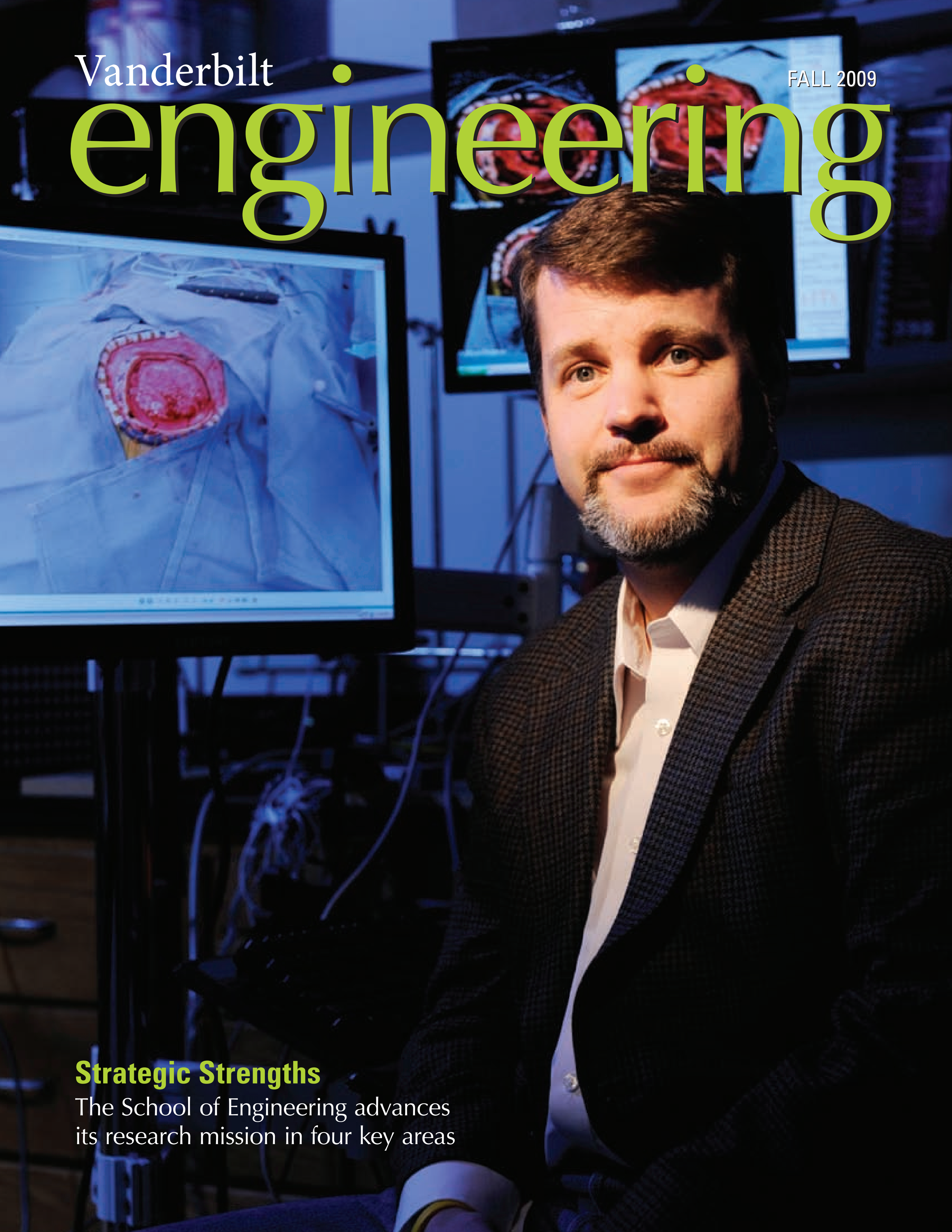
Vanderbilt
engineering
FALL 2009



Strategic Strengths

The School of Engineering advances its research mission in four key areas

honors and awards

Peter T. Cummings, the John R. Hall Professor of Chemical Engineering, has been named a member of the leadership team and a co-principal investigator for a new Fluid Interface Reactions, Structures and Transport (FIRST) Center established at Oak Ridge National Laboratory under the direction of the Department of Energy. The center is one of the new multimillion-dollar Energy Frontier Research centers recently announced by the White House. **Cummings** has also been elected a fellow of the American Institute of Chemical Engineers.

Dean Kenneth F. Galloway has been elected by his national peers to a two-year term as chair of the Engineering Deans Council, which includes more than 300 deans of engineering institutions across the United States. The council is one of the leadership organizations of the American Society for Engineering Education (ASEE).

Aniruddha S. Gokhale, assistant professor of computer science and computer engineering, and **Scott A. Guelcher**, assistant professor of chemical and biomolecular engineering, have received highly competitive National Science Foundation Faculty Early Career Development (CAREER) Program awards.

Sanjiv Gokhale, professor of the practice of civil and environmental engineering, was honored with the inaugural Distinguished Professor Award given by the Construction Industry Institute.

Michael Goldfarb, professor of mechanical engineering, recently received a new NIH R01 grant of $1.4 million for his work on developing an exoskeleton for gait restoration for paraplegics. He also has been awarded a five-year, Army-funded project that leverages his current NIH R01 on powered leg prostheses. The project will support work on a version of his team's robotic leg with neural interfaces being developed at the Rehabilitation Institute of Chicago.

George M. Hornberger, the Craig E. Philip Professor of Engineering and a University Distinguished Professor, has received a new presidential appointment to the U.S. Nuclear Waste Technical Review Board. He has served on the board since 2005.

E. Duco Jansen, professor of biomedical engineering, was elected president of the American Society for Laser Medicine and Surgery, becoming only the third nonphysician ever elected to lead the organization.

David S. Kosson, chair of civil and environmental engineering, received the 2009 ISCOWA Award given by the International Society for the Environmental and Technical Implications of Construction with Alternative Material. The award is an international recognition for contributing most significantly to the use of alternative materials in construction applications.

Sankaran Mahadevan, professor of civil and environmental engineering, received the Outstanding Professional Service Award from the American Society of Civil Engineers for sustained service to the aerospace division over the past two decades.

Clare M. McCabe, associate professor and co-director of graduate studies of chemical and biomolecular engineering, is chair-elect of the Computational Molecular Science and Engineering Forum of the American Institute of Chemical Engineers.

Ronald D. Schrimpf, the Orrin Henry Ingram Professor of Engineering, received Vanderbilt's university-wide honor, the Harvie Branscomb Distinguished Professor Award. The Branscomb Award is for outstanding accomplishments in furthering the aims of Vanderbilt University.

Vanderbilt engineering

On the cover: Michael Miga, director of Vanderbilt's Biomedical Modeling Laboratory

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Delivering Engineering Education


DANIEL DUBOIS

Dean Galloway

What skills will American engineers need in a very rapidly changing world? How many engineers are needed and where will they be located? More specifically, what are our responsibilities in providing an education that shapes careers that may last more than 40 years after our students leave the commencement stage?

These questions drive curriculum changes. Workforce issues, globalization and new technologies indicate a need for more interdisciplinary skill sets. Today, effective system-level designs require us to communicate across disciplines. And a commitment to basic research is absolutely essential if America is to keep its leadership position in engineering innovation.

At the Vanderbilt University School of Engineering, research competitiveness and engineering education are not mutually exclusive. Students take fundamental courses, and they take classes that are design-centered and application-oriented. They work alone. They work in teams. They work in labs with some extraordinary faculty who are doing cutting-edge research funded by the National Science Foundation, Department of Defense, Department of Energy, National Institute of Health and others, often with collaborators at notable universities here and abroad.

From my perspective as dean of a highly competitive, research-intensive engineering school, we spend much energy and resources solidifying our research reputation. But we also dedicate a great deal of energy and resources to innovative education initiatives. We now have extensive study abroad programs, unique first-year experiences, service-learning courses, an integrated senior design course, summer undergraduate research programs and more.

We deliver an excellent engineering education to some of the best and brightest students in the country.

Can We Do More?

This is a serious question with many implications. We have an obligation to examine if and when it is appropriate to do more, but not merely for the sake of implementing something new. If we ask, "Is it responsible? Intentional? Sustainable?" then it becomes implementation with a purpose.

We must engage in continuous examination of the effectiveness of existing opportunities and support an ongoing search for better ways of delivering a rich and rigorous engineering education.

In this endeavor, we partner with fellow institutions, corporate leaders, government, other Vanderbilt schools and initiatives, and of course, our alumni. These are exciting and pivotal times for engineers, educators and the Vanderbilt University School of Engineering. In this premiere issue of *Vanderbilt Engineering*, the successor to both our engineering newsletter *Engineering Vanderbilt* and annual *Research Report*, we share some of the excitement of our research and educational initiatives. We will continue to explore the stories, efforts and opportunities of the school and its people in future issues of *Vanderbilt Engineering*, and look forward to your participation and feedback.

Kenneth F. Galloway
Dean

VUSE by the Numbers

As part of a major research university, the Vanderbilt School of Engineering has a dual focus on advancing knowledge and educating the next generation of engineers.

- 84 — Number of tenure/tenure-track faculty
- 18 — Faculty NSF CAREER Award winners since 2000
- 9 — Endowed chairs
- $50.2 — Total research expenditures in 2009 (millions)

Awarded in 2008–2009 academic year

- 280 — Bachelor degrees
- 56 — Doctoral degrees

2009 entering undergraduate class

- 1453 — Median SAT score
- 321 — Number of incoming students


JENNY MANDEVILLE

Weiss Named One of Nation's Top Young Engineers

Sharon Weiss, assistant professor of electrical engineering, has been recognized by President Obama with a Presidential Early Career Award for Scientists and Engineers. The award is the highest honor bestowed by the U.S. government on young professionals in the early stages of their independent research careers.

Weiss is one of 100 beginning scientists and engineers who will receive up to a $1 million five-year research grant to further their studies in support of critical government missions.

