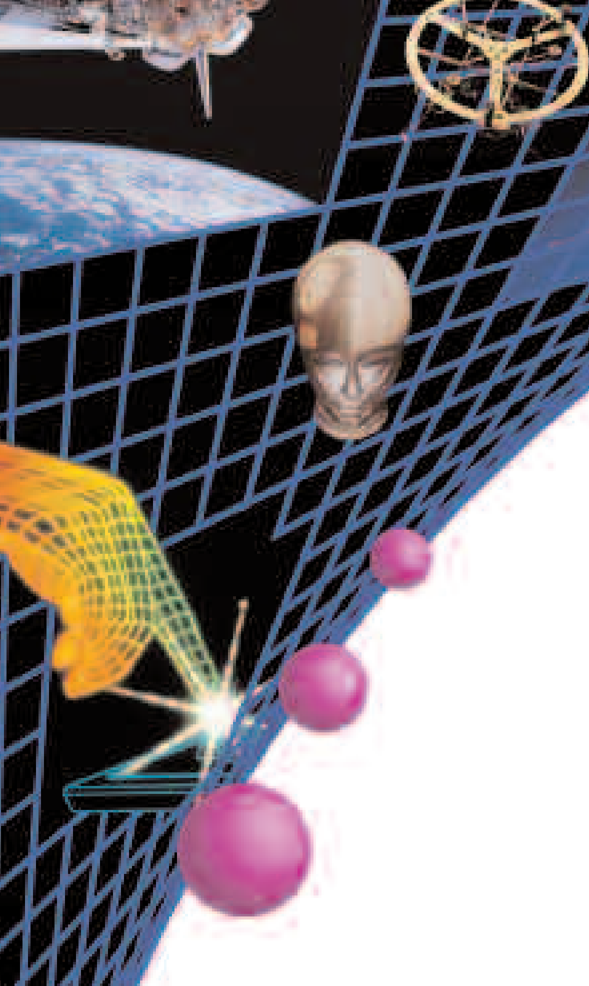

Volume 45, Number 2, 2004

ENGINEERING
VANDERBILT

Brainpower

Teamwork improves ability of nerve cells to discriminate

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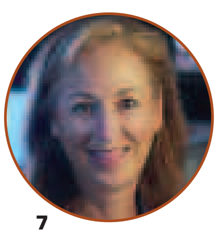

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8

IN THIS ISSUE

2 Campaign chair: Engineering 'on a roll'

3 Rogers receives Presidential Award

4 Faculty engineer risk and reliability

6 "What kind of machine are you?"

7 Alumna oversees healthcare technology

8 Music, engineering & fireflies

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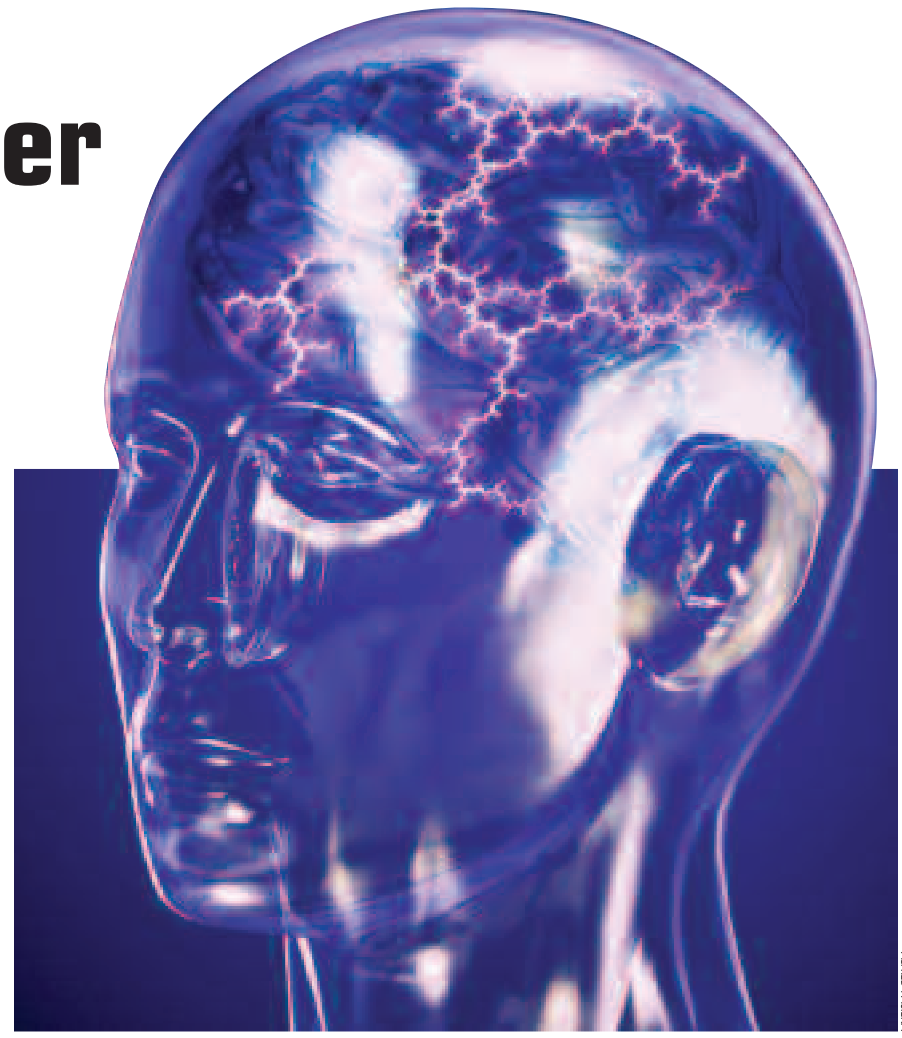


ALFRED PASIEKA

Teamwork is just as important in your brain as it is on the playing field.

A new study published online by the *Proceedings of the National Academy of Sciences* reports that groups of brain cells can substantially improve their ability to discriminate between different orientations of simple visual patterns by synchronizing their electrical activity.

The paper, "Cooperative synchronized assemblies enhance orientation discrimination," by A.B. Bonds, professor of electrical engineering, provides some of the first solid evidence that the exact timing of the tiny electrical spikes produced by neurons plays an important role in brain functioning. Bonds is also professor of computer engineering and of biomedical engineering.

Since the discovery of alpha waves in 1929, experts have known that neurons in different parts of the brain periodically coordinate their activity with their neighbors. Despite a variety of theories, however, scientists have not been able to determine whether this "neuronal synchrony" has a functional role or if it is just a by-product of the brain's electrical activity.

Until recently, studies have focused on the firing rate of brain cells as the basic unit of information—the bits and bytes—used by our organic computer. The reason for this fixation was evidence that the firing rates of sensory neurons contain important information. For example, the higher the firing rate of the pain-sensing neurons in the back of your hand, the greater your brain's perception of pain in that location.

"We are exploring how information is represented by the brain," says Bonds, who coauthored the paper with graduate students Jason Samonds and Heather A. Brown and research associate John D. Allison.

"One representation is the firing rate of individual nerve cells, but this does not acknowledge the intricate network structure of the brain, where each cell is connected with 1,000 other cells, on average. One way of representing information that depends on this network structure is the degree of 'agreement' between groups of brain cells. That is what we have found in the form of the synchronous behavior of groups of cells."

