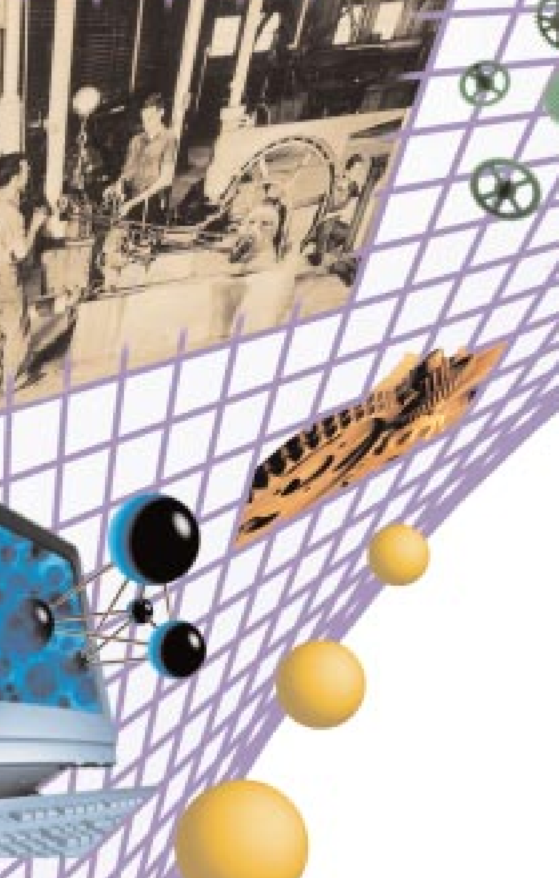
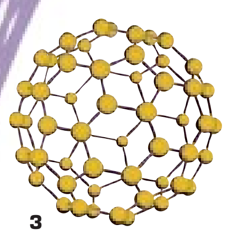
Volume 45, Number 1, 2004

ENGINEERING
VANDERBILT





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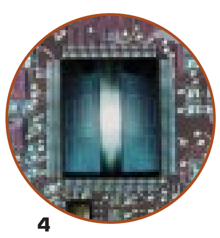

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Picture This

Computer simulations display complex dance of molecules

PHOTO ILLUSTRATION BY DANIEL DUBOIS

Professor Cummings is developing the most extensive, accurate model of water ever produced.

It's a pleasant surprise to many chemical engineers and molecular modelers to find that they're in the catbird seat these days.

Research and innovation partners from biomedical engineering and physics to electrical and computer engineering are almost lining up to work with chemical engineers to discover and uncover the molecular world of nanoscience, previously of interest mainly to chemists, chemical engineers and physicists.

It's a world that in many ways is more mysterious than Mars, and Peter T. Cummings, the John R. Hall Professor of Chemical Engineering, is one of the foremost pioneers of its unknown regions.

Professor Cummings is widely recognized as one of the world's leading experts in computer modeling and molecular simulation. Director of the Nanomaterials Theory Institute at the Oak Ridge National Laboratory, he manages numerous major research projects at Vanderbilt while keeping up with his engineering teaching load. He also edits one of the leading journals on chemical thermodynamics, *Fluid Phase Equilibria*.

When you find Cummings in his Vanderbilt office, most likely you'll catch him conferring with colleagues across the country on his ubiquitous cell phone while he rolls up his sleeves and frowns deeply into his laptop computer screen at the dazzling array of simulated molecules dancing in wild patterns of interaction.

What does he see in these unfolding models of molecular action and reaction? Is he pondering how to devise tiny lubricants to oil the molecular machines that may someday course through the bloodstream, delivering pharmaceuticals to specific locations in the body? How to design computer devices, circuits and processes, using single molecules as transistors and capacitors? Creating highly complex molecular nanostructures that assemble themselves into a wide array of tiny industrial workhorses?

All of the above. And, perhaps most intriguingly, he is working to develop the most extensive and accurate model of water ever developed.

What's so intriguing about plain old water?

"Despite being tantalizingly simple molecules, water is perhaps one of the most complex substances," Cummings says. For instance, unlike all but a couple of other substances, water becomes less dense as it cools, which has biological repercussions that make life possible.

"If ice did not float, if ice did not form first on the top of lakes, rivers and ponds, aquatic life would not be able to survive the winter in cold climates," he points out. "This is just one of the incredible properties of water, and we have never before had a molecular model that adequately explains and accounts for these and all of water's other unique properties."