Weiss was nominated for the Presidential Early Career Award by the Army Research Office of the Department of Defense. Federal departments and agencies nominate researchers whose early accomplishments show the greatest promise for strengthening the nation's leadership in science and technology and contributing to the awarding agencies' missions.


STEVE GREEN

Weiss

Weiss and her team are investigating methods to achieve faster and more accurate detection of biological and chemical materials by using portable porous silicon waveguides. This work has impact in medical diagnostics, environmental monitoring and homeland security. Her nanoscale biosensing research involves using a sensor made from porous silicon, a material with billions of tiny nanometer-sized holes (1,000 times smaller than the thickness of a human hair) to achieve more sensitive detection of biomolecules in less time. Sensors made in her photonic crystals laboratory have been used to identify specific DNA sequences and will be used to detect various toxins and viruses.

Promoted, Honored and New Faculty

The School of Engineering has newly promoted professors, a new professor, emeritus, and seven new faculty members this academic year.

Two faculty members have been promoted to full professor and a third has been promoted to associate professor. **Anita Mahadevan-Jansen**, professor of biomedical engineering, and **Bharat Bhuva**, professor of electrical engineering, were both promoted to professor from associate professor. **Xenofon Koutsoukos**, formerly assistant professor of computer science and computer engineering, was promoted to associate professor with tenure.

In May the Vanderbilt Board of Trust designated **Taylor G. Wang** as a Centennial Professor of Mechanical Engineering, emeritus; a Centennial Professor of Materials Science and Engineering, emeritus; and a professor of applied physics, emeritus.


DANIEL DUBOIS

Mahadevan-Jansen

New to the school this fall are **Jon F. Edd**, assistant professor of mechanical engineering, **W. David Merryman**, assistant professor of biomedical engineering, **Hak-Joon Sung**, assistant professor of biomedical engineering, and **Yaqiong Xu**, assistant professor of electrical engineering and assistant professor of physics. **Akos Ledeczi** also joined the faculty as assistant professor of electrical engineering and computer science. In January 2010 the school will welcome **Craig L. Duvall**, assistant professor of biomedical engineering and **Bennett A. Landman**, assistant professor of electrical engineering.

Connecting Vanderbilt's Online Community

Vanderbilt recently launched VUconnect, a new online community for all alumni and students. VUconnect replaces the previous online service, Dore2Dore, and provides new and enhanced features. Alumni can use VUconnect to provide news, find old friends and classmates, network, share career advice and leads, locate VU chapters and sign up for Vanderbilt events.

School of Engineering alumni are encouraged to go to *www.vuconnect.com* and follow the step-by-step instructions to register. Previously registered Dore2Dore users need to reregister with VUconnect (although biographical information from Dore2Dore will automatically transfer). Those alumni with an @alumni.vanderbilt.edu e-mail address will continue to have e-mail forwarding service.

VUconnect is only open to Vanderbilt alumni and students, as part of Vanderbilt's commitment to the privacy of its alumni.

For help or questions, e-mail vuconnect@vanderbilt.edu or call (615) 322-5578 weekdays 8:30 a.m.–5 p.m. Central time.

Engineers Take Over Music Row

Engineers from the School of Engineering's Institute for Space and Defense Electronics (ISDE) and the Institute for Software Integrated Systems (ISIS) have just become the newest residents of Nashville's famed Music Row.

The two institutes relocated their combined 130 personnel to new facilities at 1025 16th Avenue South, expanding to approximately 40,000 square feet of lab, office and conference space. ISIS and ISDE were formerly housed at 2015 Terrace Place and the Centre Building on Broadway, respectively, in facilities that were cramped and no longer met the institutes' needs.


STEVE GREEN

1025 16th Avenue South

The new location will not only provide much-needed space but is also expected to assist the School of Engineering in attracting top faculty, researchers and graduate students. Formerly music industry-related offices, the red brick Music Row building was purchased by Vanderbilt for the School of Engineering in 2008.

Former Chancellor Heard Dies

Alexander Heard, who served as Vanderbilt's fifth chancellor, and guided the university from 1963 to 1982, died July 24 after a long illness. The chancellor emeritus was 92.

Under Heard's leadership, Vanderbilt grew and prospered, adding three schools to the seven it already contained, constructing three dozen new or enlarged buildings, conducting two highly successful fundraising campaigns, doubling its enrollment and increasing its annual budget tenfold. The university also recruited distinguished faculty, who achieved new levels of quality in both teaching and research.

Since 1982 Vanderbilt has awarded annually the Alexander Heard Distinguished Service Professor Award to a faculty member for contributions to the understanding of problems of contemporary society. **Frank L. Parker**, Distinguished Professor of Environmental and Water Resources Engineering and professor of engineering management, and **Karl B. Schnelle Jr.**, professor of chemical and environmental engineering, emeritus, are two past recipients of the award.

By arrangement with the university, Heard's ashes will be interred at Benton Chapel. Donations in his honor may be made to the Alexander Heard Memorial Fund at Vanderbilt.

Strategic Strengths

The School of Engineering advances its research mission in four key areas

Story and profiles by Jennifer Johnston

Assistant Professor Eric Barth adjusts a free-piston engine.

DANIEL DUBOIS

One chemical engineering professor conducts research with the potential not only to fight cancer but to improve the way we draw energy from Earth's core. Work by a mechanical engineering faculty member could affect energy transfer in cars; that same researcher turns his energies to building robots that could disassemble a roadside bomb. A top electrical engineering and computer science expert oversees research on cybersecurity and patient management systems that may help congestive heart failure patients handle some of their ongoing care at home.

Innovative research and pursuit of varied applications by faculty and researchers at the Vanderbilt University School of Engineering have helped the school redefine its four top areas for growth, exploration and discovery. Those areas, or core competencies, are: **health care**, **energy and the environment**, **information systems**, and **defense and national security**.

"Our departments have grown and dramatically advanced their missions, particularly in these four areas of core competency," says Kenneth F. Galloway, dean of the School of Engineering. "Looking at our current strengths, it became clear to me that our faculty talent, as well as certain critical research initiatives, fit neatly into these very relevant categories."

Once the four core areas were identified, the School of Engineering has been empowered to tackle its research mission more strategically, Galloway says.

Collaboration is Key

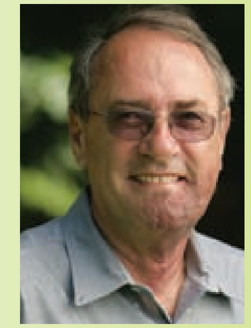
The ability to capitalize on interdisciplinary research initiatives radically advances this mission, Galloway says, particularly given the many important alliances inside and outside the university among School of Engineering faculty, colleagues from other Vanderbilt schools, medical center researchers and physicians, and other research centers, such as Oak Ridge National Laboratory. That collaboration across departments, disciplines and the world may be the true key to the school's contribution to solving real-world problems.

More than 100 researchers come together through ISIS, the Institute for Software Integrated Systems, led by Director Janos Sztipanovits. As the School of Engineering's largest center, ISIS has millions of dollars of research contracts that touch each of the four competency areas.

Other research in each of the school's five departments also involves teams with exciting potential. In biomedical engineering, for example, the husband and wife duo of Anita Mahadevan-Jansen and E. Duco Jansen, professors of biomedical engineering, are among a small number of pioneers in biophotonics,

Many of Vanderbilt School of Engineering faculty conduct research impacting several core competencies. Here Vanderbilt Engineering *introduces four whose work promises to address those critical issues in energy and the environment (Peter Cummings), health care (Michael Miga), information systems (Doug Schmidt), and defense and national security (Janos Sztipanovits).*

ISIS Defends Against Cyberattack, Enemy Forces and Even Disease



Sztipanovits

As director of the Institute for Software Integrated Systems (ISIS), **Janos Sztipanovits** oversees more than $10 million in systems and information science and engineering projects involving more than 100 researchers, staff and graduate students.

These projects engage ISIS, and Sztipanovits, the E. Bronson Ingram Distinguished Professor of Engineering, in information systems, health care, and defense and national security.

Currently the development of projects on high-confidence system design with defense applications are ongoing, particularly for avionics. High confidence systems (those that developers and users have a high degree of assurance that they will not fail or misbehave) need to be secure and durable. "We are also interested in investigating the resilience of large information systems against cyberattacks," says Sztipanovits, who chaired a study on the operational readiness of the U.S. Air Force against cyberattacks last year.

The largest effort in the defense area at ISIS, Sztipanovits says, is the development of a battle command system for the U.S. military's Future Combat System program. This initiative uses ISIS-pioneered, model-integrated computing design principles that combine various technologies into a consistent and reliable system.

"This whole area of model-integrated design of systems and software is really rapidly moving into the mainstream and that creates a quite new approach to engineer, integrate and operate large networked systems," he says. "It is also the foundation for new system design methods and tools that go beyond the conventional programming languages."

Other projects range from the development of online training materials for homeland security purposes to creating a countersniper system. This cost-effective sniper location system detects when weapons are fired and the direction of the bullets. The countersniper technology would allow soldiers or police officers to react rapidly and minimize injuries.

ISIS's expertise in understanding and incorporating complex privacy, security and systems integration issues dovetails into its work in health care. Currently ISIS researchers work with Vanderbilt University Medical Center toward creating trustworthy health information systems. Vanderbilt is joined in this National Science Foundation partnership by scientists from Berkeley, Stanford, Cornell and Carnegie Mellon universities.

A patient management system for managing sepsis is another program developed with medical center colleagues, Sztipanovits says. In May initial capabilities for the system were deployed in the medical center for testing, where it has already demonstrated viability. "We also are discussing how to extend that system toward other areas, such as home-based management of congestive heart failure patients," he says.

finding ways to use light in medical breakthroughs diagnostically, surgically and therapeutically.

"Biophotonics is small in terms of the number of faculty involved, but it's large in terms of their impact, in terms of their laboratory output, and in terms of the number of post-docs, research faculty and undergraduates involved," says Todd Giorgio, chair of the Department of Biomedical Engineering.