"For the last five years or so, a growing number of people have been exploring the theoretical possibility that the timing of the arrival of electrical spikes is useful for performing neural computations," says David Noelle, assistant professor of computer science and psychology, who did not participate in the study. "The Bonds paper can be seen as the first step towards providing a test of these theoretical models."

Scientists studying vision have known for some time that different groups of neurons in the visual cortex respond selectively to the way in which objects are oriented. For example, when a subject views a horizontal bar, one group of neurons begins firing, while a different group begins firing when the bar becomes vertical.

"People have the ability to discriminate between orientations that differ by only a third of a degree. That is pretty remarkable when you consider that individual neurons normally don't respond to changes in orientation of ten degrees or more. It is even more amazing when you stop to think that a neuron is basically a little sack of salt water," Bonds says.

Until recently, attempts to study interactions between groups of neurons have been hindered by the fact that researchers were limited to using single microelectrodes to measure electrical activity. Although this technique does a superb job of recording the electrical activity of one or two neurons, attempts to use it to record the activity of a larger number of neurons at the same time have had limited success. (The other major method for mapping brain activity—functional MRI—measures chemical changes in the brain, not electrical ones, so it cannot be used for this purpose.)

Samonds and Bonds used a new technology that employs an array of 100 microelectrodes, which can monitor the activity of dozens of neurons at a time. The researchers used this array to monitor the activity of neurons in the visual center of heavily anaesthetized cats. (The same basic technology was recently approved for clinical trials in paralyzed patients. The goal is to determine if the chip can be implanted in a way that will allow them to control a computer with their thoughts.)

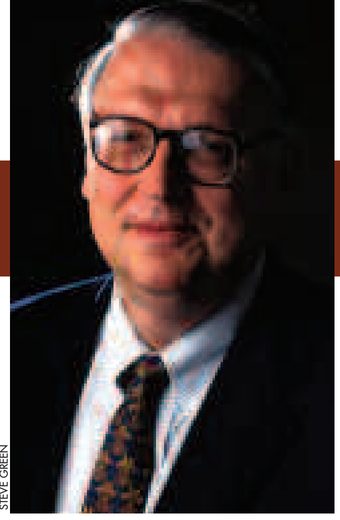
When they presented subjects with grid patterns at different orientations, the researchers found that groups of about six neurons would synchronize their firing rate for different orientations and that these groups exhibited an ability to discriminate between variations in orientation as small as two degrees, about five times better than individual cells.

"The size of the groups that we can observe was limited by the size of the electrode array," says Samonds.

"Currently, we can monitor about 50 neurons at a time. Synchronization among larger groups should allow higher levels of precision, but we don't have enough data yet to predict the number of cells necessary to achieve the level of discrimination that many animals possess."

The researchers also have found that gamma waves—the 30 to 60 Hertz waves that appear everywhere in the brain—may play a key role in this mechanism. They have determined that the neurons respond to a new pattern by synchronizing their activity. When the gamma oscillations are present, the synchronization is maintained 100 percent of the time, but when gamma waves are not present, the synchronization breaks down within a few seconds. This study was supported by a grant from the National Institutes of Health.

—*David F. Salisbury*



STEVE GREEN

William W. Featheringill

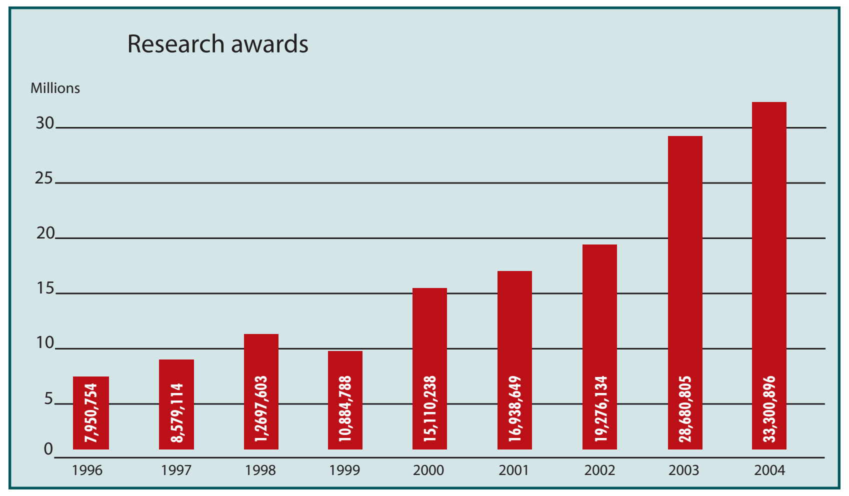
School of Engineering 'on a roll'

Alumni help needed to continue progress

The Vanderbilt School of Engineering is really on a roll, and I want everyone to know about it!

I admit that I was pretty skeptical several years ago when Dean Galloway introduced his dream of expanding and improving every aspect of the school, from faculty to facilities. But after he finished explaining his plan of how he would accomplish his goals and what it would mean, I became convinced that he would be successful, and I've never been sorry I signed up to help.

It has been a privilege to serve as chair of the School of Engineering campaign committee as part of the "Shape the Future" campaign for Vanderbilt. It's been exciting to be part of the fantastic improvement the school has experienced under Dean Galloway's leadership.



Let me tell you some of the good news.

The academic credentials of freshmen students entering the School of Engineering are at an all-time high, as indicated by SAT scores. We have enjoyed a steady increase of average SATs over the past five years, and our incoming freshman class of about 320 has a record-breaking average SAT of around 1370. Our undergraduate students are among the very best at Vanderbilt.

The school continues to recruit and cultivate bright young faculty. Eight of our young faculty members recruited to the school in the past five years have won "young investigator" awards from the National Science Foundation, the Army Research Office, or the Office of Naval Research *(please see related articles on page 3).*

The school continues to attract seasoned senior faculty, known nationally and internationally for their work: Professors Dan Fleetwood, Ron Schrimpf, Peter Cummings, David Kosson, Doug Schmidt, and Doug LeVan are some of the superb senior professors who have joined our faculty in the past few years.

While I'm bragging on the faculty, let me announce that they have achieved ***unprecedented success in winning external research awards.*** These awards support research, laboratories, graduate students and undergraduate students. In the 2003-2004 fiscal year, new awards amounted to slightly more than $33 million, more than double the figure from five years ago *(please see graph).*

In addition to constantly advancing the school's academic strength, Dean Galloway has also been the prime mover in achieving the milestone of building Featheringill Hall and renovating Jacobs Hall. For two years, students and faculty have enjoyed new and renovated space that is both beautiful and highly functional. We have many of you to thank for that achievement, for it would not have been possible without your contributions.

Friends and fellow alums, I think we can agree that the school is presenting a solid picture of success in establishing a track record that deserves our investment and support.

But, we need your help. With a push from us, our school can move to the next level in quality, in recognition and in service. I have no doubt that, with the additional resources and an already-demonstrated track record, we will make even greater progress. This is what the "Shape the Future" campaign is all about.

Here are our areas of need: Almost half of our engineering students require need-based financial aid to attend Vanderbilt. Other universities are constantly trying to woo our excellent faculty members, and we need to work to retain them. We have some terrific new academic facilities, but we still have serious needs. (We need yet another new building for engineering at Vanderbilt.)

I can tell you that the need for your support is genuine—to establish scholarships, to create faculty chaired positions, and to build new facilities. There are many ways you can help: increase your annual giving, remember the school in your bequests, or establish an endowment.

SHAPE THE FUTURE

I firmly believe that the School of Engineering represents a great investment—for the future of our University and for the future of our nation. I'm excited about it, and I hope you get a chance to be as involved in the ongoing success of the school as I have been.

