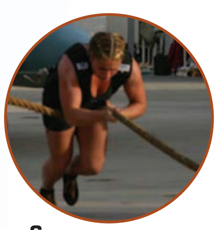
VOLUME 46, NUMBER 1, 2005

ENGINEERING
VANDERBILT

2



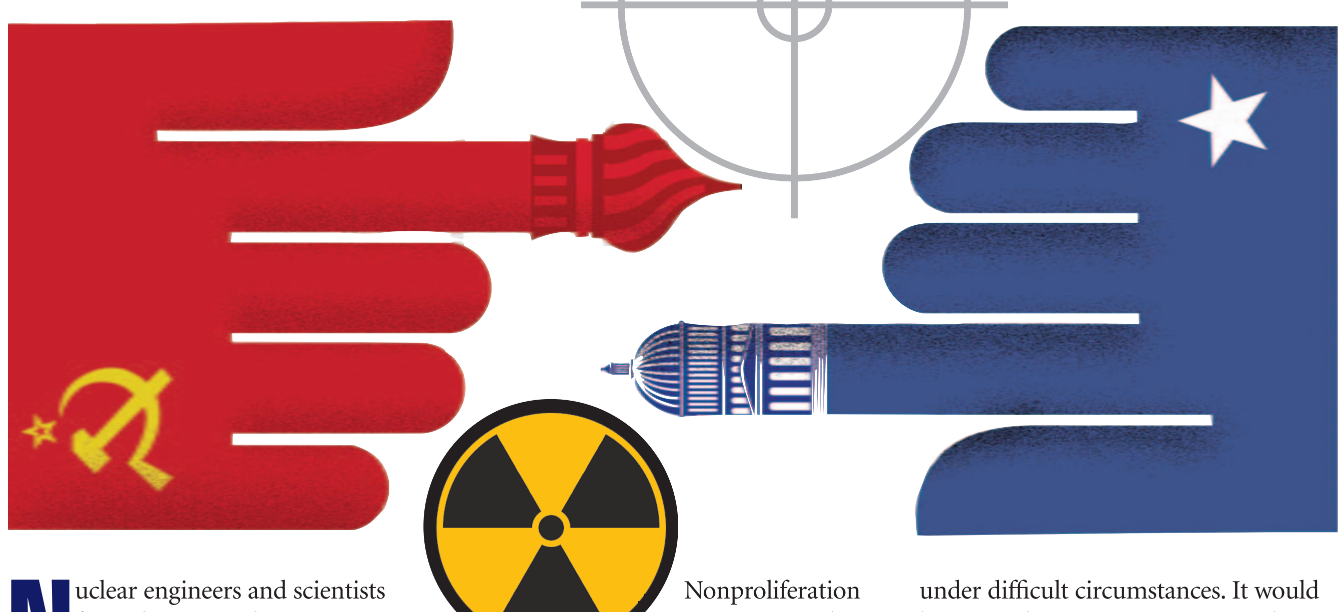
6

8

IN THIS ISSUE

International Terrorism

US & Russian engineers, scientists unite against nuclear threats



Nuclear engineers and scientists from the U.S. and Russia—two nations that for decades faced off with nuclear weapons during the Cold War—sat down together last November at Vanderbilt to join forces against a common enemy: nuclear terrorism.

The international conference brought together some three-dozen Russian and American engineers, scientists and administrators to sharpen strategies to prevent and respond to nuclear terrorist activities.

"Recent events have shown that terrorism has no nationality and is international in its nature," said General Alexander Eliseev, chief of headquarters for civil defense and emergency situations of Moscow City Government.

Terrorist strikes against Moscow included last summer's suicide bombing outside a subway station, which killed 10 people, and the seizing of a Moscow theater by Chechen gunmen in 2002. The subway bombing occurred just two weeks after two Russian passenger jets were downed in terrorist explosions, killing 90.

Agreeing that terrorist attacks involving radioactive material are merely a matter of time, conference participants pooled information and shared lessons gained from nuclear accidents and terrorist acts in the past. By combining resources, the engineers and scientists hope to prevent nuclear proliferation, terrorist deployment of nuclear weapons and mismanagement of nuclear and other radioactive materials.

The conference, hosted by the School of Engineering and co-chaired by Frank L. Parker, Distinguished Professor of Environmental and Water Resources Engineering, and Vladimir Novikov, principal investigator of the Russian Kurchatov Institute, dealt with a wide range of issues and concerns related to nuclear security.

"It is clear that we cannot cover even a fraction of this complex subject," Parker acknowledged at the onset of the conference.

Co-keynote speaker Lawrence J. Satkowiak, program director for Nuclear Nonproliferation Programs at Oak Ridge National Laboratory (ORNL), helped frame the discussion by outlining the multi-faceted problem of nuclear proliferation.

Nuclear Terrorism Threats

According to Satkowiak, the major nuclear terrorism threats can be categorized into four different scenarios:

1) Theft and detonation of an intact nuclear device; 2) Purchase or theft of materials that can be used to construct a nuclear weapon; 3) Attack or sabotage of nuclear facilities; 4) Fabrication and detonation of a "dirty bomb" of radioactive materials.

"Of the four scenarios, detonation of a dirty bomb is most likely," Satkowiak said. "These radiological dispersal devices are more weapons of mass disruption than they are weapons of mass destruction."

> "[Dirty bombs] are more weapons of mass disruption than weapons of mass destruction."
>
> —*Lawrence J. Satkowiak*

While the actual damage from such "dirty bombs" is not expected to be very significant, they are effective in raising levels of fear, he said. Because there are so many sources of radioactive materials in a vast variety of settings, "there is a 100 percent probability that a dirty bomb will be detonated somewhere," he said.

Joseph H. Hamilton, Landon C. Garland Distinguished Professor of Physics and director of the Joint Institute for Heavy Ion Research, agreed that although much effort is needed to keep radioactive sources out of the hands of terrorists, the concern about dirty bombs is out of proportion to the actual threat. "There is an absolute national paranoia about radiation," he said.

Professor David S. Kosson emphasized the importance of correcting popular misconceptions as well as communicating more clearly with the public as events occur.

"Public decision-making must be carried out with public transparency," said Kosson, chair of the Department of Civil and Environmental Engineering. "Our communication is essential, especially under difficult circumstances. It would be a mistake not to communicate how people can respond on an individual basis and to let them know that agencies are taking very specific steps to protect their and the public's health."

Conference co-chair Novikov noted that conflicting needs to keep classified information confidential make it difficult to determine what should be communicated to the public. "There is a necessity to keep information classified about preparedness as much as possible so that it couldn't be used as a road map for terrorists," he said.

Despite such policy-level complications, participants agreed that much can be done to alleviate the threats. Novikov commended Moscow's General Eliseev in leading the effort to locate and secure sources of radioactive materials. "Moscow and the Moscow Region have inherited dozens of nuclear centers and institutions that possess nuclear installations like research reactors, radiochemical labs, thousands of radiation sources and then—as a result of their functioning—temporary storages of spent fuel and sites of temporary storage of radioactive waste."