Overlapping Impact

Engineering researchers have frequent and fruitful collaboration with colleagues at Vanderbilt University Medical Center and other schools and departments, Giorgio says. For example, in Vanderbilt's Institute for Nanoscale Science and Engineering, investigators from the School of Engineering, College of Arts and Science and medical center focus on translating basic science into products. Giorgio leads projects at this collaborative interface, building biosensors that would be placed inside cells to report on activity in the cell. Another project aims to develop new imaging contrast agents.

Like his colleague on the biomedical side, Peter Pintauro, chair of chemical and biomolecular engineering, notes that a great deal of collaboration takes place between his department's researchers and the medical center, the Departments of Chemistry and Physics in the College of Arts and Science, and multiple departments and centers within the School of Engineering.

Faculty, students and researchers in chemical and biomolecular engineering are involved in important ongoing work in cancer, biology and tissue engineering, and even metabolic engineering as related to obesity. At the same time, multiple projects associated with energy and the environment are underway, as are ventures involving defense and national security, says Pintauro, the H. Eugene McBrayer Professor of Chemical Engineering.

Pintauro, as well as Associate Professors of Chemical and Biomolecular Engineering G. Kane Jennings, Bridget Rogers and Clare McCabe, all have projects relating to energy. Pintauro and his research team study polymer components of batteries and fuel cells to make existing materials work more efficiently and safely, and searching for new ones to make new technologies, such as electric cars, run better.

In the Mechanics

In mechanical engineering, Associate Professor D. Greg Walker is interested in thermoelectric modeling for energy recovery, such as taking the excess heat from a vehicle's tailpipe and using it to run the lights or battery.

Assistant Professor of Mechanical Engineering Eric Barth also works on energy applications, finding ways to store and reuse the energy wasted during the braking action of a vehicle. In potential defense-related applications of Barth's work, small, free-piston engines might power robots that could dissemble a roadside bomb.

Mechanical Engineering Department Chair Robert Pitz conducts laser measurements of scramjet combustion and rocket exhaust for the U.S. Air Force, providing data about rocket engine thrust for take-off.

Projects with potential medical applications include the use of steerable needles to maneuver around organs in the body, for example. Swallowable capsule robots would aid in diagnostics, and the use of lasers is under exploration to scan the surface of organs to create medical images during surgery. Those projects are ongoing in Assistant Professor Robert Webster's medical and electromechanical design laboratory.

Environmental Strengths

Numerous environmental and energy applications can be found in civil and environmental engineering, many under the umbrella of the Vanderbilt Institute for Energy and the Environment and still more associated with the Consortium for Risk Evaluation with Stakeholder Participation.

Professor of Civil and Environmental Engineering Sankaran Mahadevan's research has been used in the design and evaluation of structural systems ranging from roads to airplanes and from nuclear waste dumps to hydraulic structures. How to prolong the life and service of infrastructure, into which is poured huge investments of capital and resources, has been a question in the research of Caglar Oskay and Florence Sanchez, both assistant professors of civil and environmental engineering.

Work by Sanchez and David Kosson, chair of civil and environmental engineering, has also provided technical guidance to the U.S. Environmental Protection Agency's Air Pollution Prevention and Control Division. Kosson has long studied environmental issues surrounding a range of soil, sediment and water contaminants. In recent months he has been called upon as an expert in the TVA coal ash spill in nearby Kingston, Tenn.

A group of civil and environmental engineering faculty that includes Professor George Hornberger, Professor of the Practice James Clarke and Associate Professor Eugene LeBoeuf has been evaluating watershed issues where water quality and energy con-

Computer Models Guide Surgery and Improve Diagnostics

Miga

Image-guided surgery enables skilled physicians to perform difficult operations. But the images used for guidance are generally taken before surgery begins. How do surgeons account for changes that take place in tissue while the surgery is ongoing—changes brought on by the pressure of an instrument, a shift due to an incision or other factors?

That is the primary work of **Michael Miga**, director of Vanderbilt's Biomedical Modeling Laboratory and associate professor of biomedical engineering. Miga and his colleagues produce computational modeling techniques that mimic these effects and are then used to compensate for tissue changes during surgery.

Miga's computer modeling techniques so far have chiefly focused on brain, liver and kidney surgery. His lab is developing a novel computational framework that interacts with current operating room systems. It uses software and computer and measurement equipment to make calculations that modify the images for deformations during surgery.

This is important in brain operations, for example, as certain drugs shrink the brain during surgery, or when tissue is retracted during removal of a tumor. The computer modeling would cost-effectively augment the image-guided surgery techniques already in place and account for the tumor's new location.

Miga says that unlike the brain, which is largely held in position by the skull, other organs are more flexible and can move during surgery.

Each organ has unique characteristics and different surgical approaches, requiring that the engineers apply separate research methods, new approaches to computation and different algorithmic design. Research done by Miga using laser-range scanning to capture the liver shape for image-guided liver surgery has already been incorporated into a new product that has received FDA approval. It is available in the marketplace and is being tested clinically (see *Engineering Vanderbilt*, spring 2009). Miga is currently focused on using the changes measured by the laser-range scanner to incorporate deformation correction into the product. It is expected to be the first of its kind available commercially.

Computer modeling also affects medical imaging. With breast cancer detection, current imaging modalities cannot document a tissue's stiffness, an important biomarker of disease. Miga and his team are researching ways to use new noninvasive imaging methods to detect changes in tissue stiffness.

Using similar methods, but in a very different context, Miga also focuses on bone fractures. In this work, models and algorithms attempt to determine how well a fracture is healing by looking at the stiffness of the tissue at the fracture site.

"The common thread is that these are all mathematical model-based analysis approaches with a characterization, or interventional, aspect," Miga says. "Strewn throughout each research project is the integration of computer models, soft tissue mechanics and analysis, with a central focus at translating the information to direct therapy or characterize tissue changes in an active way."

Mission-Critical Systems from Defense to iPhones

Schmidt

With an enemy missile hurtling toward their aircraft, fighter pilots shouldn't have to wonder whether their defense systems will work in time. Testing how such systems perform before they're used in a hostile environment is just one of the many projects that Professor **Doug Schmidt** directs using building-block middleware computer software he, his students and staff developed.

"Our work relates to making it easier to develop and test these large-scale information systems to make sure they perform the right functionality at the right time," Schmidt says. "These are very large, complex software applications and we use middleware platforms—reusable software that coordinates the application and infrastructure components of an IT system—and tools to validate and enhance confidence in mission-critical systems."

Schmidt, professor of computer science and computer engineering and associate chair of computer science, oversees a team that currently performs such computer testing for a wide range of sponsors, including the U.S. Navy, Lockheed Martin, Raytheon, BBN Technologies, the U.S. Air Force, the Australian navy and Northrop Grumman.

Through an Air Force Research Laboratory grant, for example, Schmidt works with several companies to help develop a system to link defense fighters seamlessly to the Defense Department's Global Information Grid (GIG). The goal of the GIG is to enable military personnel in the field to securely and reliably connect to needed information whether via Internet, cell phone, e-mail, GPS or technology yet to come.

Applications for his team's work are not just defense-related: The European Space Agency is using Schmidt's middleware technology as a building block for the Galileo global satellite navigation system, the continent's own global positioning service. Europe's new CoFlight air traffic management system, which will modernize and unify European air traffic, also uses his middleware technology.

Health care applications exist as well, particularly for medical imaging and picture archiving. Siemens and GE have been shipping medical imaging products based on Schmidt's middleware for over a decade.

"Our ACE and TAO middleware are distributed using an open-source licensing model, similar to the widely used Linux operating system," Schmidt says. Users can also customize ACE and TAO or consult with Schmidt's R&D team for help in converting the baseline open-source middleware into specific applications.

"Smart" is the operative word for another area of research interest. As part of a new course, Schmidt is working with students to build applications that connect smart phones (such as Google Android and the Apple iPhone) to smart communication systems (such as cloud computing, where computing services are provided via the Internet). The project uses hardware and software provided by Google and Apple.

"We're always asking ourselves how to keep students' interest in computing. This is it," Schmidt says. "We give them something technical they can hold in the palm of their hands. We teach them the fundamentals and then we allow them to build on these by developing interesting applications. We want to unleash the creative power of smart students."

servation methods intersect. The behavior of contaminants at the groundwater level also has been a research focus, especially by Hornberger, a University Distinguished Professor and the Craig E. Philip Chair in Engineering.

Across Campus and the Country

In electrical engineering and computer science, Sharon Weiss, assistant professor of electrical engineering, collaborates with Sandra Rosenthal, professor of chemistry in the College of Arts and Science, on nanoscale solutions for energy conversion using cadmium selenide-based solar energy.

J. Michael Fitzpatrick, professor of computer science and computer engineering, has been collaborating with Robert Galloway, professor of biomedical engineering, on image-guided surgeries and therapies for patients with Parkinson's disease. Fitzpatrick also collaborates with the medical center on research involving cochlear implants.

Ron Schrimpf, the Orrin Henry Ingram Professor of Engineering, and Lloyd Massengill, professor of electrical engineering and professor of computer engineering, work on large-scale defense programs, including a life extension program for the Trident missile system. Schrimpf is director of the Institute for Space and Defense Electronics, where Massengill is the institute's director of engineering.

In the information systems area, Bobby Bodenheimer, associate professor of computer science and associate professor of computer engineering, has obtained a National Science Foundation grant to fund a virtual reality laboratory with potential applications in national security, robotics and artificial intelligence.

Creative and Engaged

Kosson says it doesn't surprise him that so many research pursuits of the engineering faculty correspond with the top areas of core competency. "That's what happens when you have researchers deeply engaged intellectually," the department chair says.

Biomedical Engineering Chair Giorgio echoes that statement when he says, "the interdisciplinary nature of what we do makes for great intellectual stimulation."