I urge you to join us to "Shape the Future."

— *William W. Featheringill*

William W. Featheringill graduated in 1964 with a bachelor's degree in mechanical engineering. He is president of Private Capital Corporation in Birmingham, Ala., and a member of the Vanderbilt University Board of Trust.

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Army funds nanotechnology program

The School of Engineering will lead a new multi-institutional nanotechnology program funded by the U.S. Army Research Laboratory to develop radically improved electronics, sensors, energy-conversion devices and other critical defense systems.

The Advanced Carbon Nanotechnology Research Program will explore various nanostructures of carbon, including diamond, at the molecular level to develop next-generation materials for use in a wide range of defense devices and systems. The Army Research Laboratory funds will support the program's first year of operation.

"Nanoscale" describes objects that measure approximately a millionth of a millimeter, or roughly 1/100,000th the diameter of a human hair.

"The goal of this cutting-edge research is to gain control of structures and devices at atomic and molecular levels and to learn to efficiently manufacture and use these devices," says Jimmy L. Davidson, principal investigator of the new program.

Davidson, professor of electrical engineering, will coordinate the research efforts. In addition to Vanderbilt, the University of Kentucky, North Carolina State University, the University of Florida and the International Technology Center will participate in the program.

Davidson points out that, although carbon is the most versatile of elements and the foundation of most fuels, synthetic materials and biological systems, little is known about its behavior at the nanoscale level.

"Using carbon as a building block in this promising new area of science is a potentially boundless resource not sufficiently explored in today's research endeavors," Davidson says.

In addition to conducting research into carbon-based nanotechnology, the new program will train graduate students to work in the emerging field and will establish close interactions among U.S. industry and government laboratories.

Initial goals include developing diamond/carbon nanostructures for biological and chemical sensors, constructing a new energy-conversion device, and devising electron emission devices for advanced electronics.

The research is sponsored by the Army Research Laboratory under Cooperative Agreement Number W911NF-04-20023. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government.

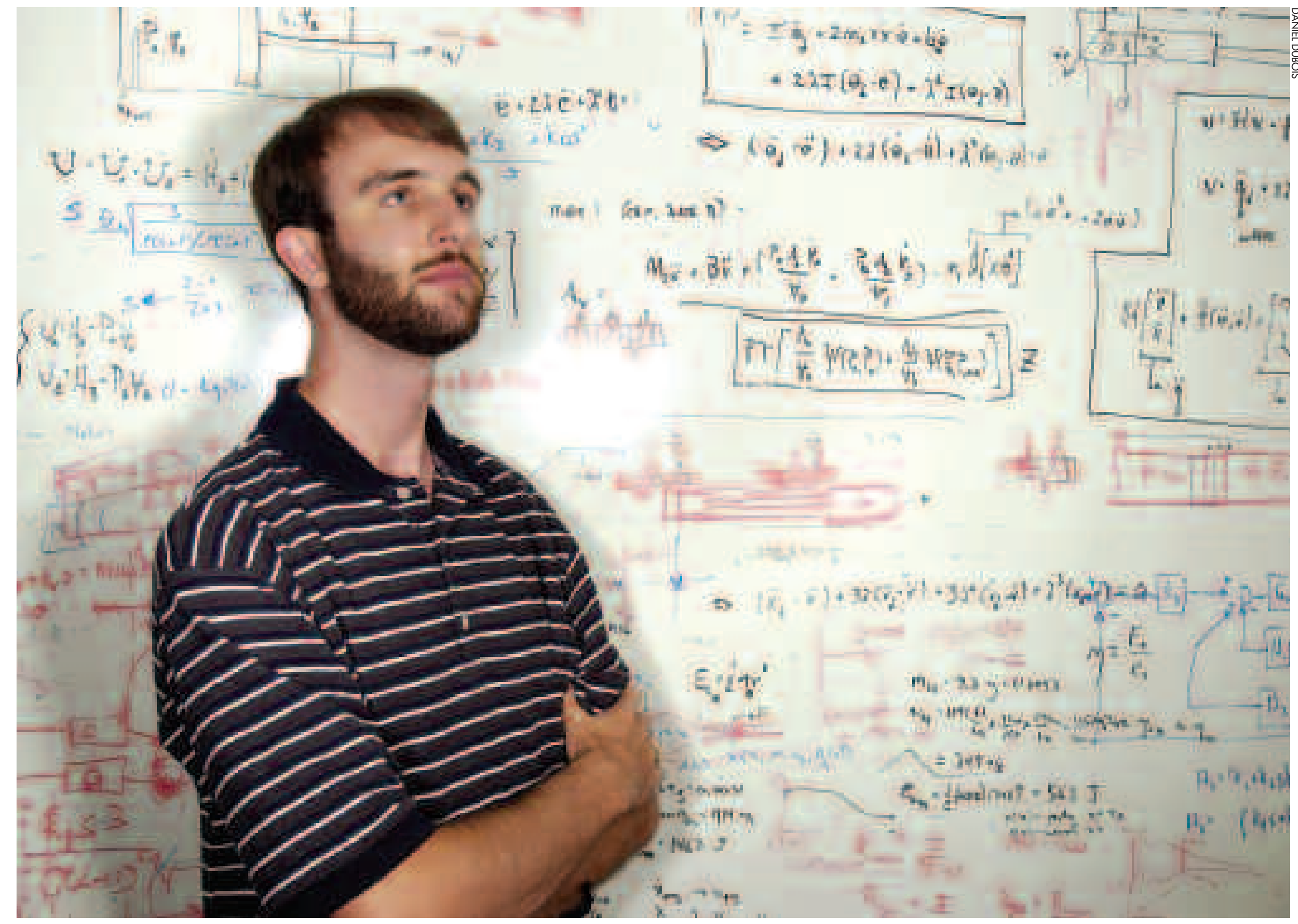
STUDENTS

Bayer Scholarship draws gifted student to Vanderbilt

Vanderbilt engineering senior Stephen McGuire knew he wanted to be an engineer when he was just an elementary student whose favorite pastime was building a complete village out of Lego blocks. As he grew up, science and mathematics came easily to him, but he doubted he would be able to go to Vanderbilt, despite his talent. The Bruce and Nancy Bayer Scholarship made the dream possible for the Baton Rouge, La., native.

"I didn't think I'd be able to go to Vanderbilt," he says, "but I really wanted to attend. I wanted to go to a school where there were other students besides engineers. I like it so much, that I'm planning to stay an additional year," he adds with a chuckle.

McGuire will receive his B.E. degree in mechanical engineering in May 2005. If all goes well, he'll complete requirements for an M.S. degree in management of technology later in the year. At the present, he's taking both bachelor- and master-level courses. "It's been challenging," he understates.



DANIEL DUBOIS

Scholarships help Vanderbilt attract outstanding students like Stephen McGuire.

Despite those challenges, McGuire maintains a 4.0 grade point average and is an Engineering Merit Scholar and member of Tau Beta Pi. He has also gained engineering experience through summer internships. One summer he wrote a quality assurance manual for the American Institute of Steel Construction certification. Last summer, he worked in Baton Rouge on process technology for Stone & Webster, a Shaw Group Company.

McGuire also has gained experience in conflict management by working as a supervisor at the Student Recreation Center. "My duties include assigning referees to games, managing escalated conflicts, and giving first aid to injured players," he says. Until this year, he also served on the Interhall executive cabinet.