Much of the conference focused on problems related to accidents or mismanagement of nuclear power facilities and waste. Technical discussions centered on radioactive waste management, transportation of radwaste and cleanup of decommissioned nuclear weapons facilities.

The scientists agreed that further collaboration was needed in order to share knowledge across international boundaries. Several suggested that international organizations—such as the International Institute for Applied Systems Analysis (IIASA), a conference co-sponsor—might serve as a clearinghouse for such information.

In addition to Vanderbilt School of Engineering and IIASA, other conference co-sponsors included the International Science and Technology Center and the University of Medicine and Dentistry of New Jersey.

—*Vivian Cooper-Capps*

Kenneth F. Thomas Jr.

Engineering Alumni Council Wants You

Kenneth F. Thomas Jr., BE'70, has been a member of the Engineering Alumni Council since 2000 and is currently serving as its president. A civil engineering graduate, he is public works division manager of Civil Engineering Consultants in San Antonio, Texas. Ken and his wife, Susan Upshaw Thomas, BA'70, have been active in the Vanderbilt Alumni Association for many years, and have served as co-presidents of the San Antonio Vanderbilt Club. Their daughter, Ashley, received her B.E. degree from Vanderbilt in December 2004.

As president of the Vanderbilt Engineering Alumni Council (EAC), I have had the privilege of seeing first hand the great work being accomplished at the School of Engineering. We have much to be proud of as alumni, including a state-of-the-art engineering facility, exceptional students, and a very talented and dedicated faculty. Under the leadership of Dean Ken Galloway, our school is thriving.

The EAC seeks to support the school's growth and progress in a number of ways:

- Helping engineering alumni continue their association with the school,
- Keeping alumni informed about the school, its faculty, students and programs,
- Promoting a Vanderbilt engineering education, and
- Bringing the ideas, concerns and thoughts of engineering alumni to the faculty and staff of the School of Engineering.

In order to serve the school and its alumni better, the EAC board recently voted to enlarge, broaden and diversify our membership to include more alumni from different geographic areas and engineering disciplines. We hope to achieve this goal through the following reorganization. Beginning in the fall of 2005, the EAC will be led by President Janice Greenberg, BS'80. She will be assisted by four vice presidents: Ron Lewis, BE'93, vice president of corporate relations and career development; Erika Brown Wagner, BE 2000, vice president of student interaction; Steve Lainhart, BE'74, vice president of recruitment/admissions; Kent Shalibo, BE'63, MS'67, vice president of development; and Bill Bond, BE'74, secretary/membership campaign.

These talented people will be working together to expand EAC membership, facilitate contacts between our engineering students and corporations seeking good employees, and increase financial and other support for the school.

All of these initiatives need the help of our alumni to succeed. Together with Dean Kenneth Galloway, we are working to identify alumni willing to serve on the EAC. We want to keep a good cross-section of technical people, but also involve alumni who are pursuing careers in fields other than engineering.

We hope you will join our efforts. If you have a desire to serve the School of Engineering in this way, please contact me at *kthomas@cectexas.com* or Bill Bond at *bbond@environmentaldefense.org.*

I would also be happy to hear any comments or suggestions you might have regarding this or any other area of the school. Together we can work to help Vanderbilt School of Engineering move to a new level in quality, in service and in recognition.

— Ken Thomas

Engineering Vanderbilt, the newsletter of the Vanderbilt University School of Engineering, is published in cooperation with the Office of Alumni Publications for alumni, parents of current students, faculty and other friends of the School of Engineering.

Volume 46, Number 1, 2005

Kenneth F. Galloway, Dean
Art Overholser, Senior Associate Dean
George E. Cook, Associate Dean for Research and Graduate Studies
Katy Brandt, Associate Dean for Administration

Dean's Office: (615) 322-2762

David M. Bass, Associate Dean for Development and Alumni Relations
(615) 322-4934
david.m.bass@vanderbilt.edu

Joanne Lamphere Beckham, Editor
(615) 322-0237
joanne.beckham@vanderbilt.edu

Vivian Cooper-Capps, Information Officer
(615) 343-6314
vivian.cooper-capps@vanderbilt.edu

Keith A. Wood, Designer
Donna Pritchett, Art Director

Neil Brake • Vivian Cooper-Capps • Melanie Catania • Clinton Colmenares • Daniel Dubois • Kara Mann, contributors

Visit the School of Engineering on the Web:
www.vuse.vanderbilt.edu

Vanderbilt University Alumni Publications on the Web:
www.vanderbilt.edu/alumni/publications

Please send news items and changes of address to the editor at
VU Station B 357703, 2301 Vanderbilt Place, Nashville, TN 37235-7703

Vanderbilt University is committed to principles of equal opportunity and affirmative action.

Ask the Faculty

Eric J. Barth

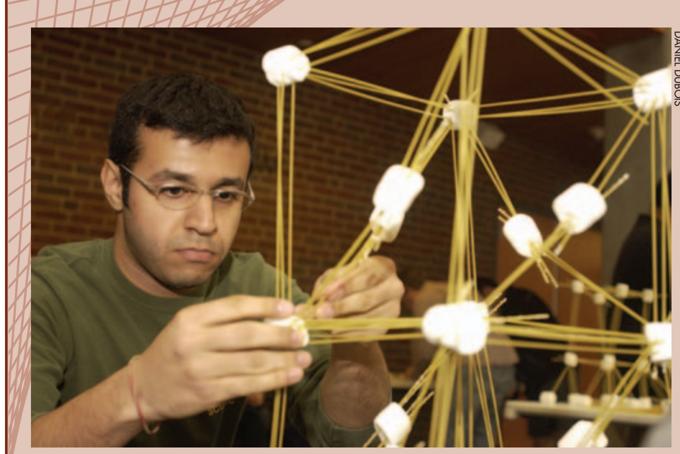
Assistant Professor of Mechanical Engineering Eric J. Barth joined the faculty in 2002. He received a B.S. degree in engineering physics from the University of California at Berkeley in 1994, and M.S. and Ph.D. degrees from the Georgia Institute of Technology in 1996 and 2000 respectively. His research interests include the design, modeling and control of mechatronic systems and actuator development for autonomous robots.

Q: What are some interesting trends in robotics?
A: Entertainment and service robots are a growing trend. Products such as Roomba that will automatically vacuum your house, lawn-mowing robots, and large-scale robots such as Honda's Asimo and Sony's Qrio represent current progress toward everyday robotics. However, we're a long way from the stylish looking, fully autonomous robots seen in movies such as "I, Robot" (or even the first "Star Wars" movie).

"Power autonomy" is perhaps the biggest bottleneck in the development of truly useful robots. The conventional power source and method of actuation for robots are batteries and electric motors. However, batteries are too heavy for the amount of energy they carry, and motors are too heavy and bulky for the level of power they can deliver. This combination leads to a robot that cannot operate sufficiently to do real human-scale work for any useful amount of time.