Dan Fleetwood, chair of electrical engineering and computer science, concurs. "It's hard to find anyone whose research doesn't touch on one or more of these areas of core competency," Fleetwood says, noting that there will always be engineering problems and solutions to be found in these four areas. "These are going to remain critical issues throughout our lifetimes." ●

Focus On the Small Has Big Potential for Energy and Health Care

Cummings

Peter Cummings may know the roads between the Vanderbilt campus and Oak Ridge National Laboratory better than he knows his own neighborhood. Cummings divides his work and time between the two institutions 170 miles apart, focusing on fundamental research in two areas with enormous potential: energy and cancer.

At the same time, as the principal scientist at the Center for Nanophase Materials Sciences at Oak Ridge, Cummings leads planning of the research agenda for a team of 95 researchers and support staff. The center is a U.S. Department of Energy/Office of Science Nanoscale Science Research Center.

And there's more. In April 2009 the White House announced the establishment of a new multimillion-dollar Energy Frontier Research Center at Oak Ridge. The Fluid Interface Reactions, Structures and Transport (FIRST) Center is one of two planned for the facility. Cummings now serves as a member of the FIRST leadership team and as a co-principal investigator. "The center represents an important investment in the basic research that will underpin new energy sources, energy storage methods and energy production techniques," Cummings says.

The technology projects share a core intent. "The work we're doing to understand what happens at the interfaces of different materials is crucial to a huge range of energy problems," Cummings says. "Our work is not very applied—we're working at a level that focuses on understanding very fundamental things that can lead to completely new energy technologies."

Part of Cummings' research focuses on developing theories that will become design tools for molecular electronic devices, which have the potential to replace silicon in future computer chips. Current chip manufacturing methods, based on lithographic etching of silicon, have enabled computer speeds to double every 18 months by carving ever smaller computing elements into the silicon. These methods will reach their limit in the next decade or two, when the etched structures will be too small to be stable.

"With molecular electronics, instead of trying to etch features into silicon, you make devices using a bottom-up technique called self assembly, with computing elements consisting of single molecules," Cummings says. "Our goal is to understand how bottom-up self assembly works and can be controlled."

Understanding from the bottom up is also at the core of Cumming's cancer research. With colleagues in the Vanderbilt University Medical Center's cancer biology department, Cummings upends the traditional model of understanding cancer at the tumor level and instead predicts tumor behavior by understanding and modeling how individual cells within the tumor move and interact with each other and their environment.

Using computer modeling, the researchers focus on the point at which cancer begins to move around the body. "We're trying to understand how the properties of cells and nature of the environment impact whether a tumor will become invasive or not," he says.

"Philosophically at the root of everything I do is the idea of understanding large, complex entities by understanding how the component entities move and interact with each other and their environment."

Undergraduate's Summer Research Is Now in 3-D

by Brenda Ellis

While many undergraduate students went home for the summer to work various jobs or take a break from studying, David Gostin stayed at Vanderbilt, doing research in a lab on the top floor in Olin Hall.

Gostin, a rising senior mechanical engineering major from Dallas, works with Assistant Professor of Mechanical Engineering Robert J. Webster III and graduate student Ray Lathrop, BE'97, his direct supervisors in the Medical and Electromechanical Design Laboratory (MEDLab). Webster's team concentrates on minimally invasive organ scanning using a laparoscope and a laser-based conoscope—a holographic scanner—to produce a three-dimensional image of the human liver.

DANIEL DUBOIS

Mechanical engineering major David Gostin works on a robotic image-guided surgery project as part of the School of Engineering's summer research program for undergraduates.

Lathrop explains that 3-D intraoperative organ surface scans currently require large incisions, while the conoscope technique can accomplish the same objectives through an incision only a few millimeters long. Their experiments have demonstrated the feasibility of a laparoscopic holography-based 3-D scanner for image registration, as well as the feasibility of using an automated aiming mechanism at the tip of the laparoscope.

The current technology of CT scans and MRI allows physicians to look at internal anatomy, but when the time comes for surgery, surgeons must mentally reconstruct 3-D anatomical information from the two-dimensional projections that they have seen.

"If a holographic scanner, which produces a three-dimensional image by recording light scattered from the surface of the organ, could robotically scan organ surfaces through a small laparoscopic incision and align that data onto a segmented CT, then a surgeon could more precisely guide surgical needles into opaque tissue like the liver," Gostin says.

Research to Real-world Use

Gostin is one of nearly 20 engineering students working on research projects this summer as part of the School of Engineering's Summer Undergraduate Research Experience program, which gives undergraduate students the chance to work in the school's labs for 10 weeks. Each student works under the supervision of a faculty member on active research projects, often on teams that include graduate students and other undergraduates. The sponsoring professor pays half of the students' wages and the dean of engineering's office pays the other half.

Webster says that Gostin has done an excellent job on his research project. "He is directly involved in translating Vanderbilt research to real-world use in hospitals. He has worked closely with a startup company that was spun out of Vanderbilt, and his research will be directly used to enhance its product."

Building Confidence, Building Experience

Once considered the domain of graduate students and faculty, research by undergraduates is an important component of the educational experience in the School of Engineering. The undergraduate research activity has been found to increase students' skills, knowledge, confidence, career preparation and likelihood to graduate and go onto graduate school.

Gostin says that his work on the project has been primarily as a software programmer. That is work that might be expected to come to him naturally: both his parents graduated from the School of Engineering with computer science degrees. His father, Gary Gostin, BE'76, is a computer hardware designer at Hewlett Packard and his mother, Janette Strother Gostin, BS'76, majored in computer science and math.

Although using computer languages C++ and LabVIEW were his primary contributions to this summer's research project, Gostin's interest in robotics and mechatronics are a large part of why he wants to continue working with Webster and Lathrop after the summer is over.

"I tell David not to worry. Some projects require software, but mechanical design work is in the very near future for him," Webster says. ●

RESISTING RADIATION

As electronics advance, so do radiation effects and reliability research

by Joanne Lamphere Beckham, BA'62

How do you design a sunscreen for a computer chip? For that matter, why would you need to?

Lloyd Massengill, professor of electrical engineering and computer engineering, has answers, both simple and complex, to those questions. Radiation from as far away as deep space and as close as our sun poses significant dangers to both space-based and earthbound computers that control an enormous array of commercial and military equipment today.

Take, for example, the Hubble Space Telescope. Each time it passes through the Van Allen radiation belt that surrounds Earth, the telescope shuts down due to the radiation—often nine times a day. With no atmosphere in space to filter radiation from galactic objects, both Hubble and the International Space Station are vulnerable to cosmic rays crashing into them at the speed of light and impacting their systems.

On a more everyday level, radiation also threatens Earth-based equipment like missile-guidance systems, supercomputers and telecommunications systems, and even cell phones and iPods. The cost of service interruptions to such systems can run into the millions of dollars.

Massengill and his colleagues in the Vanderbilt Microelectronics Radiation Effects and Reliability (RER) research group study how radiation affects electronics and are working to reduce the damage it causes.

DANIEL DUBOIS

Massengill

The mission of the RER is to help increase the reliability of systems that are exposed to ionizing radiation both on Earth and in space. Because ionizing radiation can liberate energy when it passes through semiconducting material, it can cause havoc with processing equipment.

Dedicated to Microelectronics Research

In addition to his work with the radiation group, Massengill also serves as director of engineering for Vanderbilt's Institute for Space and Defense Electronics (ISDE). The institute is among a handful of contract engineering programs conducting microelectronics research for both military and commercial space applications.

The institute's research has been applied to Trident II ballistic missiles, the James Webb Space Telescope that will replace Hubble, and sensitive medical devices where failures are unacceptable for any reason. ISDE clients include the Defense Department, NASA, Cisco Systems, The Boeing Co. and others.

ISDE engineers use laboratory experiments and computer modeling to simulate radiation effects on integrated circuits which form the nucleus of modern information technology. They also develop tools to analyze circuit design improvements and design radiation-hardened circuits that can resist both single-event and total-dose radiation.

Massengill's area of expertise is the study of single-event radiation that produces soft errors in microelectronics. Soft errors are due to isolated strikes by ionized particles emitted by cosmic rays, high-speed particles discharged by the sun and objects in deep space. Although the effect of single events on a computer is localized and transient, as circuits become smaller, the effect increases exponentially.

Of additional concern is total-dose radiation, which is caused by bombardment over time of subatomic particles released from a variety of sources, including ambient or background radiation on Earth. The accumulated effect of both types of radiation impairs performance and can ultimately destroy the computer.

Smaller, Faster . . . and More Vulnerable

The problem only promises to get worse as computers become smaller and smaller. Many companies are currently building processors at the 45-nanometer level, while others like IBM and NEC are working toward 22-nanometer chips. (A one-nanometer circuit is equal in size to one billionth of a meter.)

"Smaller electronic devices are cheaper, faster and more functional," Massengill says. "However, as these devices decrease in size, they also become more susceptible to radiation. For example, today's desktop computers are quite sensitive to ambient radiation, which is emitted by almost everything around us."

ISDE researchers are developing a variety of approaches to make integrated microelectronic devices more resilient to radiation.

One strategy is to incorporate back-up transistors within the integrated circuits, so that if one part fails, the component itself will still work. The engineers are also working on radiation-hardened circuits that can be produced without expensive changes to the manufacturing process. Such new techniques are being applied to a variety of applications, ranging from inertial guidance systems for the military to communications systems on satellites.

Massengill emphasizes that success and discovery stem from the entire ISDE and RER teams. Although not given to hyperbole, Massengill praises the ISDE staff engineers as "the finest I have ever known" and calls the graduate students with whom he works "the best in the country." In further examples, he highlights the work of colleagues Professor Robert Weller, Associate Professor Robert Reed and Research Associate Professor Marcus Mendenhall, who are developing a world-class single-event analysis computer code that Massengill says is revolutionizing the integrated circuit reliability community. The ISDE director also notes that Professor Bharat Bhuva and Research Associate Professor Tim Holman are devising radiation-hardened circuit designs that are innovative and game-changing. In other important work, he cites RER faculty colleagues: Dan Fleetwood, professor and chair of the Department of Electrical Engineering and Computer Science; Ronald Schrimpf, Orrin Henry Ingram Professor of Engineering and director of ISDE; and Kenneth F. Galloway, professor and dean of the School of Engineering.