"None of my accomplishments would have been possible without the generosity of Professor Bayer," McGuire says. "I'm happy that I was able to meet him before he died. His spirit of giving will allow me and future recipients of his scholarship to enjoy this jewel of a university."

Before his death in 2002, Bayer, BE'35, MS'52, was professor emeritus of mechanical engineering and formerly chair of the department.

"I feel privileged to have the Bayer Scholarship," McGuire says. "I will be forever grateful."

—*Joanne Lamphere Beckham*

Faculty Notes

Thomas R. Harris, Orrin H. Ingram Distinguished Professor of Engineering and chair of the biomedical engineering department, is the new president-elect of the American Institute for Medical and Biological Engineering (AIMBE). After serving as president-elect during the 2004-2005 academic year, he will automatically become president the next year.

Kenneth F. Galloway, dean of the School of Engineering and professor of electrical engineering, testified before Congress and the National Academy of Sciences in May. He delivered a strong message to both groups that defense research on U.S. campuses is vital to national security and must be adequately funded.

Xenofon D. Koutsoukos, assistant professor of computer science, has won the prestigious CAREER Award from the National Science Foundation for his research on embedded and hybrid computer systems. The award, given to selected junior faculty for their exceptionally promising research, will enable Koutsoukos and his associates to develop next-generation computational methods and tools for these systems.

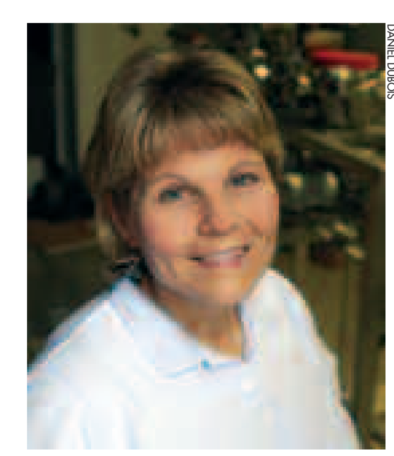
Julie E. Sharp, associate professor of the practice of technical communications, has won the 2004 American Society for Engineering Education (ASEE) Southeastern Section's Thomas E. Evans Outstanding Instructional Paper Award for her paper, "Teaching Strategies for Integrating Communication in the Chemical Engineering Lab."

Mark A. Stremler, assistant professor of mechanical engineering, has won the Army Research Office Young Investigator Award. This highly competitive award goes to promising young faculty in engineering and science.

Rogers receives award in White House ceremony

Bridget R. Rogers, assistant professor of chemical engineering, received the Presidential Early Career Award for Scientists and Engineers during a White House ceremony in May. The award is the highest honor bestowed by the U.S. government on outstanding scientists and engineers early in their research careers.

Rogers will use the award's five-year grant to study thin-film coatings for ceramic materials for use in hypersonic vehicles, such as the NASA X-43A space plane that achieved a record-breaking Mach 7—5,000 miles per hour—in March of this year.



DANIEL DUBOIS

In 2001, Rogers received a National Science Foundation CAREER Award for her research on thin films that can be used to make faster and more economical computer components. Since then she has expanded her focus to creating ultra-high-temperature ceramic composites and studying their properties and performance under the unique conditions encountered in hypersonic flight.

"Our ultimate goal is to develop an optimal thin-film coating for hypersonic vehicles that adheres well to the ceramic surface, resists corrosion and protects the vehicle from high temperatures, low pressure, and high-speed plasma flows during flight," Rogers says.

She and her associates are focusing on the processes of oxidation, which can significantly alter the performance of ultra-high-temperature ceramics. Rogers will use equipment she has designed to deposit and assess layers of thin films from tens of nanometers to microns thick.

—*Vivian Cooper-Capps*

TRANSINSTITUTIONAL

Predicting risk, improving reliability

Multidisiciplinary computer models make world safer, more reliable

Ensuring the reliability of engineering projects used to mean adding in more materials than needed and testing multiple samples to see how many failed. That approach is not possible or practical today as engineers work on projects ranging from highly sensitive aircraft to vast computer networks.

To test the reliability and reduce the risk associated with such large, complex systems, engineers needed to develop new design tools—reliability and risk engineering.

An interdisciplinary team of Vanderbilt researchers is leading the way in this new field. They are developing computer models to improve the safety and reliability of systems as small as an electrical circuit and as large as the next-generation space shuttle.

Their work is supported by a five-year, $2.7 million Integrated Education and Research Training grant (IGERT) from the National Science Foundation (NSF). The program is beginning its fourth year.

"No matter what the system is—a heart device, a large highway network, an aircraft or the space shuttle—anything engineers build—we have to be concerned about how reliable it is," says Sankaran Mahadevan, professor of civil and environmental engineering and director of the IGERT-funded Multi-disciplinary Reliability and Risk Engineering and Management program.

NSF funds IGERT programs to promote interdisciplinary collaboration and innovation in research and teaching and to help create more diversity and creativity in science, medicine and engineering. Since 1997, NSF has funded approximately 100 IGERT programs nationwide. In addition to the reliability and risk program, Vanderbilt received a second IGERT in 2003 for nanoscience research, in partnership with Fisk University. Vanderbilt's is the only risk and reliability IGERT program that the NSF is funding.

"We have a very wide range of expertise in this program, and that is how we were able to convince NSF that we were the place for this IGERT," says Mahadevan, known as Maha to his colleagues and students. "There are so many different aspects—not only all the different engineering disciplines, mathematics, economics and management, but also human reliability, organizational issues and more. Nobody else covers such a wide range of issues. That is really what NSF's IGERT program is all about—fostering multidisciplinary research and education."

"The IGERT has enabled us to tie together commonalities between structural engineering, electrical engineering, environmental engineering and other areas when treating uncertainty," David Kosson, professor and chair of civil and environmental engineering, says. Kosson is an IGERT co-principal investigator. "As a result of our multi-disciplinary collaborations, we are a national leader in several areas, such as structural reliability and remediation of contaminated waste sites such as the DOE nuclear complex."

"As a result of our multidisciplinary collaborations, we are a national leader in several areas, such as structural reliability and remediation of contaminated waste sites."

—*David Kosson*

DANIEL DUBOIS

'A new way of doing design'

The Vanderbilt reliability and risk IGERT program is training more than 20 doctoral candidates and involves 29 faculty members from the School of Engineering, the College of Arts and Science and the Owen Graduate School of Management. The researchers and students are collaborating across their traditional discipline boundaries to design and use computer models and statistical methods to improve the reliability and safety of a system's performance.

"This is a new way of doing design, where you actually factor in uncertainty right from the beginning by using probability and statistics," Mahadevan says. "In the past, people would say, 'Well, we know that there is uncertainty, so if we want a thickness of, say, one inch, make it 1.5 inches just to be on the safe side.' But how much safety did you really put in? So we are developing computer models to determine more accurately what is needed for safety and reliability."

In addition to enhancing safety, Mahadevan and his colleagues are breaking new ground in cutting the cost of reliability tests for highly complex systems.

"In classical reliability engineering, people look at small devices like light bulbs or electronic transistors and test a large number of them to see how many failed," Mahadevan says. "But you can't test and measure the reliability of a large system like a building or a space shuttle by waiting to see what fails. So we've been developing large computer models to analyze the behavior of these systems and predict reliability."

Ron Schrimpf, professor of electrical engineering and an IGERT co-principal investigator, says collecting data with which to build models poses significant challenges. As director of the Institute for Space and Defense Electronics, Schrimpf and his associates study issues related to the effects of radiation on electronic devices.

