE'89, from an undergraduate degree in electrical engineering to a medical degree and a thriving obstetrics/gynecology practice at Gulf Coast Medical Center (GCMC) in Biloxi, Miss.

"I chose ob/gyn because it's the specialty where most patients are happy, healthy, and glad to see the doctor," says McClure-Ruiz, who walked away from a promising career in management with Exxon Chemical to attend Louisiana State University's medical school. Even so, engineering is woven into the fabric of her medical practice.

"A lot of medicine is physics based," says McClure-Ruiz, who finished her medical degree in 1997. "It starts with the skill engineers have for attacking work in a logical, problem-solving, fact-based way." Then there's the technology.

"All the equipment is based on physics," she says. "Take ultrasound. It uses sound waves to go deep into the abdomen and create an image."

At GCMC, McClure-Ruiz's gift for problem solving and goal-directed leadership was recognized in 2005 when she received a one-year appointment as the hospital's chief of staff. Six months later the work took a radical turn, challenging her personal and professional resources: Hurricane Katrina hit.

"Hospitals practice for events like Katrina," says McClure-Ruiz. "I'm originally from Texas and Louisiana. I've been through hurricanes. But nothing, absolutely nothing could have prepared us." As warnings went out on Sunday, Aug. 28, the 189-bed medical center's hurricane team and their families—about 100 people in all—moved into the hospital and hunkered down. "The hospital sits about 100 yards from the shore," says McClure-Ruiz.

Working with hospitals in neighboring communities, all GCMC patients who could safely be moved, including a 400-pound man who had to be carried down the stairway because the elevator could not accommodate him, were transferred.

"The first thing we noticed was the flooded parking lot. Then we noticed the wind was so strong it blew the pea gravel off the roof of the hospital and broke the windows of nearby buildings," says McClure-Ruiz.

Because the hospital has no Gulf-facing windows and stands a high and dry 28 feet above sea level, Katrina seemed like just another hurricane. Blissfully ignorant of the devastation across the Gulf Coast, the hospital was a safe haven—safe, that is, except for the disturbing way the storm surge kept bumping the emergency-room doors. With three of the hospital's four generators out, communication, except by radio and cell-phone text messaging, was cut.

"During the storm we dealt a lot with what we call 'the worried well,' people who were scared or had minor injuries," says McClure-Ruiz.

A Hurricane Wake-Up Call

After eating cold food and sleeping on the floor in the dark for three days, the hospital staff was relieved when Katrina finally subsided. Once medication and supplies had been shipped to nearby hospitals that still had power, the staff went outside. "We were all so happy we'd survived, we took pictures of each other," McClure-Ruiz sighs. "We thought if they could just get the power run down the street, the hospital would be back in business. We just didn't know how bad it was."

The clues came quickly. Interstate 10, the east-west Gulf Coast corridor through Biloxi, was a sand-covered beach. The trees were bare, and everywhere they looked was devastation. McClure-Ruiz's beachfront home was destroyed, but it wasn't until she found her cat, injured and dying, that Katrina hit home. "That's when I lost it," she says.

Recovery has been slow in Biloxi. GCMC was closed in the storm's aftermath but became an unofficial community center where residents came for the latest news. The hospital officially reopened in October.

A year after Katrina, McClure-Ruiz and her husband, Ronald, are still in temporary digs—a trailer on the lot where their house once stood. Sitting outside on a mild evening watching the sunset over the Gulf, she says that professionally, Katrina was a hurricane wake-up call.

"We learned you're never as prepared as you think you are. You can't take things for granted," she says. Having four generators on hand doesn't matter if three of them fail, and designated emergency patient-transfer routes are useless if roads are blocked by storm debris. "Next time we'll have a mobile generator, one we can move to a secure location," she vows. "Even then, what happens if you run out of fuel?"

On the personal side, she says Katrina was a reality check on taking Mother Nature for granted, but also a sort of blessing. "I know people who have made career changes as a result of surviving," she says. "Katrina brought out the best in people. I've realized that people are what this community is about, and the people are the hospital.

"Family, friends, your health, your life—those are the things that really matter," she says. "So what if you've lost Grandma's china? What matters are the people you eat Christmas dinner with."

—*Mardy Fones*

"So what if you've lost Grandma's china? What matters are the people you eat Christmas dinner with."

"We learned you're never as prepared as you think you are. You can't take things for granted," says Dr. Kathryn McClure-Ruiz, BE'89, who still lives in temporary housing a year after Hurricane Katrina destroyed her beachfront home.

Slide Trombone Zen

A.B. Bonds doesn't blow his own horn—except when he's playing with the Nashville Community Concert Band. Then he lets loose with his slide trombone at concerts in parks, churches and synagogues.