Industry-changing Discovery

Massengill's team made an important research discovery recently when they found that single-event particles do not affect a single isolated circuit node in technologies smaller than 100 nanometers. Instead, they actually affect multiple circuit nodes through an effect called charge sharing.

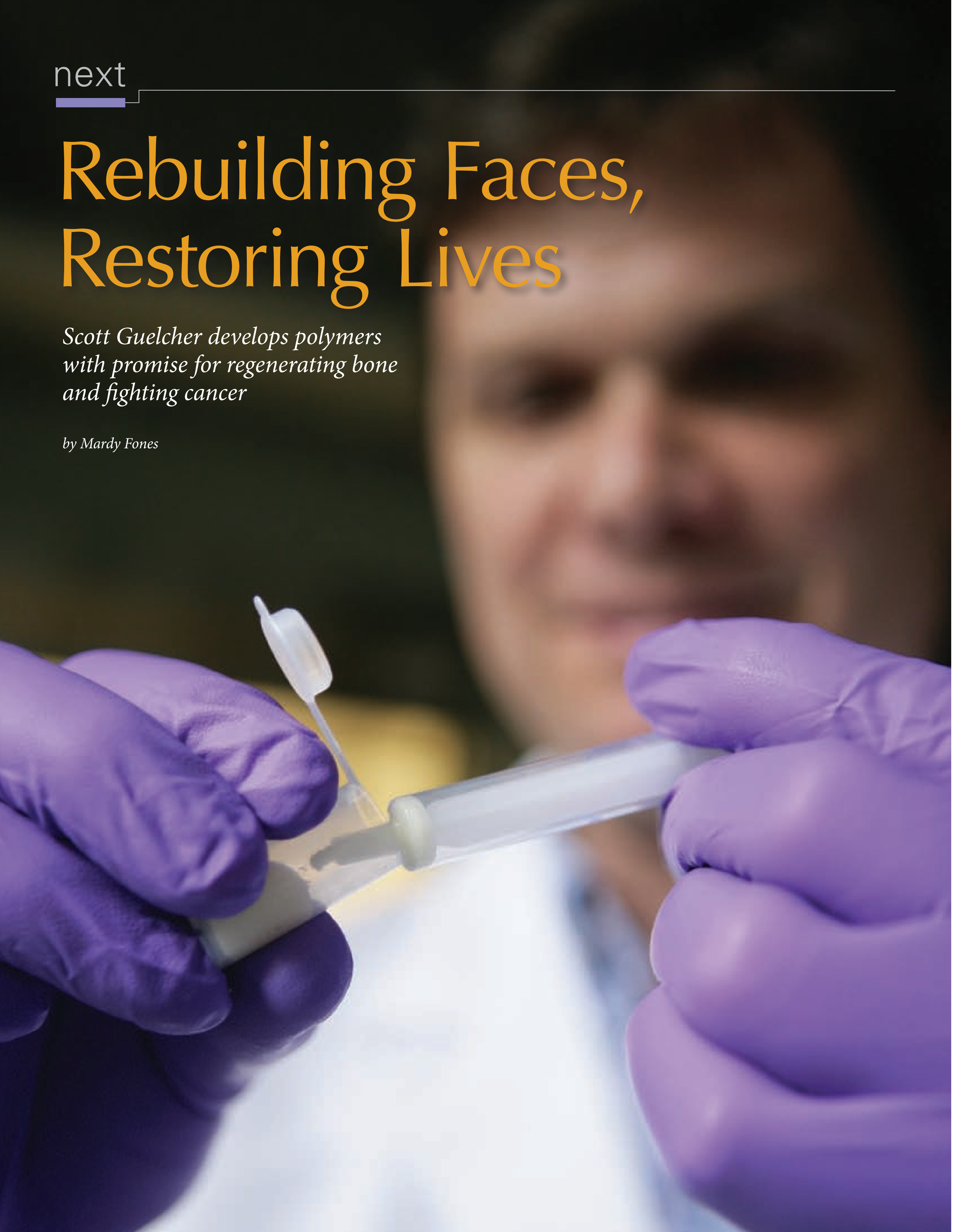
"This discovery explained why certain supposedly radiation-hardened circuits were in fact sensitive to single events," Massengill explains. "The use of separate circuit nodes to protect the signal information was thwarted by charge sharing.

STEVE GREEN

Lloyd Massengill and members of the ISDE team

"We presented our discovery at the International Reliability Physics Symposium and published it in the *IEEE Transactions on Nuclear Science*. It has profoundly affected the design of soft-error-tolerant microelectronics, including the DARPA Radiation Hardened by Design Program." DARPA, the acronym for the Defense Advanced Research Projects Agency, is the Defense Department's central research and development office, and one of ISDE's clients.

Called a research genius by his colleagues, Massengill brings millions of dollars in research grants to the School of Engineering each year. He recently received a $2.4 million grant from the Defense Department's Defense Threat Reduction Agency to analyze the effects of single-event radiation in 45-nanometer integrated circuits and to develop radiation-hardened microtechnologies for spacecraft and satellites.



Rebuilding Faces, Restoring Lives

Scott Guelcher develops polymers with promise for regenerating bone and fighting cancer

by Mardy Fones

DANIEL DUBOIS

War is hard on the human body. Explosions, shrapnel and gunfire are unique in the trauma they inflict, particularly to the head. They also produce injuries that dramatically change lives.

Guelcher

"If a soldier loses a leg, he can get a prosthesis and his injury isn't as evident. But with trauma to the head and face, that's another story entirely," says Scott Guelcher, assistant professor of chemical and biomolecular engineering.

Since his undergraduate days at Virginia Tech, Guelcher has been on the developing edge of the design, synthesis and characterization of polymers and related materials. The promise these materials and Guelcher's research hold for improving the lives of people with injuries and cancer fuels his passion and provides multiple avenues for exploration.

Restoring Faces and Lives

In collaboration with the U.S. Army and civilian medical companies, Guelcher is developing a polymer solution for injuries. The goal is to create biodegradable polyurethane biomaterials that substitute for bone and encourage new bone growth.

Via five-year grants under the Army's Orthopaedic Trauma Research Program and the Armed Forces Institute for Regenerative Medicine, Guelcher is working to rapidly bring to market these polymer-based biomaterials. "One of the most important goals is developing materials that can heal devastating injuries to the face," Guelcher says. In past wars, soldiers with such injuries died. With modern medical treatment, they live, but the options for rebuilding bone and restoring a normal appearance and function are inadequate.

"Currently if damage to the skull isn't too large, a type of calcium phosphate cement can be applied. For larger injuries, where more bone is missing, they can manufacture replacement parts with plastic or metals," Guelcher says.

The problem with these tried-and-true solutions is that the materials don't integrate well with the human body. They break and carry a high risk of infection. "The Army charged us with developing something that is more mechanically robust," says Guelcher.

"Men and women whose lives have been saved face difficult recovery. The Army is allocating extensive resources to regenerative medicine to improve the quality of life of wounded soldiers," Guelcher says. He recalls a soldier whose jaw was damaged in combat. "He told the surgeon if they could just repair his injury so his tongue would stay in his mouth, his life would be better."

Guelcher's work has potential for civil medical needs as well. "The materials we are developing have applicability to civilian orthopedic trauma and metastatic bone disease, where the bone removed or damaged must be regenerated," Guelcher says. "Orthopedic companies will, I believe, continue to invest in development of new therapies to regenerate bone."

In addition to the military grant, Guelcher has a five-year, $500,000 National Science Foundation CAREER grant that dovetails with the Army's fast-track product mandate. "The basic science that leads to understanding and practical application, that's the space I'm working in," he explains. "I'm looking at the fundamentals of polymeric biomaterials using in vitro cell culture techniques to get a better understanding of the biology and mechanisms involved, and how to accelerate and control the integrative and regenerative processes."

Guelcher's NSF work incorporates content for two undergraduate courses. Concurrently he'll develop curricula on bioprocess engineering and regenerative medicine for students in grades 9–12. These materials will be used at the School for Science and Math at Vanderbilt, a part-time public high school joint venture with Metropolitan Nashville Public Schools.

"Students don't get exposed to engineering in high school, so many of them don't consider engineering as a profession," he says. His own taste for chemical engineering was whetted at a science and math high school he attended in Fairfax County, Va.

> "Some people come up with ideas that violate the laws of physics. Scott's full of neat ideas, and each one has merit."
>
> John L. Anderson
> *President, Illinois Institute of Technology*

Guelcher's journey from budding chemical engineer has included jobs with Eastman Chemical Co., where he worked on polymer intermediates, and Bayer Corp.'s polyurethanes division. He holds 12 patents in areas that include bioprocess-engineered products, polyurethane intermediates and polymers that have medical applications.

Creative Collaborations

Guelcher says his move in 2002 from industry to academia has opened new avenues and opportunities to take his work deeper.

"The great thing about Vanderbilt is you get to meet all kinds of people, internationally recognized experts who are collegial and willing to hear about new ideas," says Guelcher, who earned advanced degrees and did postdoctoral work at the University of Pittsburgh and Carnegie Mellon University.

In one collaborative project, Guelcher collaborates with Dr. Greg Mundy, professor of medicine, pharmacology, orthopaedics and cancer biology at Vanderbilt University Medical Center. They are exploring the creation and use of artificial substrates to imitate the stiffness of bone and also softer structures such as breast, lung and liver tissue.

"Scott's work has been valuable to us in trying to understand why some tumors grow so well in bone," says Mundy, the John A. Oates Chair in Translational Medicine and director of the Vanderbilt Center for Bone Biology. "Stiffness makes tumor cells more aggressive. Scott's artificial substrates have enabled us to understand the role the rigidity of bone plays in influencing how tumor cells behave."