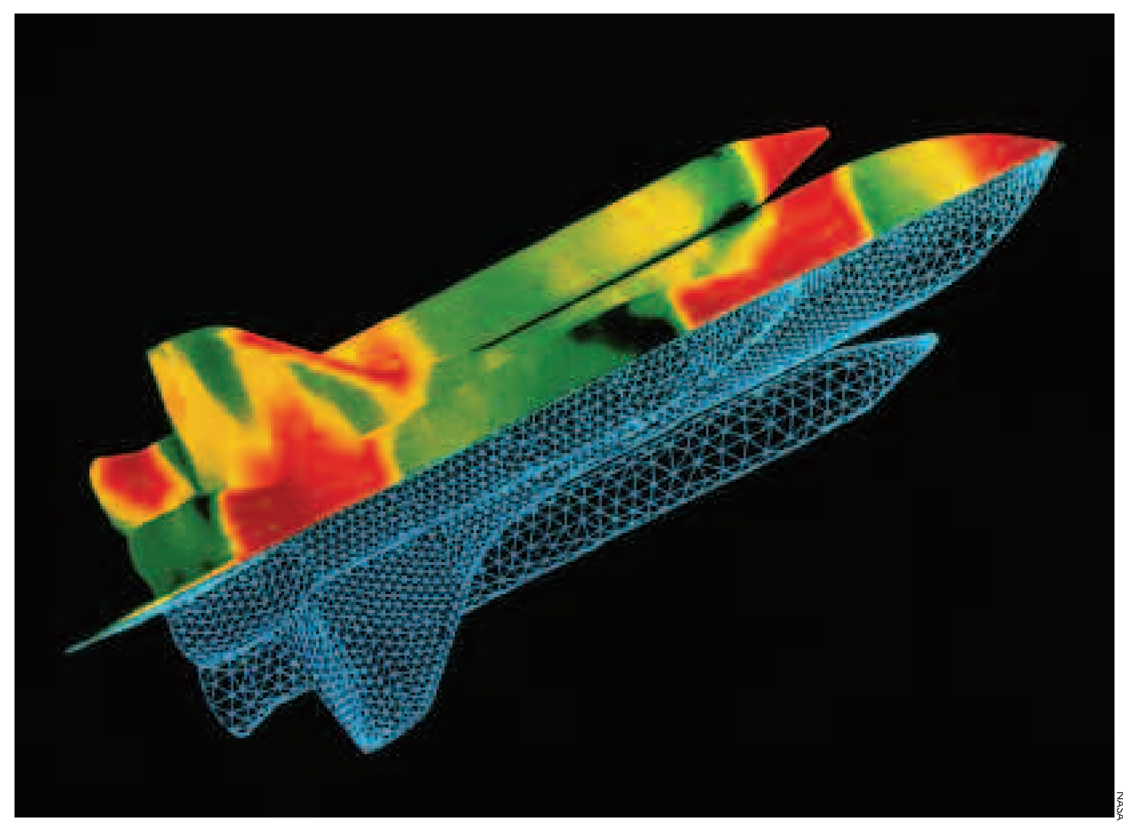
"One of the real challenges is that there are not a lot of data related to old parts—a lot of things just get thrown away. There aren't really data that demonstrate how long these things are going to last," he explains. "So it's going to be a combination of finding appropriate data where these things exist plus doing computer analysis. We're trying to work on both fronts.

"One of our students, Martin Rodgers, is doing an internship this summer at General Electric. GE has large systems that are in place for decades, in some cases," Schrimpf continues. "For a lot of electronics, you simply replace them when they get old. But if you are building a power plant and the control systems are in place, those may be expected to last for 40 years. So then you start to care about what happens to electronics just due to getting old."

The researchers not only need to develop the models, but also must investigate whether or not the models accurately predict reliability.

A project Mahadevan and his team undertook for the U.S. Army involved predicting the fatigue and life of helicopter rotor components. The project provided the unique opportunity to collect hard data to test the accuracy of the models.

"The Army gave us funding to develop a computer model to predict the life of the component. They also funded the company that makes the helicopters to actually make the rotor components and test them to see if our models were accurate. It turned out that our predictions matched the test data very closely," Mahadevan says.



NASA

DANIEL DUBOIS

"This is a new way of doing design, where you actually factor in uncertainty right from the beginning by using probability and statistics."

—*Sankaran Mahadevan*

The IGERT team also worked on a small study for FedEx. "They estimate 98 percent reliability on their next-day delivery system, but to achieve that they have to put in a lot of extra capacity," Mahadevan says. "They want to tighten their budget, so they want to find a more systematic, mathematical way for them to achieve the same reliability without too much additional margin."

Risk management

The FedEx project and other IGERT endeavors step outside the bounds most people usually think of when they think about engineering. That's one reason the Owen Graduate School of Management is involved.

"I'm a modeler, so one of the primary things I care about is how reliable my models are," Bruce Cooil, associate professor of management (statistics) at the Owen School and a co-principal IGERT investigator, says.

"The business school is full of people building models that look at risk and reliability," Cooil explains about how he got involved with the IGERT project. "Maha was interested in writing an interdisciplinary grant proposal, and I was a natural choice as a principal from this school, since I had obvious interest in reliability and risk."

"It is the same theme of using mathematics and computer models to minimize cost and yet meet a certain target of reliability. Whether it's a structural system, aerospace, or a distribution network—it's the same concept," Mahadevan explains. "That's why I think we were successful with the NSF proposal. We showed how the central integrating, unifying theme could apply to a variety of disciplines."

Another IGERT co-principal investigator, Gábor Karsai, is based at Vanderbilt's Institute for Software Integrated Systems (ISIS). Karsai, associate professor of electrical engineering, works primarily on embedded computing systems, which are found in cars, appliances and countless other everyday devices.

"Everyone understands that this is an area where computing will grow," Karsai says. "Most computers today are not PCs—PCs are less than 10 percent of the market. The majority are used in other devices: cars, telephones, washing machines, clocks, watches, etc.

"We are working together with people from industry, such as Boeing, on projects related to onboard computers that monitor what's going on with the aircraft," he continues. "If you want to have a reliable, safe transportation system, these are the kinds of things that you need. The consequences of system failure are extremely serious. These computers are used for diagnosing faults and other problems."

Mahadevan hopes the multidisciplinary risk and reliability program will continue after the IGERT funding ends. "We could do several things when the funding ends. We could re-compete for another five years. Or we could even move to another level—apply to develop a NSF science and technology center, which is a much bigger effort involving several universities and industry and government laboratories, to address systems of a much larger scale than at present," Mahadevan says. "There are opportunities to make this a sustained program—that is in everybody's interest." —*Melanie Catania*

Win-win for everyone

"One of the great things about this program is that we have a lot of industry and government partners," Professor Sankaran Mahadevan says. "We send our students to do summer internships with these organizations, where they actually develop their Ph.D. dissertation research topic. The sponsor gets interested in their work and then typically supports them financially.

"So it's win-win for everyone. We get to do good research, the student gets a career-building opportunity, and the sponsor gets good work done and also perhaps a future employee who is already well-versed in what they want."

"The IGERT has helped us do a great job of attracting high quality students," says Professor David Kosson. "These students then benefit from multidisciplinary training, internships, professional connections and exposure to the leaders in the field."

Graduate student Sabrina Turner will begin her second year in civil engineering after finishing a summer internship in financial risk engineering with a bank in her hometown of Baltimore, Md. Turner's emphasis on financial risk has her working with faculty across campus. She values the flexibility afforded by the IGERT program.