Q: What is the School of Engineering doing to solve this problem?
A: At the Center for Intelligent Mechatronics within the Department of Mechanical Engineering we are attempting to bridge the gap by replacing batteries with rocket propellant and motors with pneumatic actuators. The rocket fuel, called a monopropellant, stores significantly more energy per unit mass than batteries. When the monopropellant contacts a catalytic metal, it releases hot, pressurized gas that actuates pneumatic piston actuators. This system carries more energy and weighs a fraction of the weight of a comparable battery/motor system. It also demonstrates better energetic performance by more than an order of magnitude than current state-of-the-art robotic power supply and actuation.

E-Week



Engineering Senior Ali Husain concentrates on constructing a tower out of spaghetti straws and marshmallows during the Engineers Week Tower Building Competition. Husain and his teammate Ernie Moore won the competition.

Elizabeth Stevens (left) and team-mate Sarah Rollins construct their entry into the Egg Drop Competition, held Feb. 22 as part of Engineers Week.

Stimulating nerve cells with laser precision

Vanderbilt biomedical engineers and physicians have hastened the day when artificial limbs will be controlled directly by the brain by developing a method that uses laser light, rather than electricity, to stimulate and control nerve cells.

The researchers have discovered that low-intensity infrared laser light can spark specific nerves to life, exciting a leg or even individual toes without actually touching the nerve cells.

"This technique brings nerve stimulation out of the Dark Ages," says Anita Mahadevan-Jansen, assistant professor of biomedical engineering. "Much work is going on around the world trying to make electric nerve stimulation better, but the technique is inherently limited. Using lasers instead, we can simultaneously excite and record the responses of nerve fibers with much greater precision, accuracy and effectiveness."

The method was developed by Mahadevan-Jansen her husband, Duco Jansen, associate professor of biomedical engineering, along with Dr. Peter Konrad and Dr. Chris Kao—both assistant professors of neurological surgery—and biomedical engineering doctoral student Jonathon Wells.

In an experiment with rats, the scientists used a laser to stimulate the sciatic nerve and to control muscles in the animal's hind leg and individual toes, demonstrating accuracy beyond the limitations of electrical stimulation. Immediately following the experiment, the rats regained full use of their legs with no signs of weakness or damage.

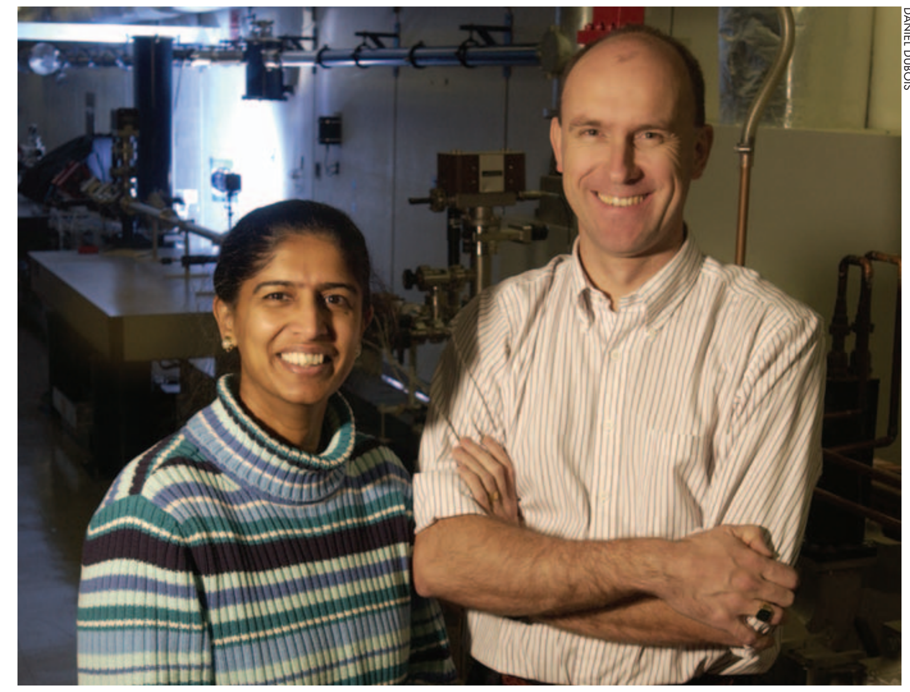
Konrad, who is also director of the Vanderbilt Functional Neurosurgery program, points out that neurostimulation is ideally done cell by cell. "The problem with the conventional electrical method is that we have a large zone around our target neuron that also is affected, simply because of the way electricity travels throughout the tissue. Using light to stimulate neurons, we can pick off a single neuron without affecting the other neurons around it."

In a matter of months, Kao says, a machine could be created that helps guide neurosurgeons to the target nerves during rhizotomy, a procedure that frees someone from a spastic or seemingly frozen muscle.

"This research results from the marriage of biomedical engineering, optical science and neurological research," Mahadevan-Jansen says. "Some programs are working on optics, and some are working on neurological stimulation, but nobody else has put them together."

Imagining future applications, Konrad says he can envision an array of fiber optic threads that runs directly from the brain or spinal cord to a prosthetic arm or leg, creating the ultimate man-machine interface.

—Vivian Cooper-Capps and Clinton Colmenares



Professor Anita Mahadevan-Jansen and her husband, Professor Duco Jansen, have developed a method that uses laser light, rather than electricity, to stimulate and control nerve cells.

Robots by Design

Vanderbilt alumnus Ken Fernandez probably never imagined when he was working on his Ph.D. in electrical engineering in the 1980s that he would one day use his dissertation to help minority students in Alabama solve problems with the space shuttle. But that's just what happened.

Fernandez was named a NASA Administrator's Fellow this year, a program that places NASA employees at historically black colleges and other minority universities, and brings faculty from these institutions to NASA to conduct research. Fernandez was placed at Alabama A&M University, where he used ROBOSIM, the software he helped develop for his dissertation, to teach robotics.

ROBOSIM is a graphics simulation software package that allows students and researchers to design and test robots. It was developed by Fernandez and George Cook, professor of electrical engineering. Cook, who is also associate dean for research and graduate studies in the School of Engineering, was Fernandez's dissertation adviser.

"The problem that most students have is visualizing the robotics systems and applying the transform mathematics, which you have to use to control the robots, to specific designs," Fernandez says. "Graphic simulation allows them to do that very easily. The simulation allows you to test your designs without putting the hardware or yourself at risk."

"ROBOSIM allows us to design a wide variety of robots that we certainly couldn't afford to do if we had to buy physical robots for each of those designs," Cook says. "It's a great tool, and it allows you to visualize very easily things happening in three-dimensional space—that's not easy to do for everyone."

Since 1988, two more of Cook's students have overhauled the software, updating it for modern computers and enhancing its features.

"The original ROBOSIM required $1 million worth of computer equipment," Fernandez says. "Today the performance is much greater and you can run it on a simple laptop."

Fernandez's students at Alabama A&M used ROBOSIM to respond to a finding of the Columbia Accident Investigation Board that recommended NASA develop a means of inspecting shuttle tiles after launch. The board was convened to study potential causes of the explosion of the Space Shuttle Columbia on Feb. 1, 2003, which resulted in the deaths of the seven shuttle crewmembers.

"The students came up with their own designs, wrote up their recommendations and sent them to Houston," Fernandez says. "We had a number of NASA officials in class to hear their final presentations. It was a great experience for the students.