Beyond the shared clinical pursuit, Mundy says Guelcher brings a perspective and personal style that fosters a productive lab and creative thinking.

"Scott is smart, even in areas where he isn't trained. And he has insights that differ from ours, so through him, we get a fresh look at the work," Mundy says. The physician says he particularly values Guelcher's industry experience in moving work through patenting and the Food and Drug Administration approval processes. "He has good instincts. When we've confirmed what the problems are, he's good at picking the directions that are blind alleys and the ones that are the right way to go."

Guelcher is also part of a team headed by Dr. Alissa Weaver, assistant professor of cancer biology. He applies his expertise with polymer-based models to advancing her work on the link between dense breast tissue, the rapid progression of cancer and its metastasis to bone.

"Scott is a collaborative person. There's a natural application to the work he does and he's willing to get out of his lab to do it," Weaver says. When Guelcher needed a rheometer to test the substrates he'd developed for her work, Weaver says he wrote a mini-grant to use a device at the Oak Ridge National Laboratory. He then went along to supervise the testing. "He's a hands-on person."

Illinois Institute of Technology President John L. Anderson affirms Weaver and Mundy's assessments of Guelcher. "Scott's a very creative guy," says Anderson, who was Guelcher's mentor at Carnegie Mellon. "He's always looking for applications for his theoretical work. Some people come up with ideas that violate the laws of physics. Scott's full of neat ideas, and each one has merit.

"He's a valuable person in an academic setting because he's creative but also good at theory and fundamentals. At the same time, his experience in industry leads him to always be looking for practical applications," Anderson says. "He has an excellent understanding of the need for the balance of application and theory, plus the mental horsepower to get it done."

Lessons from Industry

Guelcher says that working in industry taught him to refine ideas in the early stages. "I learned early if you can't reduce your work to something that makes products and money, no one cares," Guelcher says. "Here at Vanderbilt, that's translated to bringing scientific knowledge to solve problems while filtering out the constraints and creating a system you can deal with."


DANA JOHNSON

Guelcher collaborates with Dr. Alissa Weaver (right) to study the link between breast density and cancer aggressiveness. Weaver's team members include, from left, Guelcher, research fellow Aron Parekh and graduate student Kevin Branch.

He says he was drawn to Vanderbilt by the School of Engineering's stature as well as the opportunity to raise his family in the South. Guelcher and his wife, Karyn, a native of North Carolina, have six children.

His industry experience also helped him hone his people skills, which translate well to mentoring graduate students. "I had numerous mentors who taught me the importance of thinking beforehand about what you'll say and how the other person may hear it," Guelcher says. "Similarly, with students, you have to refine your approach, to expect mistakes while also tempering your expectations.

"As a mentor, you're teaching them what it means to be a good colleague and to interact with others in a constructive way. It's rewarding when you see them change over time from someone who you have to tell what to do to the point where they are successfully solving problems you never thought of." ●

Unforgettable

Robert E. Stammer Jr.

Associate Professor of Civil Engineering, Associate Dean of Student Affairs for Engineering, 1989-2000


DANIEL DUBOIS

Triple Honors

Recently, Bob Stammer

- was elected by the members of the Southern district of the Institute of Transportation Engineers to a three-year term on the institute's international board of directors.
- received the Herman Hoose Distinguished Service Award from the Southern district of the Institute of Transportation Engineers in recognition of contributions to and leadership in the transportation engineering profession.
- was awarded the School of Engineering's Edward J. White Engineering Faculty Award for Excellence in Service.

by DeWitt "De" Thompson V, BS'95

In the winter of 1993, I was rescued by a small-statured, big-hearted, full-of-energy, academic dean by the name of Bob Stammer. I had entered Vanderbilt's School of Engineering without a strong background in classes from high school, and it did not take long for me to fall into a deep, dark hole academically. I was surrounded by some of the most intelligent kids in the country, and now a sophomore, I was struggling to find my way.

One day while sitting in my dorm room, I got the call that saved my college education. Of course I knew that when the dean of students asked to meet with me in the morning, it likely was not a good omen, but at that point I was ready to face the music. As I walked into his office expecting the worse, I had no idea what a big day it would be for me, not only as a student but well beyond my time at Vanderbilt.

I sat down with Dean Stammer. I was mentally prepared for him to ask me to leave the school, but he asked me what I liked about the engineering school. I struggled to find an answer that satisfied either him or me. He quickly turned his questioning to what I liked about life in general and what got me excited. We spent the rest of our morning talking about all the classes that Vanderbilt had to offer. Dean Stammer listened closely, taking several notes.

The following day he called me back to his office. He had designed a curriculum that he felt I could get excited about, one which was a blend of engineering basics with a heavy focus on business. After seeing my delight, he promptly sent me off to pursue an engineering science degree.

Over the next two and half years, he spent many days with me providing personal tutoring as my engineering skills slowly developed. In the end I managed to balance enough credits in business and engineering to earn a diploma from Vanderbilt. Because Dean Stammer focused upon my strengths instead of trying to fix my weaknesses, he enabled me to see graduation was truly a possibility.

Looking back, I feel that I was very fortunate to be mentored by a professor who was interested enough to help me get back on track. He never gave up on me. It would have been justified and understandable for him to kick me out of school—but he didn't. I will always be grateful to Dean Stammer for believing in me, getting me remotivated and having the patience to see me through the program.

One of the happiest days of my life was getting a signed diploma with an engineering science degree from Vanderbilt. That evening several of us had one heck of a party, and Dean Stammer was the guest of honor.

DeWitt "De" Thompson V, BS'95, uses his engineering and business skills as president and CEO of Thompson Machinery Commerce Corp., founder and chairman of PureSafety, and board member of SouthComm Inc. and the Nashville Predators.

Alumnus Maps the World (and Beyond) with Google Earth

by Fiona Soltes

When Chikai Ohazama graduated from Vanderbilt University School of Engineering in 1994, the world stretched in front of him. Today the world stretches before everyone, thanks to Google Earth and Ohazama, the former biomedical engineering major who helped develop it.

Ohazama

Ohazama, BE'94, used engineering, geographic information system (GIS) technology, 3-D mapping and imagery skills to develop an application that would literally enable people to see the world in new ways. That project became Google Earth, the online service that incorporates satellite imagery, aerial photography and other sources to allow users to pinpoint their houses, grade schools and places they've always wanted to visit.

> "Giving people an experience they had never had before was tempting. And so was the technical challenge."
>
> —Chikai Ohazama, BE'94

Rather than deeming Google Earth's success as a dividing point in his life's timeline, however, the 37-year-old considers it simply a point on a road map. That road map has taken him from studying biomedical engineering to research in 3-D ultrasound visualization to developing Internet technology—and all driven by ideas that interest him.

"I guess the simple answer is that I want to work on stuff I'm excited about," says Ohazama, product manager for Google Earth.

The technology that made Google Earth, originally called Earth Viewer, possible was only just starting to evolve when he began working on its development, Ohazama says. The software compiles vast amounts of data from various sources and crunches it down for delivery online. "At that point, being able to fly through the world in 3-D, using GIS technology mapping and imagery, could only be done with really expensive graphics systems," he recalls. Opportunity came with the expansion of the Internet. 3-D technology became widely available on laptop and home computers. "The idea of taking all of this, and making it accessible to the everyday person, that became pretty exciting to me," Ohazama says. "Giving people an experience they had never had before was tempting. And so was the technical challenge."

Aiming for Academia

That challenge was a far cry from where he thought he'd end up. Growing up in Florida, Ohazama long had an interest in both biomedical engineering and computer science. He came to Vanderbilt because he was, in his words, lucky enough to receive an impressive scholarship and because VUSE was one of the few schools where he could earn an undergraduate degree in biomedical engineering.

"When I was an undergrad, my mindset was that I would be a professor," he says. "I would do some research, I would get my Ph.D., and then be a professor at a university. I never anticipated I would go into industry, working in Silicon Valley."

While at Vanderbilt, Ohazama took classes from Robert Galloway, professor of biomedical engineering in the School of Engineering. He also worked in Galloway's lab.

"Chikai took advantage of the opportunities that Vanderbilt presents, and that's what made him go. It was never, 'Oh, do I have to do this?' It was, 'Cool! I can do that?' With those sorts of people, it's not so much that you mentor them, as much as you just try not to screw them up," Galloway says. "You realize there's something magic there."

When it came time for his doctorate, Ohazama chose Duke, Galloway's alma mater. "He did exactly what I expected he would do at Duke, which was excel there as well," Galloway says of his former student. "With everything he does, he has a willingness to be excited. He has the courage to do new things, and then he has the discipline once he's started to see them through. That sort of combination is remarkably rare."

A New World of Technology

Moving west, Ohazama joined Silicon Graphics in 1998. Two years later, he co-founded Keyhole Inc., where his background in 3-D and medical imaging paid off as he worked on combining geospatial data and gee-whiz graphics. When Google acquired Keyhole in 2004, Ohazama was part of the deal. Now as a director of product management, Ohazama leads the revenue generating efforts for Google Maps and Earth, as well as manages the global high-resolution imagery database and the systems that organize all the geographic information of the world.

These days, Google Earth—now in version 5.0, presenting historical imagery as well as ocean floor and surface data from marine experts—is being utilized in ways Ohazama admits he never imagined.

In addition to humanitarian efforts, such as assisting in fire fighting in San Diego and studying the impact of Hurricane Katrina, he says he's heard of people using the technology to track airplanes in midflight, propose marriage and find unusual things like capsized ships and meteorites. As of mid-2009, Google Earth had received more than 500 million downloads.