"Ensemble playing is really a gas," says Bonds. "It's very Zen. You are totally focused on the music, and all the things you were worrying about disappear. It's my therapy."

By day, Bonds teaches circuits, digital logic and microprocessors as professor of electrical engineering, computer engineering and biomedical engineering. A 26-year veteran of the Vanderbilt engineering faculty, he also serves as associate chair of the Department of Electrical Engineering and Computer Science and director of undergraduate studies in computer engineering.

Music, Collections and Cars

After playing in bands from junior high through graduate school, Bonds put down his horn to concentrate on establishing his academic career. Then in 1991 during a "midlife crisis," he picked up the trombone again and hooked up with the Nashville Community Band. They play classical music, jazz, show tunes and martial airs, often teaming up with military and university ensembles, including the Vanderbilt Community Concert Band.

But performance isn't Bonds' only groove. He collects early recording devices, like an Edison cylinder patented in 1878, and vintage recordings such as Caruso singing an aria from *Pagliacci*. He has shared his collection with alumni at Reunion and in an engineering freshman seminar titled "Audio Reproduction."

Bonds also collects and restores antique cars, including a 1930 Rolls Royce, a 1952 MG and a 1973 MGB. "As an engineer I like fixing things," he says with a smile. "I like to see old machinery doing its job."

COURTESY OF A.B. BONDS

Professor A.B. Bonds and his restored 1952 MG.

Brain-Cell Teamwork

An early interest in radios, which continues to this day, steered Bonds to a career in electrical engineering. "I built my first radio when I was 11," he says. "By the time I was 13, I was doing some fairly sophisticated designs."

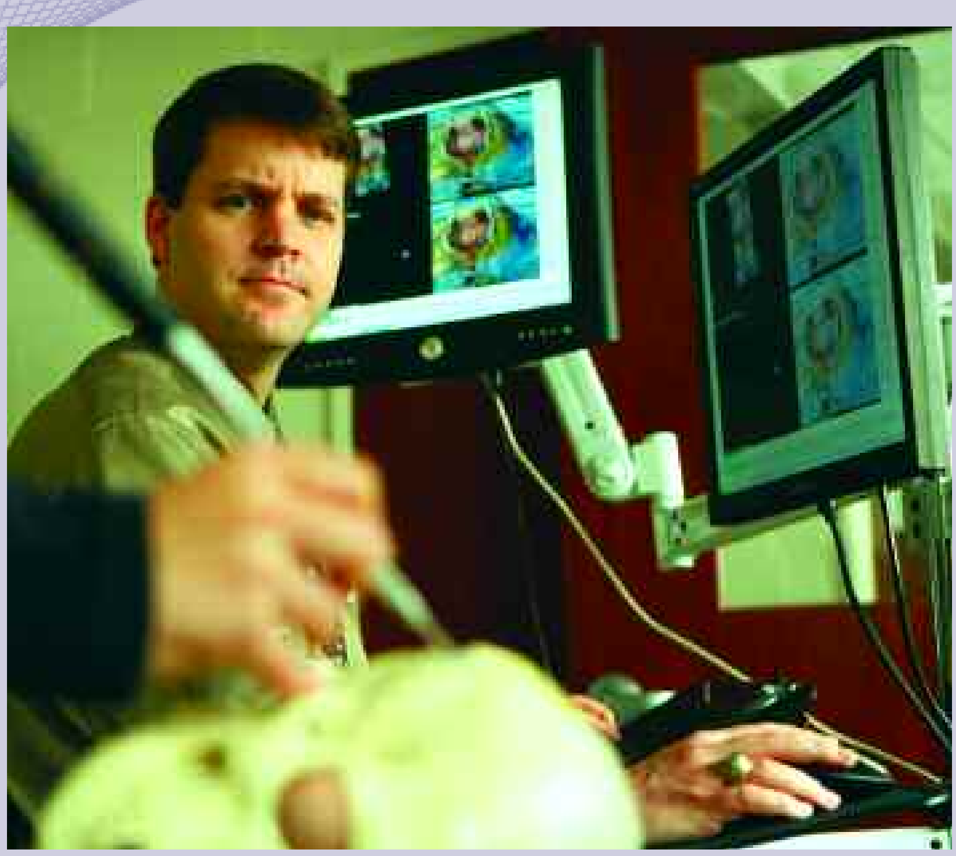
He also took courses in biomedical engineering while earning a Ph.D. in electrical engineering from Northwestern University. Today, as a member of the Vanderbilt Vision Center and the Center for Integrative and Cognitive Neuroscience, Bonds studies the brain's visual system from an engineering perspective. His recent discovery that teamwork among nerve cells improves their ability to discriminate between visual patterns has opened up a revolutionary new way of looking at how the brain functions.

"One of the most immediate applications of this knowledge will be to help us build much more efficient systems of robot vision," he says.