"I find many students really throw themselves into the class and go way beyond what I would have expected because they get very enthusiastic about seeing their concepts materialize, even if it's only a graphic simulation," he continues.

Vanderbilt electrical engineering graduate student Katherine Achim agrees. She used ROBOSIM to develop her final project, the modeling of a robot in the form of a weight lifter, for her robotics class with Cook.

"The software was very helpful in understanding concepts by allowing us to visualize what we were working on," she says. "It is more educational to be able to see what you are designing and transform it from equations on paper to a simulation of a robot."

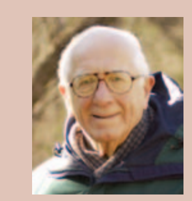
—Melanie Catania

This robotic chess game was designed by graduate student Ridelto Gutierrez "using ROBOSIM for his class project in George Cook's Introduction to Robotics."

Faculty Notes

Leonard C. Feldman, professor of materials science and engineering and Stevenson Professor of physics, and **Dennis Hall**, professor of electrical engineering, professor of physics, and associate provost for research and graduate education, have been elected by their peers as Fellows of the American Association for the Advancement of Science (AAAS).

Lloyd Massengill, professor of electrical engineering, has been elected a Fellow in the Institute of Electrical and Electronics Engineers (IEEE). According to the IEEE, the title of Fellow is bestowed on the recipient who has had an extraordinary record of accomplishments in any of the IEEE fields of interest.



Frank L. Parker, Distinguished Professor of Environmental and Water Resources Engineering, has been named lifetime National Associate of the National Academies for his service as adviser to the U.S. government and the public on engineering, scientific and medical matters. Parker is a member of the National Academy of Engineering and has served on numerous advisory committees, including long-term membership on the U.S. Department of Energy's Environmental Management Advisory Board.

R. Alan Peters II, associate professor of electrical engineering; **Kazuhiko Kawamura,** professor of electrical engineering and computer science, and **D. Mitchell Wilkes**, associate professor of electrical engineering and computer engineering, received the Space Act Award from NASA for their robot control architecture research that could help the agency meet space and aeronautics goals. Peters also received a patent for the research.

Solar Weather

Cosmic rays and solar wind are just two of the invisible but powerful forces that engineers grapple with in designing onboard computers for satellites, the International Space Station, and other space-faring equipment.

When "space weather" gets rough enough to play havoc with our satellites, things don't go well on Earth (please see sidebar, next page). We are increasingly dependent on space-based infrastructure for our communications and defense needs, for everything from cell phones and pagers to weather reports and defense intelligence.

"The Night the Pagers Died" is one example. On May 19, 1998, the Galaxy IV communications satellite, which controlled communications with nearly 90 percent of North America's pagers and several major broadcast networks, unexpectedly died, the victim of "killer electrons" in space.

Interstellar cosmic rays can penetrate a five-foot-thick wall of concrete without really slowing down, so shielding isn't much help against this galactic invader. And they strike at random, hurled from deep space, leaving a cascade of showering atomic particles in their wake as they blast down to Earth. In space, with no atmosphere to hinder them, cosmic rays slam into equipment at close to the speed of light.

That's not the worst, either. For all their potential destructiveness, cosmic rays are but bit players in the drama pitting sensitive microelectronics equipment against radioactive threats in space.

Our radiant sun is the major player, the source of rapidly streaming high-energy-particle "solar wind," unpredictably erupting solar flares. The sun also emits even deadlier, gigantic bubble-like coronal mass ejections packing 10 billion tons of hot, electrically charged gas with more energy than 1 billion megatons of TNT. That's a whole lot of extra energy bombarding delicate microelectronic systems that operate equipment and make decisions on the basis of very tiny electrical charges signaling "on" or "off" states.

Houston, we have a problem.

The Vanderbilt Institute for Space and Defense Electronics (ISDE) is working out solutions. Established in 2003 by the Vanderbilt Radiation-Effects Group, ISDE supports the U.S. Department of Defense in studying radiation effects for defense applications and is one of a few programs involved in microelectronics research for space applications.

Lloyd Massengill, professor of electrical engineering and ISDE's director of engineering, and his team are working on "radiation-hardening by design" techniques.

We are increasingly dependent on space-based infrastructure for our communications and defense needs, for everything from cell phones and pagers to weather reports and defense intelligence.

"Rad Hard"

Professor of Electrical Engineering Ronald D. Schrimpf and his group are delving into unmapped regions of the atomic-scale territory of radiation effects on electronics equipment.

As director of ISDE, Schrimpf is leading the team of engineers in finding ways to make next-generation electronics resilient, or "radiation-hard," in the face of radioactive onslaughts of any kind.

"The good news is that current technology is becoming naturally resistant to 'total dose ionization,' which is what you might think of as background radiation," he says. "As circuits and devices continue to shrink in size, so do the oxide layers within integrated circuitry that ordinarily collect positive or negative charges from radiation over time.

"The bad news is that continued miniaturization results in circuits and devices that are more vulnerable to single-event phenomena like cosmic rays or high-energy protons, and these events are increasingly likely to cause a significant failure within a system or shut it down altogether," he says.

Down to Earth

In fact, ongoing miniaturization of computer circuits is making computers more vulnerable to radiation even on Earth itself.

"Computer chip manufacturers are very concerned about the effects of radiation on microelectronic devices," says Lloyd Massengill, professor of electrical engineering and ISDE's director of engineering. "This problem will become much more significant when the 65-nanometer chip generation comes on the market."