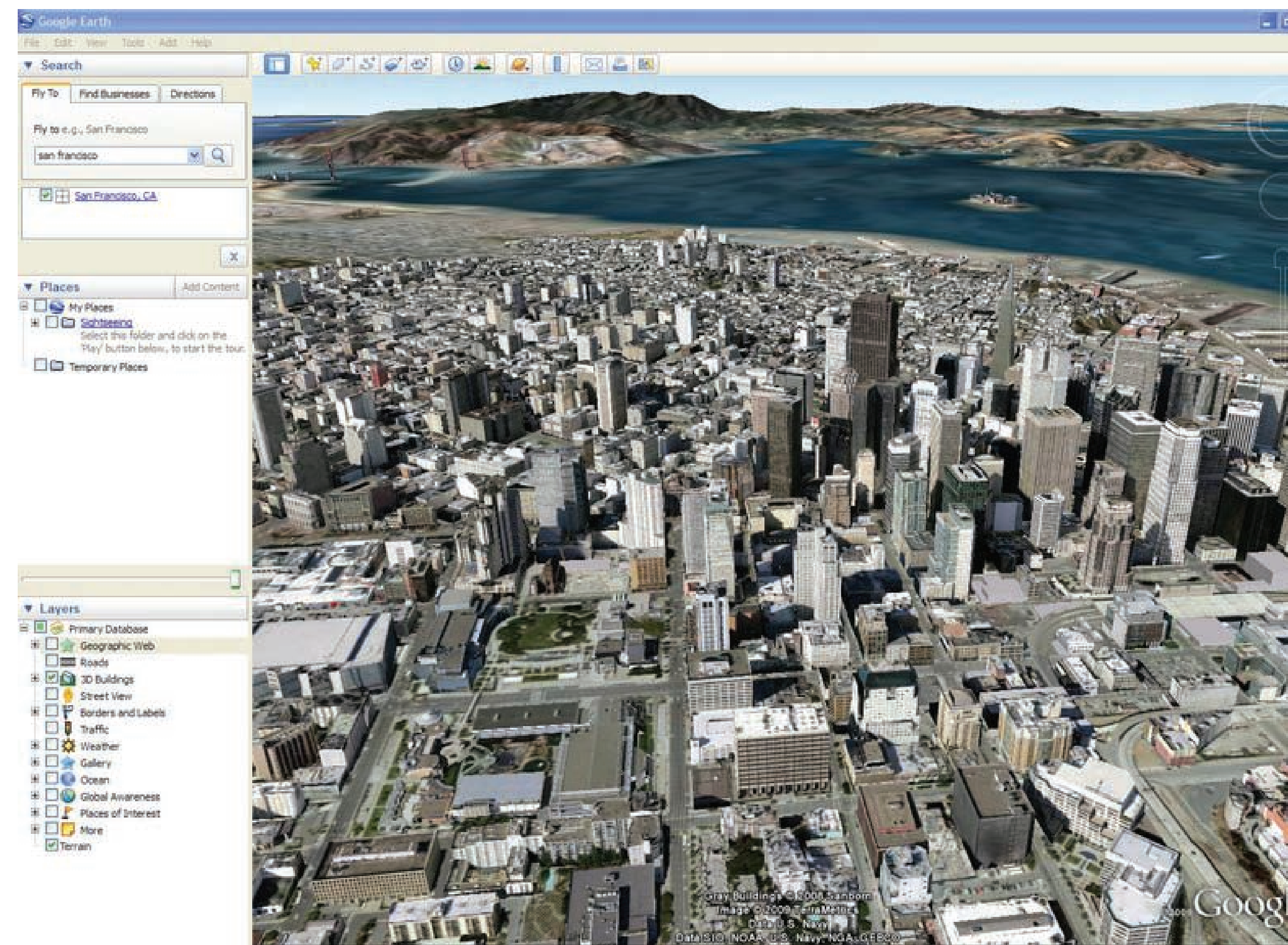
"It's pretty amazing how broadly it's been used," he says.

Mapping His Own Path

Ohazama continues to work on projects he's excited about, both at Google Earth and in his personal life. The one-time biomedical engineering student is a musician, as well, with his efforts available on iTunes. He has written for theater and documentary films and produced a couple of albums: one in a room all by himself, and the other with session players. He's also enjoying being a husband—he married in 2008.

The Internet technology guru is quick to credit his parents with his work ethic, and says hard work and persistence always pay off. But if he has any real advice for others who hope to follow his trajectory to success, it's simply this: "Do what you love."

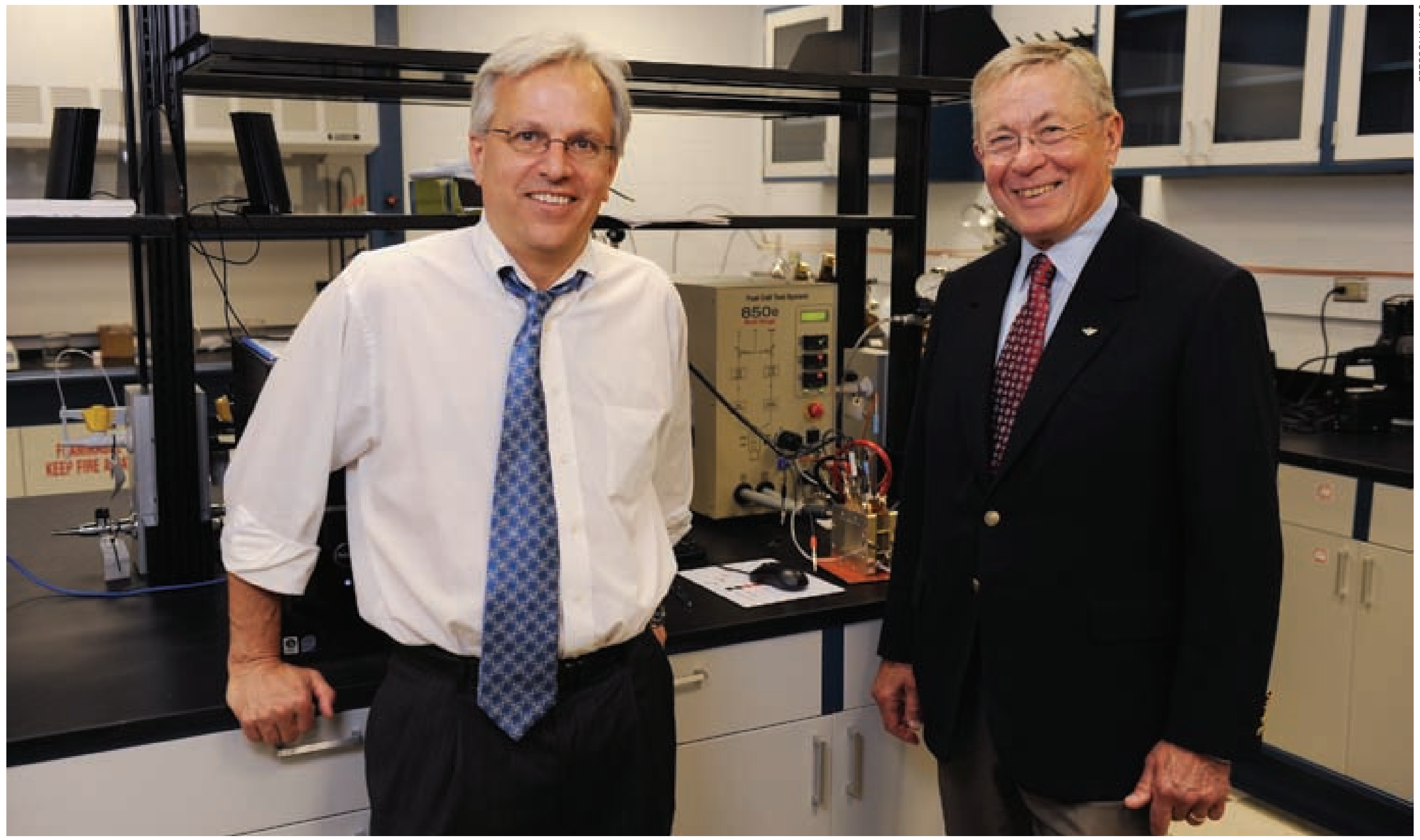
"My theory is that you may do many things that you don't enjoy," he says. "But eventually you will end up doing what you enjoy, because you can't stand not to. So you might as well just go ahead and do it. … Know what excites you, stay true to what you want and keep your eyes open to opportunities." ●



One of the Internet's most innovative new applications, Google Earth, was developed by Chikai Ohazama, BE'94. Google Earth (http://earth.google.com/) makes it possible to see the entire planet (or even just the house you grew up in) in 3-D online.

SCREENSHOT: GRAY BUILDINGS©2008 SANBORN. IMAGE©2009 TERRAMETRICS. DATA U.S. NAVY. DATA SIO, NOAA, U.S. NAVY, NGA, GEBCO

Former Exxon Leader and Chair Holder Have Engineering Chemistry



JOHN RUSSELL

H. Eugene McBrayer (right) and Peter Pintauro, the newly named H. Eugene McBrayer Professor of Chemical Engineering, discuss fuel cell technology in Pintauro's lab.

by Brenda Ellis

Blend early responsibility with a father's Depression-era work ethic and a mother's emphasis on education. Add a competitive nature, a much needed academic scholarship to Vanderbilt University in 1950, and a fortuitous summer job as a junior chemical engineer with Esso Standard Oil Company between junior and senior years.

This formula produces a student from Birmingham, Ala., who earns a bachelor's degree in chemical engineering and a job at graduation in 1954 with Esso in Baton Rouge, La.

For the next 38 years, H. Eugene McBrayer, BE'54, made his career with that company—which would later become ExxonMobil Corp., *Fortune* 500's No. 1 largest American corporation in 2009.

A path that began at Vanderbilt led to a fulfilling career and a blessed life. "It made my life in many ways," says McBrayer, who retired as president of Exxon Chemical in 1992. Now McBrayer and his wife, Fay, have endowed a chair in the School of Engineering as part of their commitment to education and Vanderbilt. "I have been extremely fortunate in life. Now it's time to pay it forward," he says.

Peter N. Pintauro is the first recipient of the H. Eugene McBrayer Chair of Chemical Engineering. The nationally recognized scholar and chair of the Department of Chemical and Biomolecular Engineering says he's honored to hold the chair named after McBrayer.