Bonds says his greatest satisfaction as a teacher comes when an alumnus returns to campus and tells him, "I really hated it when you taught such-and-such a course, but I have used it a lot in my career."

—Joanne L. Beckham

INNOVATIONS



Surgical Precision

Assistant Professor of Biomedical Engineering Mike Miga watches as research associate Aize Cao moves a stylus probe across a skull phantom. They are testing a surgical guidance system that pinpoints where a surgical implement is relative to the MRI and CT scans of the patient taken earlier, allowing the surgeon to operate with more precision. In order to perform image-guided surgery, it is necessary to digitize landmarks on the patient and then find the same landmarks in the medical images. Miga and his associates have developed mathematical transformations that allow the surgeon to touch any part of the patient's physical neuroanatomy, and the respective MR image slices will appear on the display. A laser range scanner tracks deformation of soft tissue during surgery. As surgery progresses, tissues deform and change shape. The laser range scanner passes a laser stripe over the field of interest, collects the reflected light with a camera, and then generates a three-dimensional image of the surface of the object it scanned. This data is used to measure how the brain is deforming, and computer models update the surgeon's neuronavigation system.

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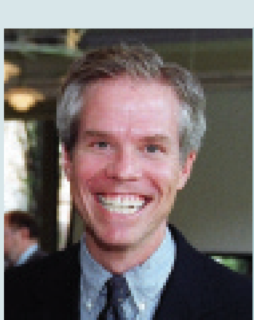

"Following the example set by my father and grandfather, I give back in order to strengthen the School of Engineering that had such an impact on us."

—*Joseph Flowers, BE'88*

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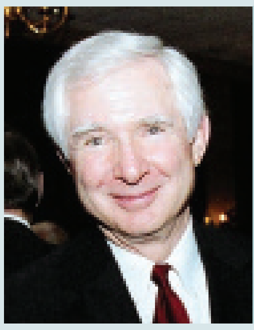

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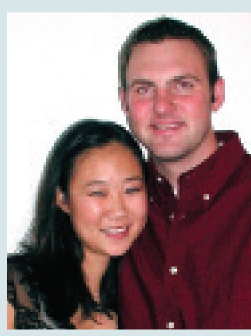

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E. Bert W. Smith III (BE'80)

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Randall S. Brown (BE'81)*
Jeffrey C. Carlton (BE'81, MD'85)*
Paul Breckinridge Jones (BS'81)
Michael S. McCarthy (BS'81)*

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Anderson L. Baldy III (BE'82)*
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Deborah Stanford Watson (BE'82)*
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Nancy Begel Phillips (BE'83)*
Marcus G. Rivas (BE'83)

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Scott D. Yates (BE'87)*

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Scarlett Weakley Martin (BA'88, MBA'92)

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Kenneth R. Martin (BE'91)
Jennifer Young Sundell (BA'91, Med'94)*

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Tricia Doak Thomas (BE'94)

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Dugan H. Schwalm (BE'97, MS'00)*
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Class of 1999
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Louise Busch Wilson (BE'00) and Michael A. Wilson

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Amanda Rose Lea (BS'02)
Shannon M. Roe (BE'02)

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Brian C. Edwards (BE'03)
Eduardo J. Fernandez (BS'03)*
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S. Kyle Murphree (BE'05)
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Matthew P. Stevens (BS'05)
Andrew J. Wald (BE'05)

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While the School of Engineering Development and Alumni Relations Office has made every effort to ensure the accuracy of this list, we want to hear from you to correct any omissions or errors. Please notify us by e-mailing *AlumniEngineering@vanderbilt.edu.*

** Denotes members who have made a 5-year pledge*
† Deceased

We're Coming to a City Near You!

The School of Engineering is making its way around the country, bringing a piece of Vanderbilt to you—our parents, alumni and friends. The first stop was Houston on April 25, 2006. Dean Kenneth F. Galloway and other engineering faculty and staff made their way to the Lone Star State to induct James A. Johnson, BE'63, PhD'72, as a School of Engineering distinguished alumnus and the first new member of the Academy of Distinguished Alumni. (Look for a full report on Jim and the other members of the Academy in the Spring 2007 issue of *Engineering Vanderbilt*.) We also introduced Dongqing Li, the H. Fort Flowers Professor of Mechanical Engineering, to the Houston community. More than 70 Vanderbilt faithful turned out to show their support and learn about the exciting things happening at the School of Engineering. We hope you'll join us at our next stop—Atlanta, in the spring of 2007!

Professor Dongqing Li, Dean Kenneth F. Galloway, and Distinguished Alumnus James A. Johnson (left to right) gathered to meet parents, alumni and friends of the School of Engineering in Houston.

Check us out online at www.vuse.vanderbilt.edu