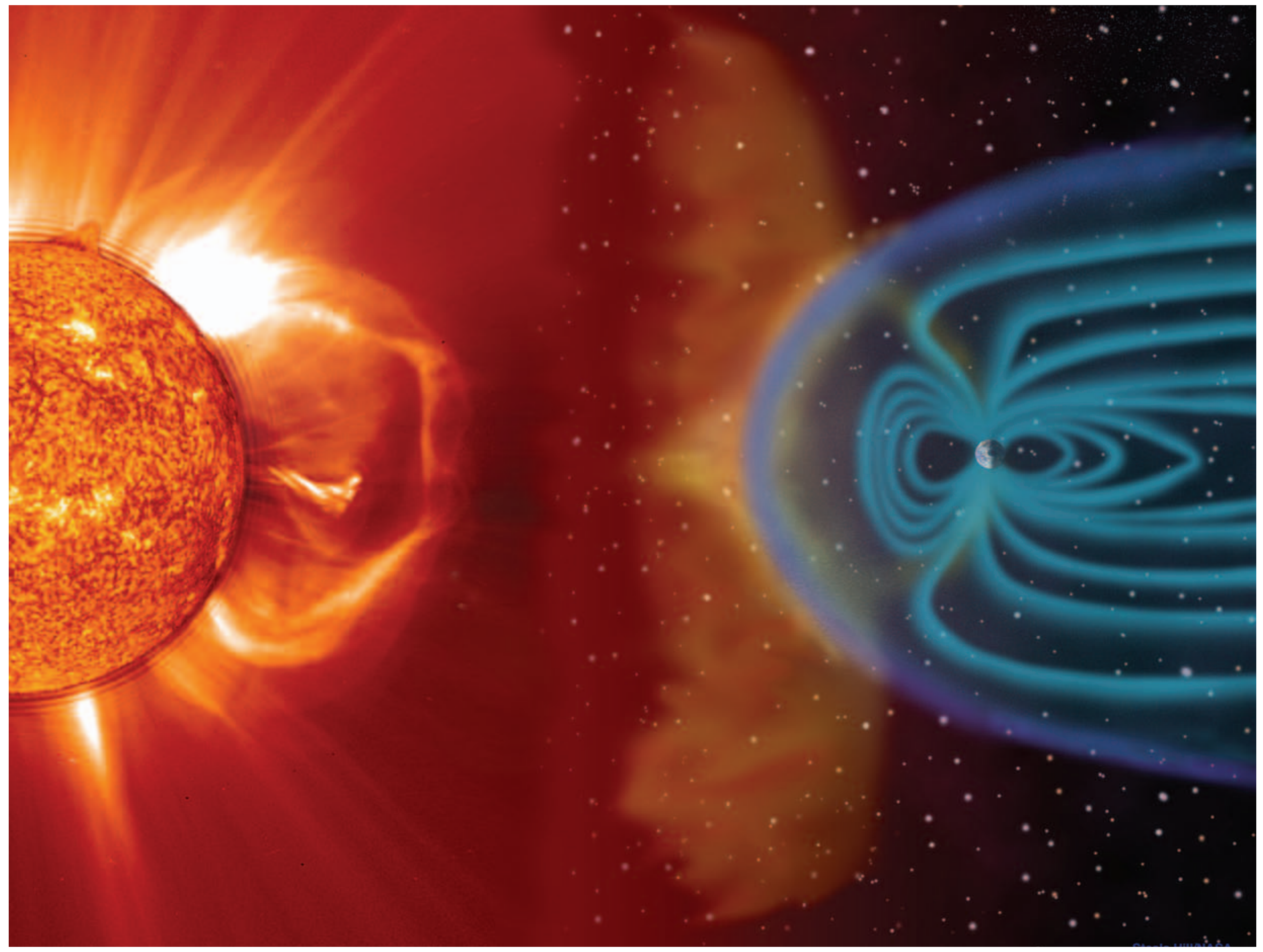
The next-generation technology of tiny, fast and memory-rich computer chips —expected to be available in the next year or so — will have a much greater susceptibility to memory loss, system degradation, or outright failure due to radiation.

Many of these data-corrupting changes from radiation and cosmic rays produce "soft errors" that may be corrected the next time the computer boots up or may be caught by error-detection circuitry or software. Massengill and his team are working on "radiation-hardening by design" techniques that reduce the number of these errors that occur, without requiring expensive process modifications.

"Hard errors" bring the entire system down.

Vanderbilt radiation-effects engineers determine ways to protect integrated circuits and semiconductor devices from radiation by studying radiation effects in the laboratory and by developing computer models and simulations.

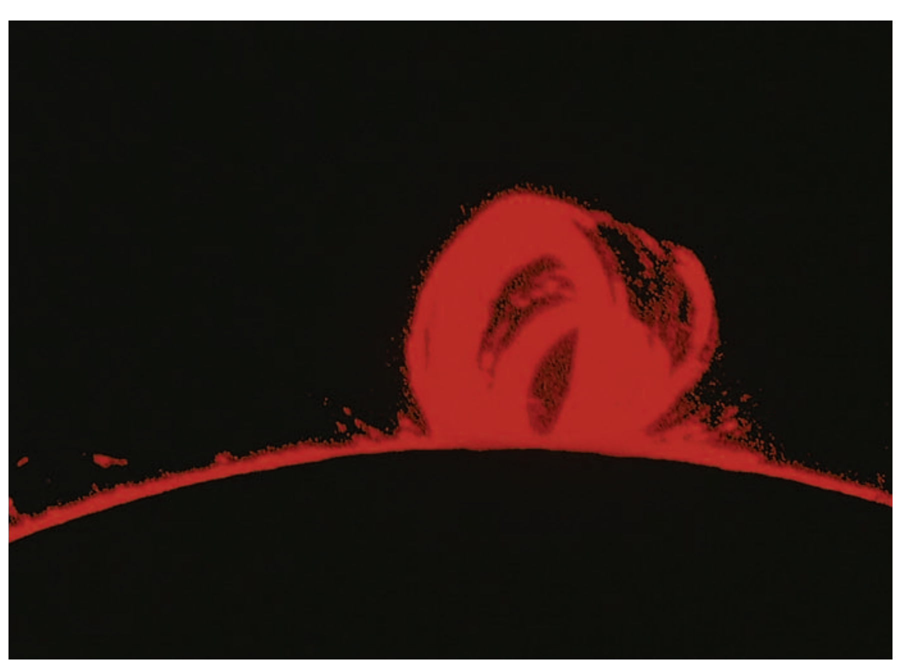
They are exploring the complex dynamics of all significant radiation effects, including the following:



- Total ionizing dose: the charging of sensitive devices by liberated electrons or protons;
- Single-events: cosmic rays, ion strikes, proton strikes;
- Dose-rate effects: high amounts of energy in a given area in a short time, and
- Displacement damage effects: energetic particles displacing atoms in the integrated circuit materials.

Total-dose radiation is caused by bombardment over time of particles or photons, which are emitted from a variety of sources. The accumulated effect of the radiation degrades performance and can ultimately destroy the computer. Single-event radiation is due to isolated strikes by ionized particles, such as cosmic ions. The effect on a computer circuit is localized and transient.

"Everything emits radiation at some level," Massengill explains. "In one famous example many years ago, it was determined that the packaging materials for the computer chips contained trace amounts of system-damaging radioactive residues. They were tracked back to virtually undetectable contaminants in the water supply used in the processing of the packaging compounds."

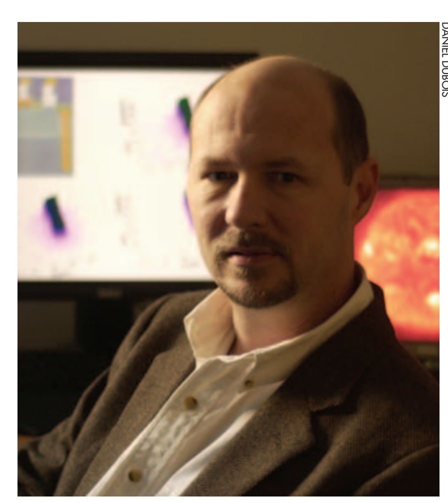


Hardened by Design

The ISDE researchers study the different radiation effects in the laboratory, subjecting devices and circuits to X-rays, gamma rays, and accelerated protons, neutrons and ions.

Computer models and simulations are created to develop a comprehensive understanding of radiation effects on microelectronic devices and circuits.

"We are combining all the different levels of abstraction to give a seamless understanding of radiation effects, from the atomic scale to the system level," Schrimpf says.



Robert Reed, research associate professor of electrical engineering and a former NASA engineer, is working on developing computer tools to predict reliability and survivability of electronics in space.