"Endowed professorships bring prestige to the chair holder, to the benefactor who funded the professorship and to the university," Pintauro says. "Often such chairs are endowed by alumni like Mr. McBrayer, and in this regard, they establish or reinforce critical links between a department's past and present."

Industry Leader

In his career with Exxon, McBrayer moved quickly through the corporation's management ranks, eventually heading Exxon Enterprises, Exxon Nuclear Co. and finally Exxon Chemical. In the year he retired, he was also awarded the prestigious Chemical Industry Medal given by the America International Group of the Society of Chemical Industry.

While leading Exxon's chemical business, he served as chairman of the Chemical Manufacturers Association (now the American Chemistry Council) and as a trustee of the Malcolm Baldridge National Quality Award Program. As an officer of the CMA, he and several other chemical company CEOs launched Responsible Care, which has become one of the most successful safety, health and environmental performance improvement initiatives in American industry.

McBrayer's energy industry background makes Pintauro's honor as the H. Eugene McBrayer Chair even more appropriate. Pintauro's research focuses on developing new membranes for hydrogen/air, direct methanol and alkaline fuel cells; modeling species transport in ion-exchange membranes; and investigating electrochemical methods for organic synthesis.

The biggest impact of this research will be on the performance (power output) of fuel cells, which will lead to less expensive fuel cells. Better membranes will improve fuel cell performance and durability, which will ultimately make fuel cells more attractive for portable, automotive and stationary power applications.

"Both of us share the belief that chemical engineering and electrochemistry will play a major role in the world's energy future," McBrayer says of Pintauro. "Fuel cells have been around for a long time. Their potential energy conversion efficiency has always been compelling; however, high cost has held back widespread application. Research by Peter and his team could significantly rebalance the cost equation and their membrane developments could have significant application in advanced batteries."

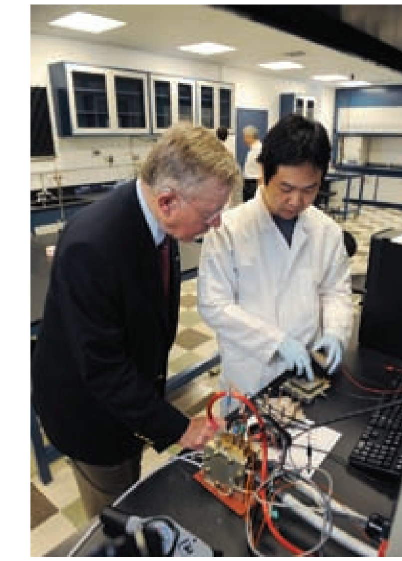
Giving Back

Endowing the H. Eugene McBrayer Chair in Chemical Engineering at the School of Engineering fits nicely into the philanthropic goals of Fay and Gene McBrayer, high school sweethearts who have been married 56 years.

Although they support a number of organizations and causes, the couple has two main philanthropic interests: the Vanderbilt School of Engineering and the Museum of Flight, located in Seattle, where they now live.

"I was so blessed to be able to go to Vanderbilt," says McBrayer, who couldn't have attended the School of Engineering without the academic scholarship offered by the university. "I had to maintain a 2.5 grade point average out of a 3.0 every quarter to keep my scholarship. That was a high standard." He says he had to work hard to keep it while holding a variety of odd jobs and finding summer employment.

A Living Legacy



JOHN RUSSELL

Pintauro team member Jun Lin (right) briefs Gene McBrayer on a fuel cell research project.

The McBrayers have previously supported the School of Engineering through the endowed H. Eugene McBrayer and Fay W. McBrayer Scholarship and through the creation of the H. Eugene McBrayer and Fay W. McBrayer multipurpose room adjacent to Adams Atrium in Featheringill Hall, which was completed in 2001.

"I see this type of gift as a crucial element in student and faculty recruitment and retention," says McBrayer, a member of the School's Academy of Distinguished Alumni. "Vanderbilt engineering has always attracted excellent students, but it needs more endowed chairs to attract the very best faculty and to further important research."

In both his interests at VUSE and the Museum of Flight, the engineer and former corporate head advocates STEM—education in science, technology, engineering and mathematics. And he remains passionate about the power of a chemical engineering degree.

> "I have been extremely fortunate in life. Now it's time to pay it forward."
>
> — H. Eugene McBrayer, BE'54

"Chemical engineering is still a key discipline for young people who want to make a real difference in high-tech society," McBrayer says. "Oh, there may be more popular engineering disciplines today, like biomedical or environmental, but I believe chemical is still the best at teaching young people how to think analytically."

NOTE:
The Fred J. Lewis Society
report (pages 22-27)
only appears in
the print version of
Vanderbilt Engineering.

Opportunity Vanderbilt

Two of Vanderbilt's volunteer leaders discuss the expanded financial aid initiative

DANIEL DUBOIS

Shape the Future **Campaign Chair Rodes Hart, BA'54, and Vice Chair Orrin Ingram, BA'82**

Rodes Hart and Orrin Ingram believe in Vanderbilt. As alumni, trustees, philanthropists and visionaries, they understand the opportunities—and challenges—of eliminating need-based loans and increasing scholarship endowment.

Rodes Hart, who graduated from the College of Arts and Science in 1954 and now serves as chair of Vanderbilt's $1.75 billion *Shape the Future* campaign, joined the Vanderbilt Board of Trust in 1979, becoming trustee emeritus in 2007.

Orrin Ingram received his bachelor's degree from Vanderbilt in 1982. A member of the Board of Trust since 2002, he chairs its Medical Center Affairs Committee and serves as vice chair of the *Shape the Future* campaign. He also chairs the Vanderbilt-Ingram Cancer Center Board of Overseers and the Vanderbilt University Medical Center Board.

These two leaders answered questions about Vanderbilt's commitment to replace need-based undergraduate loans with scholarships and grants—and the $100 million philanthropic effort, Opportunity Vanderbilt, that will sustain this historic expansion of financial aid.

Why is Vanderbilt's expanded financial aid initiative, with its emphasis on scholarships rather than loans, so important?

Hart: It's the right thing to do. Scholarships replace the burden of student loans, and those loan obligations can adversely impact students' career choices or their plans for advanced or professional education. We want to ensure that financial need is not a deterrent for highly qualified students who want to attend Vanderbilt.

Ingram: When a class is made up of individuals of all economic, geographic and cultural backgrounds and experiences, that blend enriches the learning environment for the whole class—and every student.

Opportunity Vanderbilt is seeking $100 million in new gifts to support this financial aid initiative. Why not postpone this, given the current economy?

Ingram: By waiting we could be denying someone who is qualified a chance to attend our university. Though we are certainly mindful of the current economic climate, Vanderbilt's strategic decisions and philanthropic priorities focus on what's important to sustain the university's mission over the long term. And increasing Vanderbilt's scholarship endowment is crucial to that mission.

What has been the School of Engineering's progress toward its Opportunity Vanderbilt goal?

Hart: Engineering has set a goal of $8.5 million for new gifts to scholarship endowment for its undergraduates. To date, $2.48 million in gifts and pledges has been made by alumni, parents and friends.

Why not incur student loans in order to receive an education of the caliber Vanderbilt offers?

Hart: The young people Vanderbilt educates will be the leaders who will guide our country and positively influence societies throughout the world. But debt will influence their choices.

Vanderbilt has been addressing the challenge of student debt for many years, and since 2000, students' loan burdens have been reduced by 17 percent. Scholarship giving to our *Shape the Future* campaign has had a vital role in those debt-reduction efforts, and Vanderbilt's expanded financial aid announcement builds directly on the university's long-term focus on this issue of student debt.

Approximately 61 percent of Vanderbilt engineering students receive some sort of financial aid. And it's important to keep in mind that even as we eliminate loans in our financial aid packages, all families still have an expected financial contribution, and some families will meet that contribution through loans—so this expanded financial aid initiative does not make Vanderbilt cost-free.

How do you think the educational needs of your children and grandchildren are/will be different from those of your generation?

Ingram: Thank goodness I'm not in college right now. When I was in school, I was being prepared to compete with other companies inside the United States. My children are going to have to compete with businesses both within the U.S. and globally.

Hart: When I was in school, we used a slide rule. The tools of today are completely different. To maximize education today and tomorrow, students need a broad educational experience to cope with the fast pace of change and expansion of knowledge.

What makes Vanderbilt an important institution in today's world?

Hart: There's no doubt that Vanderbilt is equipping its students for leadership roles in an increasingly complex world. Students develop the ability to think critically and develop innovative solutions to problems—critical skills that all leaders need.

Ingram: Vanderbilt recognizes that big, important, game-changing breakthroughs and discoveries typically come at the interdisciplinary crossroads. Students can work at the interface of the physical/biological sciences and engineering, or combine their passions for history and economics, or work side-by-side with renowned faculty whose research will save lives. Engineering is one of the ultimate interdisciplinary fields—it takes ideas from all fields and makes them useful, practical, affordable and achievable. All around us, every day, engineering contributes to improving the quality of life, today and for generations to come.

Some might wonder if the School of Engineering really needs their support or whether a small gift can make any kind of difference at a big university with a sizable endowment. What do you tell alumni and others when you encounter that?

Ingram: You'd be surprised at what a difference a little can make in somebody's life. A lot of "littles" can add up to be a lot. Our endowment per student isn't as large as many other schools'—so every penny counts. Vanderbilt receives more than 85,000 gifts each year from alumni, parents and friends who give in amounts from $10 to $10,000.

Hart: Every gift is important and every gift makes a difference. Of course we need large contributions to reach the Opportunity Vanderbilt goal of $100 million and our overall *Shape the Future* goal of $1.75 billion—but we need gifts at every level. When School of Engineering alumni support the school, they're supporting young men and women who will be tomorrow's leaders in a broad spectrum of industries and arenas. These students deserve the best we, as alumni, can offer, and they will take their School of Engineering education, and apply it to the enormous challenges of the future.

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