"In all my personal statements for graduate school, I said I wanted to combine my math skills with my interest in engineering, economics and finance. I found out about the risk and reliability program at a conference," she says. "I love it—I finally found something I like to study and a program that gives me the freedom to study it."

Second-year graduate student Kevin Brown, BE'85, MS'87, has been with the Department of Energy's (DOE) Savannah River Site in South Carolina, where he worked at the Defense Waste Processing Facility. He came back to Vanderbilt to pursue his Ph.D. because of his familiarity with the University and his relationships with faculty here.

"I kept in touch with people here like (Distinguished Professor of Environmental and Water Resources Engineering) Frank Parker, and I really didn't consider going anywhere else," he says.

Brown is working on a project to bring consistency to the regulation of buried transuranic waste at DOE complexes. Transuranic waste, according to the National Safety Council, "generally consists of protective clothing, tools, glassware, equipment, soils, and sludge contaminated with man-made radioisotopes heavier than uranium."

In addition to training graduate students, Vanderbilt's IGERT program also offers summer research internships for undergraduates from across the country. Six students, culled from 50 applicants, participated last summer. They came from Duke University, the University of Missouri, the University of Mississippi and Vanderbilt.

Vanderbilt undergraduate Paul Jabour, a senior majoring in civil engineering, applied for the internship after taking a class in environmental risk management.

"Long-term nuclear waste storage has become a growing problem for the Department of Energy," he says. "I am specifically looking at physical and chemical concrete degradation mechanisms in order to generate numerical models that predict how long a design will work until failure occurs."

Jabour says his project has provided the opportunity to exercise skills not typically called upon in the classroom.

"Normal engineering coursework is much more regimented with weekly problem sets and exams over specific concepts," he says. "This kind of research requires more independent learning and problem-solving techniques. Often the answers to your questions are not all conveniently located in your textbook.

"The best part of this experience has been working with world-renowned professors in a field that is used in all engineering disciplines. Risk and reliability has vital implications for any system design and operation over an extended period of time."

MECHANICAL ENGINEERING

Making it real

Gregg Hedgren, BE'03, has a unique double viewpoint of the two-semester senior mechanical engineering course that assigns real-world design problems to teams of students.

In the spring of 2003, his team came up with a way to check the seal of roller bearings for Denso Manufacturing of Maryville, Tenn. Their solution proved to be so useful that Denso began using the team's water and laser device. The company also provided Hedgren with a job after graduation.

This year Hedgren served as the company liaison to the 2004 Vanderbilt Denso design team. Happily, history repeated itself. This year's team of Kevin Dow, Daniel Golden, Michael Lahr, John McFarland and Marion Westby also successfully solved a real-world problem for Denso.

"Course work is one thing, but actually solving a problem is something different," Hedgren said. "The 'Design Projects' class is a special, very worthwhile experience. It gives students a taste of what engineering is really all about."

Taught by Donald L. Kinser, professor of mechanical engineering, and Joel Barnett, senior lecturer in mechanical engineering, Design Projects is the second semester of a two-course sequence. The first semester, Design Synthesis, concentrates on general design problems and team formations. Teams also select their project to solve in the follow-up Design Projects class.

A subcontractor to the automotive industry, Denso manufactures, among other products, a starter motor that uses an actuation spring. The problem was that sometimes the springs, manufactured by third parties, did not conform to specifications under compression. This caused jamming problems on the assembly line. Denso needed a way to measure the outer diameter of the springs under compression to within a .01 mm margin of error. The student team also had to take into account safety, feasibility of production, a tabletop footprint of no more than one square foot, ease of operation, lightweight portability and aesthetics.

Following their research on measurement systems and spring-testing mechanisms, the Denso group considered several different solutions, but ultimately settled on making a prototype based on a bolt-action rifle. The springs are slipped on to a cylinder, which is then manually moved into a "locked" position, thus enabling an accurate measurement without spring buckling.

The prototype—a handsome, elegant machine tooled from recycled aluminum by team member Daniel Golden—proved to be safe and effective. "We're pleased with the outcome," reported Hedgren. "They came up with a design that met our needs. We're using it and it's working just fine."

The team with their successfully completed project includes Michael Lahr, left, Marion Westby, Kevin Dow, Daniel Golden and John McFarland.

"Team dynamics is something we begin teaching to freshmen," Barnett explained. "By the time a class reaches their senior year students will have worked on many teams, and may well have worked previously with some of the people that form their Design Projects course group. I tell them, when they look to form teams, to gather together people with diverse skills, because that is what they are going to need.

"In addition to the core subject matter, we stress communication and presentation skills at Vanderbilt," Barnett continued. "Often we hear feedback from the field that not only do our graduates really know their engineering, they can also handle the human side of things, too. This class strives to call upon all aspects of their learning at Vanderbilt. It's challenging as a teacher to line up these opportunities, but the realism that the students experience is worth it. These problems are not hypothetical, and it makes a huge difference having to negotiate with clients and other team members to get good work within the constraints of time, materials and talents."

The Denso team was impressive to observe in action. The PowerPoint presentations about their chosen problem were clear and cogent. Their group meetings ran on time. They stayed on task, divided the labor equitably (usually by the volunteer method) and with good humor, and addressed problems with polite directness.

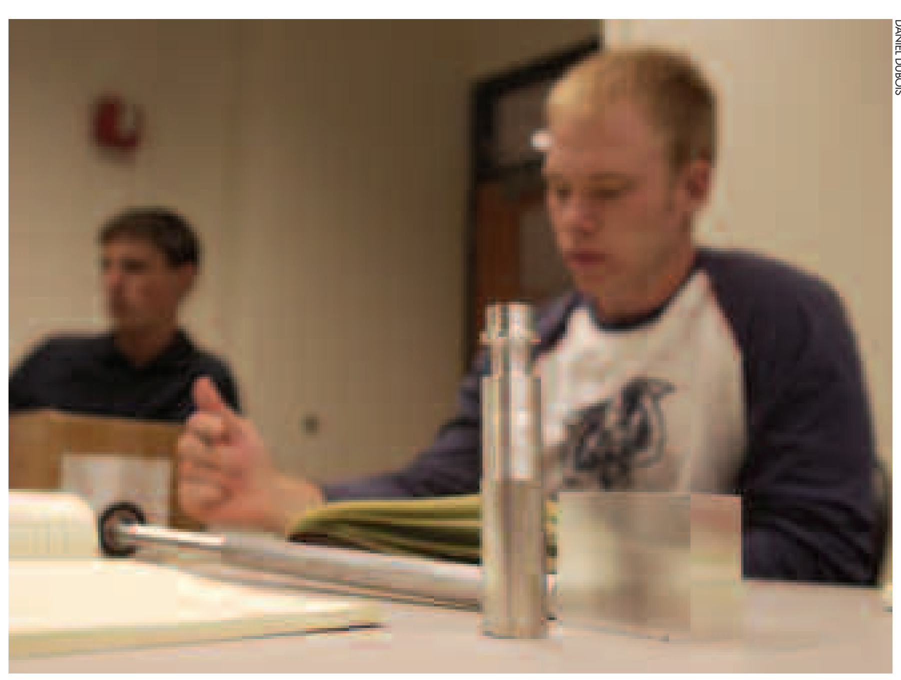
Academically, the team already had a substantial track record, with a combined grade point average of 3.72, multiple appearances on the Dean's List, and other professional and academic honors. They also had solid experience behind them, through summer internships. They applied their varied experience to the researching, writing, public presentation, designing, constructing and refining necessary to solve the Denso engineering problem.