"As we understand and predict how devices and circuits will behave in different environments through analysis, characterization and modeling, we are better able to make design recommendations that will protect equipment from radiation."

Professor Massengill focuses on circuit design that enables integrated circuits to correct or compensate for radiation damage. Schrimpf is studying transistors and the semiconductor materials of which they are made.

One rad-hard strategy is to incorporate back-up transistors within the integrated circuits, so that if one part fails, the component itself will still work. Since adding transistors adds to the system's complexity, slows it down and increases manufacturing costs, the engineers are evaluating which devices within the complex circuitry are most critical to the mission and most vulnerable to radiation.

"Our computer models simulate radiation effects and help us pinpoint the most vulnerable aspects of specific devices, circuits and circuit designs affected by radiation and potentially most damaging to the entire system if they fail," Massengill says.

The ISDE team is inventing and testing device design changes, such as altering the shape of the device to keep electrical current from leaking at the edges and using different materials. The group is studying silicon germanium bipolar transistors, which are commonly used in amplifiers and high-speed applications such as a radio on a single chip. They are also studying gallium arsenide, to be used in cell phones.

Space and Defense Applications

Because space is such a complex environment, ISDE recruited Robert Reed, research associate professor of electrical engineering and a former NASA engineer, to help develop computer tools to predict reliability and survivability of electronics in space.

He's helping to map the behavior of electronics equipment subjected to solar particles, cosmic rays and trapped magnetic fields of radiation. "The models we were using were based on '70s and '80s technology," Reed says.

He's working with Robert A. Weller, professor of electrical engineering, to develop fundamental physics models that describe and predict radiation transport at the atomic scale.

"The Hubble Space Telescope has to shut down each time it passes through the South Atlantic Anomaly (part of the Van Allen radiation belt that comes closest to Earth), which no one predicted or expected," Reed says by way of example (please see sidebar). "We found that transient radiation events would create a glitch in the infrared camera's optocoupler that shuts down portions of the system. It made it clear that we needed better models," he says.

"No one can tame the sun, but we can develop better predictive tools to deal with space weather and can design more resilient systems that are better prepared to deal with extreme conditions found in space."

— *Vivian Cooper-Capps*

"No one can tame the sun, but we can develop better predictive tools to deal with space weather and can design more resilient systems that are better prepared to deal with extreme conditions found in space."

— *Robert Reed*

Professor of Electrical Engineering Ronald D. Schrimpf is director of the Vanderbilt Institute for Space and Defense Electronics (ISDE).

Storms in Space

"Solar wind" is a highly fluctuating stream of plasma, a slightly magnetized ionized gas that reaches 100,000 degrees Kelvin.

"Solar flares" are explosions on the sun equivalent to 10 million volcanic eruptions.

"Coronal mass ejections" are eruptions of plasma from the sun's corona, or outer atmosphere. They are the largest eruptions from the sun, traveling at 1-5 million miles per hour and carrying 10 billion tons of plasma.

"Van Allen Belts," discovered in 1958 by James Van Allen, are doughnut-shaped rings of hot ionized gas and very energetic particles trapped in the Earth's magnetic fields. The inner belt is about 300-7,000 miles from Earth, while the outer belt stretches from 7,000 to 40,000 miles above the surface.

"South Atlantic Anomaly" is a region in the Earth's magnetic field over South America and the Atlantic Ocean where the lower Van Allen belt is particularly close to the Earth's surface.

Some 600 active satellites orbit the Earth. Between 1997 and 2001, space weather was implicated in more than $500 million in insurance claims for satellite failures.

A coronal mass ejection in 1997 was responsible for destroying the $200 million Telstar 401 satellite, cutting off ABC, Fox, UPN and PBS transmissions to affiliates.

In August 1972, the sun produced an unanticipated series of flares and explosions, including a coronal mass ejection that damaged power facilities and power production in Minnesota, Wisconsin, South Dakota and Newfoundland.

During the Cold War, the U.S. launched a 1.4 megaton nuclear bomb about 300 miles into space. The explosion created new radiation belts about 100–1,000 times stronger than normal space radiation levels, causing three satellites to fail and leading to power surges as well as blown circuits, fuses and streetlights in Hawaii. Residual radiation stayed in the magnetosphere for almost seven years.

From *Storms from the Sun*, by Michael J. Carlowicz and Ramon Lopez.

STUDENTS

Vanderbilt's StrongMann

Challenging stereotypes is nothing new for Kara Mann. Balancing a rigorous Vanderbilt engineering course load with a 475-pound yoke on her back is what keeps this chemical engineering junior on her toes.

In just three short years, Mann has quickly climbed the ladder of success and is now the reigning national champion professional strongwoman in the sport of Strongman (events in speed, strength and stamina). She is an active member in the North American Strongman Society (NASS).

Achievements are what separate Mann from her competitors. She has racked up an impressive array of victories in this male-dominated sport. Mann has displayed a tenacious work ethic that has ultimately led her to success in Strongman and continues to support her academic success in the predominantly male field of engineering.

According to Strongman promoter Art McDermott, Mann has the right kind of makeup and work ethic to be successful. "Kara is extremely athletic and she has the build for this sport," says McDermott, a former Olympian and four-time All American in track and field at Boston University. "You have to have broad shoulders, speed, power and athletic ability. She has a tremendous athletic background and has taken to this sport very quickly. She is a natural at it."

During high school, Mann was a standout three-season athlete. Introduced to Strongman by a friend, she "fell in love with it after I pulled two Ford 350 pickup trucks chained together 50 feet in 30 seconds," she says.

Along with the 2004 national title, Mann set a woman's record by carrying 200-pound cylinders in each hand a distance of 200 feet in 31 seconds at the X-Treme Strongman Showdown in February 2004. Also this past summer, Mann pulled an A-4 fighter jet weighing more than 14,000 pounds a distance of 47 feet in 60 seconds at the California Pro-Am.

Mann accomplished all of this while maintaining a 3.1 GPA and serving as president of Vanderbilt's chapter of the Society of Women Engineers.

"Strongman is similar to engineering," she says. "It's important to surround yourself with positive-thinking people who share your enthusiasm for accomplishing difficult tasks, whether it's holding two Mini Cooper cars up ramps longer than other competitors, or finishing three problem sets, taking a quiz and attending lab on time."

She works out four to five times a week, balancing her cardio exercises with strength routines.