Like most nanoscience problems, the rub lies in the difficulties inherent in predicting the behavior of massive numbers of molecules in a variety of conditions. Quantum mechanical calculations can account for the basic, first- principles behavior of a small number of atoms or molecules. But when larger numbers of molecules interact, the behavior gets bewilderingly complex.

Undaunted by the complexities of this task, Cummings is confident that he and his team can produce the much-needed satisfactory model for the behavior of water. Existing models can predict this behavior within normal temperature and pressure ranges, but Cummings seeks to develop a model that also incorporates water's behavior in extreme temperature and pressure conditions. This information could be extremely useful to chemical engineers working on ways to solve environmental and industrial purification problems by using more efficient solvents.

Like engineers everywhere, Cummings is intrigued by the practical applications of his research. But unlike many engineers, he has veered away from experimental research toward theory and computation using complex computer tools.

Foremost among these tools is molecular simulation, which is a process of modeling and representing the highly complicated dynamics of individual atoms on the computer.

"I found that, for me, molecular simulation by computer is actually easier at predicting behavior than experiment," he says. "In science in general, computer simulation is becoming a tool that is the third 'leg' of scientific discovery, complementing the two traditional areas of theory and experiment. I find computer simulation easier than doing experiments. I was never a very accomplished experimentalist!"

"Easier" is a relative term. Computer simulation involves first developing a model of a system that incorporates all known physical and mathematical principles governing the system. Then, harnessing new powerful computing capabilities, the simulation applies the model to the myriad and varied behaviors of vast numbers of components of the system over time. Finally, the simulation analyzes the results.

The molecular simulations Cummings develops usually include a visual representation of the system under consideration, which gives the analyst an intuitive grasp of the molecules' interactions as well as the more austere analytical product.

While computer simulation is based on mathematics and physics, the modeling process allows researchers to reproduce more accurately the complex and highly varied behavior than would theoretical mathematical computation alone. With advances in computing power, simulations have developed a clear advantage for understanding dynamic, multi-faceted, and highly variable systems.

Cummings knows how important it is in this nanotechnology age to work with a variety of other experts in diverse academic disciplines.

"The cross-disciplinary collegiality at Vanderbilt is one of the main reasons I chose to come here," he explains. "This is how significant work is being done now and how it will be done in the future. Vanderbilt has the climate that makes that happen, and I'm already seeing the positive results of my choice."

— *Vivian Cooper-Capps*

IN THIS ISSUE

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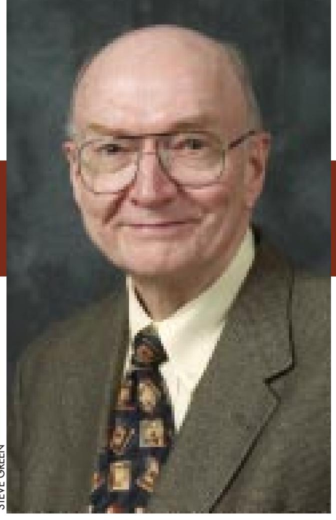
STEVE GREEN

Associate Dean George E. Cook

Vanderbilt Engineering, 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 45, Number 1, 2004

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The Future of Graduate Engineering Education

Professor of Electrical Engineering George E. Cook recently became associate dean for research and graduate studies for the School of Engineering. Formerly associate dean for research and director of the school's Industrial Liaison and Technology Development Office, Cook is a Fellow of IEEE and the American Welding Society and has served on the Vanderbilt engineering faculty for 39 years. He earned a bachelor of engineering degree from Vanderbilt in 1960, a master's degree from the University of Tennessee, and a Ph.D. from Vanderbilt in 1965, all in electrical engineering.

The School of Engineering is committed to recruiting the very best graduate students in the nation, particularly at the doctoral level. Our overriding goal is to provide graduate students with the facilities, resources, faculty mentoring and social experiences needed to prepare them for careers as future intellectual leaders. We want graduate students to come to Vanderbilt because we are the leader in their particular area of interest. We want to raise the level of excellence in our graduate programs to ensure that our graduates, through their teaching and writings and patents, will be intellectual leaders and that our undergraduate programs will be strengthened and elevated as a result.

In recent years, the School of Engineering has hired and given tenure to outstanding faculty who are well equipped to meet the challenge of enhancing graduate education and the school's national stature. Research awards have grown from about $7.5 million in 1996 to around $28 million in 2003. These awards support research, laboratories, graduate students and undergraduate students. They come from the National Science Foundation, the Department of Defense, NASA and many other federal agencies.