Last, but not least, the team demonstrated an easy confidence. When asked if he felt any pressure from the success legacy of the 2003 Denso team, Kevin Dow, who joined the Navy Nuclear Submarine Program after graduation, responded casually, "Not at all. There's no reason why we shouldn't perform as well or better."

Barnett is a real believer in his students and this program. "All these teams are very impressive to watch…We've worked with Coca-Cola, Trane, Proctor & Gamble, Whirlpool Corporation, NASA and Saturn, among others, and I'm proud to say our students ge e, even in the real world. Making it real is paramount."

Alumni who wish to have their companies become partners for the senior Design Projects class are encouraged to contact Joel Barnett by email: joelbar@vuse.vanderbilt.edu. *Barnett is especially interested in southeastern U.S. companies, but would be happy to discuss collaboration with companies across the U.S.*

—F. Lynne Bachleda



Kevin Dow, left, and John McFarland discuss the design prototype in the foreground.

What kind of machine are you?

When writer F. Lynne Bachleda asked the Denso team to characterize their group as a machine, here is what they answered:

Our design group is like a gas turbine engine. In such an engine, there is an initial intake of air. This is like the initial design problem, in this case the information and specifications given to us by Denso. First, we had to intake the problem and understand it before we could proceed.

Second, in the gas turbine engine air is compressed with many blades. Our design group consists of people, or "blades," that compressed our information and examined it. Sifting through the specifications and using what we truly needed to complete our objective, our group then came up with many designs and features that could be implemented. This was our brainstorming phase, finally encompassing the end of "compression" to produce an actual decision for the final design.

Then comes the combustion area, or, in our case, the creation of our prototype. All this compressed air, or information and final design specifications, came forward and were mixed with modeling and machining, or "fuel," to create a final product.

In any good design group there is always a type of recirculation. Problems can arise, and these problems have to be addressed and perhaps some things must be changed. This recirculation is analogous to the turbine in the gas turbine engine that turns the compressor blades in a continuous cycle to keep the air or "information" under compression.

Finally, there is the exhaust that creates the thrust or forward motion of the airplane or jet. In our case, the final prototype, completed modeling and final design presentation propelled approval from Denso and the design professors.

ALUMNI

Alumna oversees technology for healthcare company

Noel Brown Williams scans the banks of computer terminals and television screens that fill HCA's Business Service Surveillance Center. "This is mission control," she says.

The scene does resemble NASA's command and control center, but this one has Williams, BS'77, at the helm.

As HCA's senior vice-president and chief information officer, she is responsible for the extensive information technology systems that govern the giant healthcare company's financial and clinical services. She's also in charge of developing HCA's overall technology strategy.

In addition, Williams serves as president of HCA Information Technology & Services, Inc., a wholly owned subsidiary of HCA. "We provide technology systems and services to two outside hospital companies, LifePoint and Triad, that were spun off from HCA in 1999," she says.

"Information security is a top priority," Williams says, "because of the world situation, with computer viruses and worms and terrorism. Protecting patient privacy is paramount, she says, and has become even more complex because of the privacy regulations mandated by HIPAA, the Health Insurance Portability and Accountability Act.

Williams oversees a staff of 1,100 at the central data center in Nashville and at seven regional data centers serving 191 hospitals and 82 outpatient surgery centers in 23 states, England and Switzerland. In addition to developing and operating the technology systems, they also train the staff in using the systems, provide customer support, and manage the company's Web presence.

Williams credits the "good technical background and critical thinking skills" she received at Vanderbilt School of Engineering, as well as "luck and great mentors," with her rise from systems analyst to senior management of "the world's leading healthcare company."

Noel Brown Williams, BS'77, oversees technology for HCA, one of the world's leading healthcare companies.

"The logic and reasoning I learned at Vanderbilt have served me well," she says.

Her mentors include Jack Bovender, chairman and CEO of HCA; Tom Cato, retired former CIO at HCA, and her father, former Vanderbilt football player Van T. Brown, BE'49. As her earliest mentor, Brown made sure that his only daughter received the same excellent education in mathematics and science as did her brother.

While studying mathematics at Auburn University, Noel Williams learned to love computers on taking her first computer science course in FORTRAN. When she transferred to Vanderbilt her junior year, her advisor suggested she pursue a double major in mathematics and computer science.

After graduating from Vanderbilt, she earned a master's degree in healthcare financial management from the University of South Carolina. She worked for a time for EDS, before joining HCA.

Today, Williams carefully balances her professional responsibilities with being a mother of two and wife to attorney Charles "Chuck" Grice, BA'74.

"I have the privilege of working for a company that understands that you have to balance family and work in order to be successful at the latter," she says.

"Coming to work everyday is a pleasure because of the people I work with. We work hard, but we have a lot of fun."

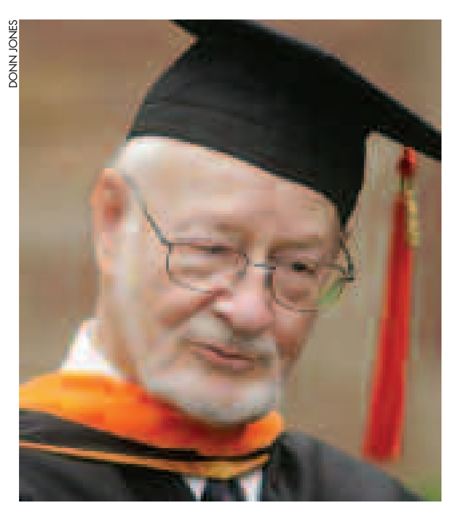
—Joanne Lamphere Beckham

Octogenarian earns master's degree

He's a lot older, grayer and wiser than his fellow graduates—and twice as old as many of the professors.

He has accomplished a great deal in the past 54 years, despite not finishing his studies for a master's degree from the School of Engineering.

But 80-year-old William G. Morrison thought it was important to earn that degree as a capstone to a successful engineering career. And last May, he achieved that goal.



Eighty-year-old William Morrison completed his master's degree 54 years after leaving Vanderbilt.

"Mr. Morrison had a distinguished career as an engineer at Phillips Petroleum's facilities in Texas and Idaho," says Dean Kenneth Galloway. "When we understood what he wanted to do and what it meant to him, we were quite enthusiastic about helping him realize this goal."

After reviewing his records, Galloway and his colleagues determined Morrison was just three credit hours short of completing his degree. He enrolled in a special topics course and submitted the required paper to fulfill the requirements for a master of engineering degree.

A native of Lawrenceburg, Tenn., Morrison joined the United States Army after graduating from Lawrence County High School in 1942. He fought in the Pacific, storming the beaches at Iwo Jima in 1945. He survived that brutal assault against the Japanese, which killed almost 7,000 Americans, but lost part of his hearing in the process.

After returning from the Pacific, Morrison entered Vanderbilt Engineering School in 1946. He earned his bachelor's degree in chemical engineering in 1949, then started work on his master's degree.

Morrison said a variety of factors kept him from completing his degree in 1950, including frustration with his thesis and money problems. "I completed all of the curriculum except for the thesis," he says.

When his G.I. Bill ran out, Morrison left Vanderbilt to work for Phillips Petroleum in Texas and Idaho. During his career, he obtained three patents for his work on a liquid extraction process used in the nuclear industry.