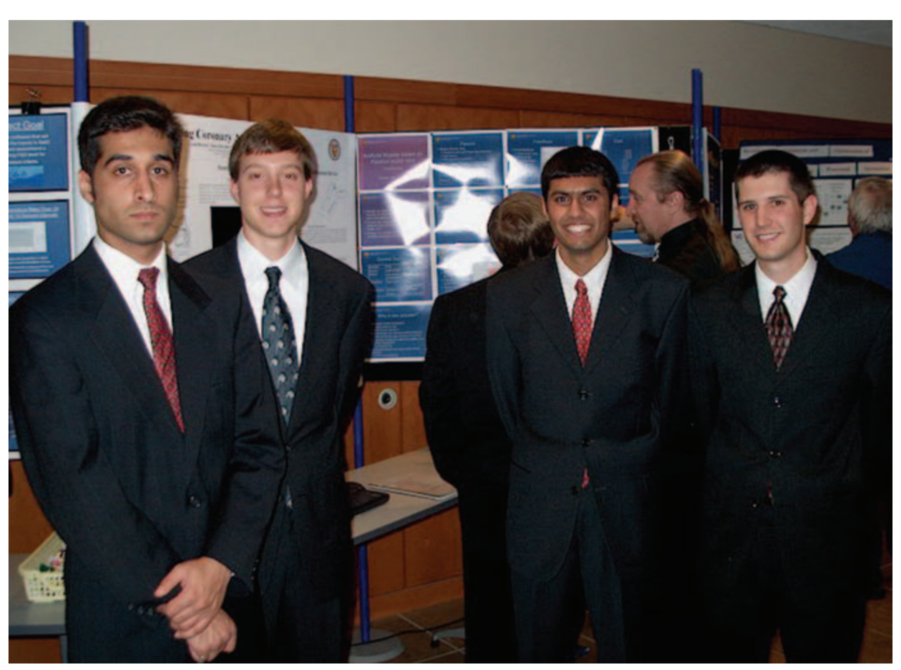
Mann isn't sure where all this will lead, but for now it's her proven formula for success: balancing tough academics with heavy objects.

(left) The A-4 fighter jet Mann is pulling weighs more than 14,000 pounds. (above) Mann set a woman's record by carrying these 200-pound cylinders in the 2004 X-Treme Strongman Showdown.

Students design bypass surgery device

A team of former Vanderbilt biomedical engineering students finished second in the Association for the Advancement of Medical Instrumentation (AAMI) "Young Investigator Competition." Lucas Burton, Amir Durrani, Benjamin Hoagland and Santosh Tumkur invented the award-winning coronary artery bypass graft device as part of the Senior Design Class taught by Paul King, associate professor of biomedical and mechanical engineering.

The team also won an award for undergraduate research at the 2003 national Biomedical Engineering Society meeting in Nashville. All received B.E. degrees at Commencement 2003.



Amir Durrani, left, Lucas Burton, Santosh Tumkur, and Ben Hoagland invented an award-winning coronary artery bypass device when they were biomedical engineering students at Vanderbilt.

Paddling a Concrete Canoe

Each year, the Vanderbilt student chapter of the American Society of Civil Engineers (ASCE) vies with teams from other engineering schools in ASCE's Southeast Regional Conference competition. The team tied for second place overall and won fourth place in the concrete canoe competition in 2004. The four-person race team included civil engineering seniors, back to front, Drew Walker, Kim Beek, Amy Lenhart and Andy Stone. The students are paddling their repaired and renamed concrete canoe, "Vander-re-built."

Doug LeVan, left, J. Lawrence Wilson Professor of Engineering, and Krista Walton, a doctoral student in chemical engineering, graced the cover of the summer 2004 issue of *Space Research*. Published by NASA's Office of Biological and Physical Research, the magazine carried an article that included the Vanderbilt researchers' efforts to produce oxygen from the Martian atmosphere as part of the proposed manned Mission to Mars.

ALUMNI

Hilfiger CEO Named Distinguished Alumnus

David F. Dyer, president and chief executive officer of Tommy Hilfiger Corporation, has been chosen the 2005 Distinguished Alumnus from the School of Engineering.

He received the award Friday, March 11, at the school's annual Leadership Dinner at the University Club.

An apparel and retailing executive with more than 30 years experience, Dyer has served as president of Lands End, Home Shopping Network, and J. Crew Catalog during his career.

Dyer graduated in 1971 with a bachelor's degree in engineering science, and he credits his Vanderbilt engineering education as an important contributor to his professional success. He began his apparel and retailing career with Burdines, a division of Federated Department Stores, where he held a variety of posts for 17 years. He later served as president and chief operating officer of Home Shopping Network and was acting president of J. Crew Catalog as a consultant for Texas Pacific Group.

As president and CEO of Lands' End from 1998 through 2002, he established the company as the largest apparel Internet business in the U.S. and oversaw its sale to Sears, Roebuck & Co. in 2002.

During Dyer's tenure as president of Lands End, *Fortune* magazine recognized the company as one of the 100 best places to work.

In addition to his business and professional achievements, Dyer has retained strong ties to the School of Engineering. He and his wife, former Vanderbilt engineering student Harriet Dyer, contributed to the Featheringill Hall building campaign and established a scholarship for engineering students. Their son, Will, graduated with a degree in engineering science in May 2004.

The Distinguished Alumnus Award recognizes distinguished achievement, significant service, excellent character, and a reputation that reflects well on the School of Engineering. The honoree is chosen by a committee of representatives from the Engineering Alumni Council and the engineering faculty.

— *Vivian Cooper-Capps*

David F. Dyer, BE'71, second from left, received the School of Engineering's 2005 Distinguished Alumnus Award at the Leadership Dinner in March. With Dyer is his family, left to right: son Will, who earned a B.S. degree in engineering science at Vanderbilt in 2004; David's wife, Harriet, E'74; and their son John, a student at the University of South Florida.

Richard Chenoweth, BE'79, is the principal designer for the Washington, D.C., Metro entrance canopies. His four prototypes, one of which is pictured above, won a 2003 Washington chapter AIA award of excellence. He has won similar awards in 2000 and 1997. His firm, Lourie & Chenoweth LLC, is the architect of record for the project.

Steve Lane, BE'78, MS'91, right, executive vice president of Smith Seckman Reid Inc. and president of the American Council of Engineering Companies of Tennessee, presents an $1,000 scholarship from ACEC TN to Adam Crunk, a junior majoring in civil engineering.

Lewis Society helps deserving students

When Walter Yehl thought about studying engineering, Vanderbilt was his first choice among a number of good universities. "My grandfather always told me how great a school Vanderbilt was and how I would be lucky to go there," Yehl recalls. But with eight brothers and sisters, Vanderbilt's tuition seemed out of reach for the Crossville, Tenn., native.

Today, thanks to members of the Lewis Society and a combination of scholarships, loans and work-study, Yehl is enjoying his freshman year at Vanderbilt. He is maintaining a "B" average in his studies and plans to major in electrical engineering.

Yehl is one of many Vanderbilt engineering students who need financial assistance above and beyond what their families can afford in order to attend Vanderbilt. Some need financial assistance to enroll as freshmen. Others may find they have difficulty remaining at Vanderbilt in the face of family financial reversals. Thanks to the generosity of Lewis Society members, such students are able to complete their Vanderbilt educations.

The Lewis Society includes 342 individuals who make five-year pledges or unrestricted gifts of $1,000 or more annually to the School of Engineering. Their gifts, which represent more than 65 percent of the school's annual unrestricted contributions, are used to provide scholarship support for deserving students.

In 1969, a key group of alumni and friends formed the Lewis Society to provide the financial support necessary to secure the school's future as a leader in education and research. They chose the name Lewis Society to honor one of the school's most colorful and beloved deans. Fred J. Lewis served as dean of engineering from 1926 until 1959. He led the school to new growth in many areas. But his greatest contribution was his ability to influence and inspire excellence in his students, both professionally and personally.

Today the Lewis Society carries on Dean Lewis' commitment, passion and intense belief in the importance of engineers to society and the role the Vanderbilt engineer plays.

According to Dean Kenneth F. Galloway, the financial help given by members of the Lewis Society is critically needed by many Vanderbilt engineering students.

"Sixty percent of our undergraduate students receive some form of financial aid," he says. "These students are often the first in their families to attend college, and their families often have limited financial resources. Many of these students have overwhelming financial need. The dean's office uses a significant percentage of generous unrestricted gifts provided by Lewis Society members to increase financial-aid packages and scholarships for these students, who would not be able to continue their engineering educations otherwise."

For more information on how to join the Fred J. Lewis Society, please contact David M. Bass, associate dean for development and alumni relations 615-322-4934 or by email at *david.m.bass@ vanderbilt.edu*

An international flair for engineering

Assistant Professor Florence Sanchez is a native of France teaching engineering in an American university and engaged to marry a Texan.

A petite, vivacious woman with a lovely French accent, Sanchez was born in the south of France, about 15 minutes from Spain and the Mediterranean coast. Like many engineers, she was the first member of her family to earn a college degree.

After earning her Ph.D. in engineering in 1996 from the National Institute of Applied Sciences in Lyon, France, she came to the United States for post-doctoral studies at Rutgers University. "I wanted to gain some experience by doing something different," she says. "I had the opportunity to collaborate with David Kosson, professor of civil and environmental engineering, for six months when he was at Rutgers, but it turned into two-and-a-half years. It was a great experience."

Sanchez returned to the National Institute as a faculty member, but she wasn't satisfied. "Engineering in France does not provide as good of a balance between fundamental and applied research as in the U.S.," she says. "The engineering profession in France wasn't developing fast enough for me."

So when Kosson urged her to join him at Vanderbilt and continue their collaboration, she answered an enthusiastic "yes." She came to Vanderbilt in 2001 as an assistant research professor, and became an assistant professor of civil and environmental engineering on the tenure track in 2003.

Immigrating to the United States involved a cultural change, she says. "It wasn't easy, but I've learned so much." Today, Sanchez is engaged to marry someone she met her first day in the United States — Hamp Turner, one of Kosson's former engineering students who is fluent in French. He now heads his own engineering company, Turner Technology, LLC, focusing on software development, and located in Nashville.

As part of their research, Sanchez and Kosson are designing protocols for the Environmental Protection Agency to monitor the potential for chemicals leaching into the ground water from landfills and during beneficial use of byproduct materials in construction. They have created more accurate tests than the Toxicity Characteristic Leaching Procedure (TCLP), which the EPA has been using to predict chemical reactions involved in mixing different kinds of wastes in a given landfill. Sanchez is also evaluating the use of recycled concrete in road construction and the long-term performance of cover systems for nuclear waste landfills.

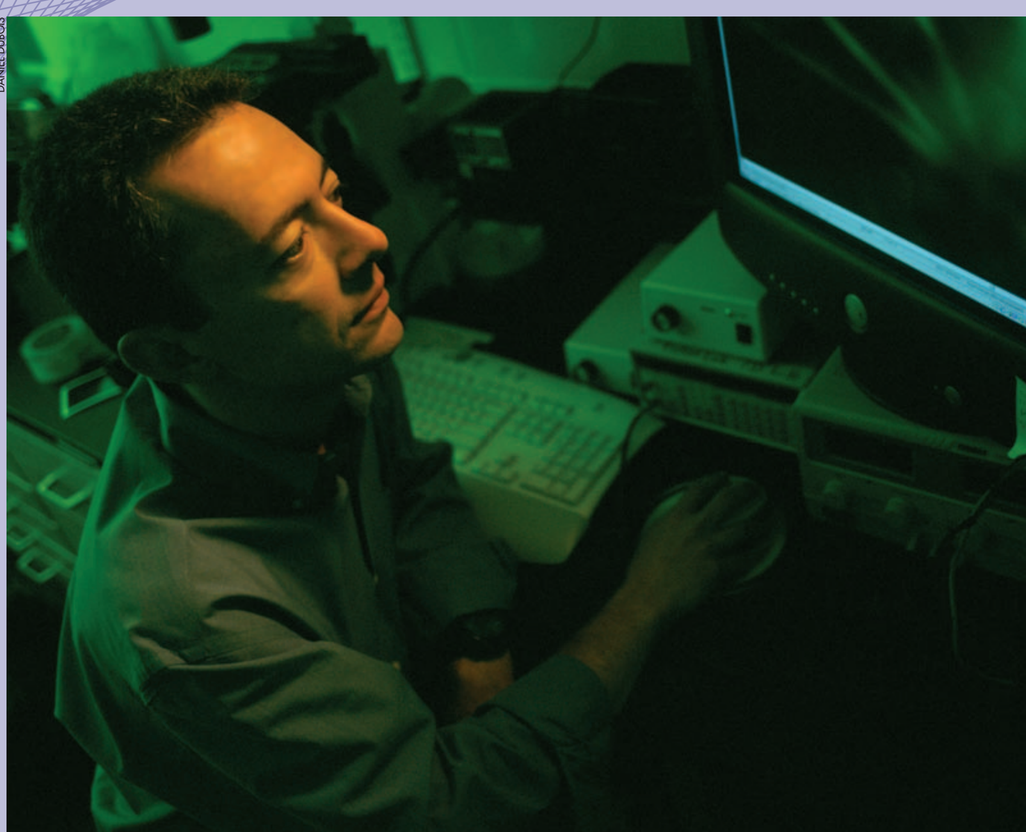
When she isn't teaching or working on her research in her office in Jacobs Hall, Sanchez likes to decompress by running and exercising at the gym.

—Joanne Lamphere Beckham

DANIEL DUBOIS

Assistant Professor Florence Sanchez stretches before running, one of her favorite ways to unwind.

TECH TIME



DANIEL DUBOIS

Professor Todd D. Giorgio and a team of biomedical engineers at Vanderbilt are developing novel ways to infiltrate the nuclei of cancerous cells and deliver a knockout punch of chemotherapy more effectively than conventional methods, with few side effects. The team of researchers in nanoscience, genetic engineering, molecular biology, physics and medicine has discovered five previously unidentified molecules that can penetrate cancer cell nuclei. In fact, the first one of these new molecules that the team tested has already proven its potency by successfully bypassing defenders and depositing the payload in the cancer nuclei. The team has also found ways to detect breast cancer in the very early stages of the disease, using coated gold nanoparticles that are taken into breast cancer cells, where they can be easily imaged with current mammogram and CT technology. And to target even earlier stages of the disease, they are developing an at-home breast cancer test that could be used much like a home pregnancy test.

Vanderbilt University
School of Engineering
2201 West End Avenue
Nashville, TN 37235

Nonprofit Org.
U.S. Postage
PAID
Nashville, TN
Permit No. 1460

ENGINEERING
VANDERBILT