After retiring from Phillips in 1983, he continued to work with the American Nuclear Society on an international committee that studied issues related to nuclear criticality and safety controls for fissionable materials outside of reactors.

Morrison met Frances Scott, a Vanderbilt nursing student, while he was an undergraduate. The couple enjoyed 50 years of marriage before Frances died in 2002. Morrison has since endowed a scholarship in her memory at the School of Nursing.

Now living in Idaho, Morrison enjoys fishing for steelhead trout, playing bridge and dancing.

(Parts of this story were taken from articles by Bill Cass of the Tennessean *and Melanie Catania.)*

Lewis Society mourns leaders

Two former distinguished alumni and early presidents of the J. Fred Lewis Society died recently: Robert "Bob" Bibb and Dan Barge Jr.

Both men were members of the Vanderbilt Engineering Class of '43 and were 82 years old at the time of their deaths.

Bibb, retired chairman and president of Nashville Machine Co. Inc., died on March 23 in Vanderbilt University Medical Center, where he was being treated for a respiratory illness.

Dan Barge Jr., chairman emeritus of Barge Waggoner Sumner and Cannon, Inc., passed away at his Nashville residence July 1. He established the Nashville engineering firm in 1955 with two of his Vanderbilt classmates, William Waggoner and Billy Sumner. The family has requested that memorial gifts be made to the Dan Barge Jr. Memorial Fund in the School of Engineering.

CLASS ACT

Music, engineering & fireflies

Duco Jansen is a talented musician with an interesting day job: associate professor of biomedical engineering. When he meets his freshman class for the first time, he surprises them by recounting the time he played saxophone during a show with Sting.

Jansen, a native of the Netherlands, comes from a musical family. At one time, he wanted to pursue a career as a professional musician. The closest he came to realizing that dream was touring the world with "Up with People" for a year during college. Highlights of that musical tour included appearing with Sting and other performers in Canada. He also played with Mexican pop star Yuri before 120,000 people in the Plaza Del Toros in Mexico City. And he performed at halftime during the Australian version of the Super Bowl in Sydney.

"I really enjoyed that year," he says, "but it made me realize I had made the right decision in choosing a career in science and engineering over one in music."

After earning bachelor's and master's degrees in medical biology from the University of Utrecht in the Netherlands, he secured a second master's degree and Ph.D. in biomedical engineering from the University of Texas at Austin. While there, he met his wife, Anita Mahadevan-Jansen, who is an assistant professor of biomedical engineering at Vanderbilt.

Today, Duco Jansen enjoys playing saxophone, keyboard, guitar and bass with his family, which includes seven-year-old daughter, Kiana, and three-year-old son, Arvin. His avocation is a welcome respite from his intense teaching and research schedule.

Jansen's research includes two main areas. One is with the Free Electron Laser, which he has adapted for use in brain and eye surgeries and wound healing.

He also works in molecular optical imaging, using light to image tissue and disease states, such as cancer and diabetes, in mice. He does this by fusing the DNA of luciferase (the protein that makes fireflies light up) with the DNA of heat shock protein, which is produced by cells under stress, and injecting the fused DNA into cells. Whenever the injected cells produce heat shock protein, they also light up.

Jansen and his Medical Center colleagues have developed a strain of mice in which every cell has this ability to light up, allowing the researchers actually to see when and how tumors start growing, metastasizing and producing new blood vessels.

Jansen is also working with Vanderbilt endocrinologist Dr. Alvin Powers on Type I (juvenile-onset) diabetes. By injecting luciferase DNA into pancreatic islets and then transplanting them into diabetic mice, researchers can track the islets and determine how many remain viable. This research also has implications for more effective drug development and therapy.

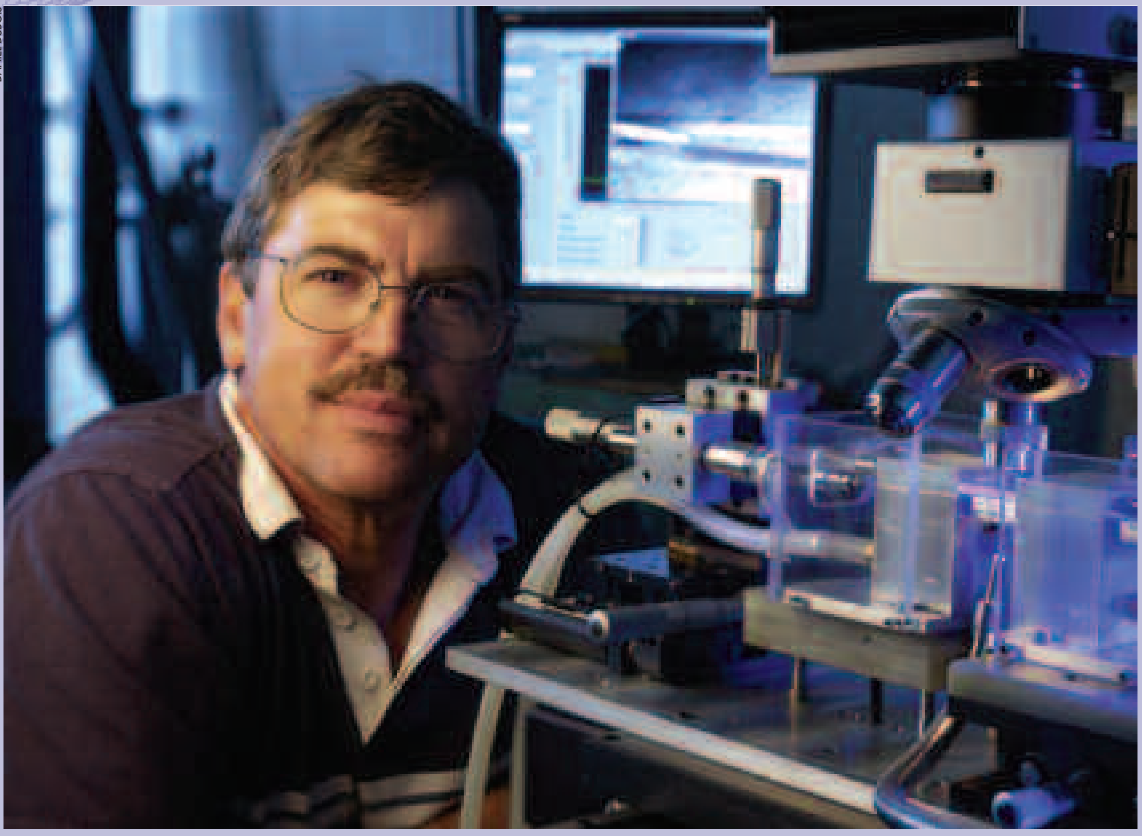
The bottom line, says Jansen, is that "Vanderbilt is uniquely positioned to take advantage of the interdisciplinary nature of research today, and that's really exciting."

—Joanne Lamphere Beckham


DANIEL DUBOIS

Professor Duco Jansen once appeared on stage with Sting.

TECH TIME


DANIEL DUBOIS

William H. Hofmeister, BS'73, MS'84, PhD'87, research associate professor of materials science and engineering, uses this micro scale directional solidification system for research on nanoscale fluidic channels. Such nano channels, which are important for drug development and cancer research, are extremely difficult to make. Hofmeister and his colleagues are testing a new technique to train polymers to "grow" millions of nano channels through self-assembly. Much of his research takes place in Vanderbilt's new nanotechnology laboratory, which is located in the Stevenson Center.

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