Our challenge going forward is to create an environment that attracts talented students with passion and drive and supports the development of their talent. Our faculty must be given time to mentor their students individually and enhance their scholarly apprenticeship experience. It is through that kind of close apprenticeship that students form much of their professional identity, scholarly taste and standards.

We must make a commitment to a new, active program of recruitment. We need to create a communications plan that elevates the standing and visibility of graduate education in the School of Engineering through the Web and other media. We also need to develop a way to evaluate and collect data to track student progress and benchmark measurable program goals.

We need to be competitive in awarding fellowships to the very best students. One way we do this is by awarding "topping up" Dean's Honor Fellowships to the most promising students early in the admissions process, as guaranteed backup to the Graduate School's Honor Fellowship nominations. We need to increase the number of such awards, which provide extra funds above tuition and the normal graduate student stipends. We also need funds to bring potential graduate students to campus to visit our programs. Once they visit the school and our outstanding facilities such as Featheringill Hall, they are more likely to choose to attend Vanderbilt.

But funding is not the sole factor in recruiting the best graduate students. We are encouraging talented Vanderbilt undergraduates to participate in our summer research programs, as a means of learning first-hand about research and graduate education at Vanderbilt. We also are working to recruit more outstanding minority students to our graduate programs, and we are developing international collaborative research and student exchange programs to increase our students' sensitivity to the cultural diversity of our highly interconnected and interdependent world.

Graduate alumni can help with recruitment by sharing their Vanderbilt experiences with potential students. And all of our alumni can help by supporting the school's goals through their gifts to the annual fund and to the Shape the Future Campaign.

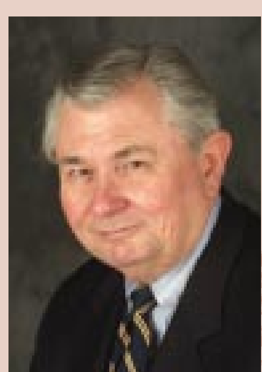
In February 2003, the Graduate Education Task Force issued its report, *Our Best Minds and Efforts: Graduate Education at Vanderbilt*. The phrase "best minds" suggests that faculty and their graduate students should possess some of the best minds in the university. Faculty — through their teaching, research and mentoring — bear the ultimate responsibility for excellence in graduate education. We must build a culture of graduate education in the School of Engineering that puts our graduates on par with our outstanding junior faculty. It will take the best minds and efforts of the entire engineering community — faculty, administrators and alumni — to achieve that goal.

— George E. Cook
Associate Dean for Research and Graduate Studies

Harris receives national award

Thomas R. Harris, professor and chair of biomedical engineering, has received the highest award given by the biomedical engineering division of the American Society for Engineering Education.

Harris, who is also the Orrin Henry Ingram Distinguished Professor of Engineering, received the Theo C. Pilkington Outstanding Educator Award. The award is given to an educator for lifetime achievement in teaching, research and administration in biomedical engineering academic programs.



Citing Harris' "national influence on the development of biomedical engineering as a discipline," the award announcement credited his leadership in building a strong department in biomedical engineering at Vanderbilt, his national leadership as past president of the Biomedical Engineering Society, and his service as leader of the Chairs of Bioengineering and Biomedical Engineering.

"Of great current and potential significance to American bioengineering education is his leadership as the director of the Vanderbilt-Northwestern-Texas-Harvard/MIT NSF Engineering Research Center in Bioengineering Educational Technologies," the announcement continued.

Dr. Harris' research has focused on quantitative cardiovascular physiology. He has developed important new methods in less invasive optical and ultrasound technologies for diagnosis, work that has resulted in two patents. He received his Ph.D. in chemical engineering from Tulane University and his M.D. from Vanderbilt University.

The School of Engineering undergraduate programs scored among the top 10 in the Southeastern United States in recent rankings by *U.S. News and World Report*. VUSE jumped six places to tie for 38th in the nation with Yale, Brown, Washington University, Notre Dame, Virginia, Case Western Reserve, Michigan State, Arizona and Arizona State.

The Vanderbilt biomedical engineering program ranked 12th out of some 70 degree-granting undergraduate programs.

Fleetwood appointed EECS chair

Daniel M. Fleetwood, professor of electrical engineering, has been named chair of the Department of Electrical Engineering and Computer Science. He was formerly associate dean for research in the School of Engineering.

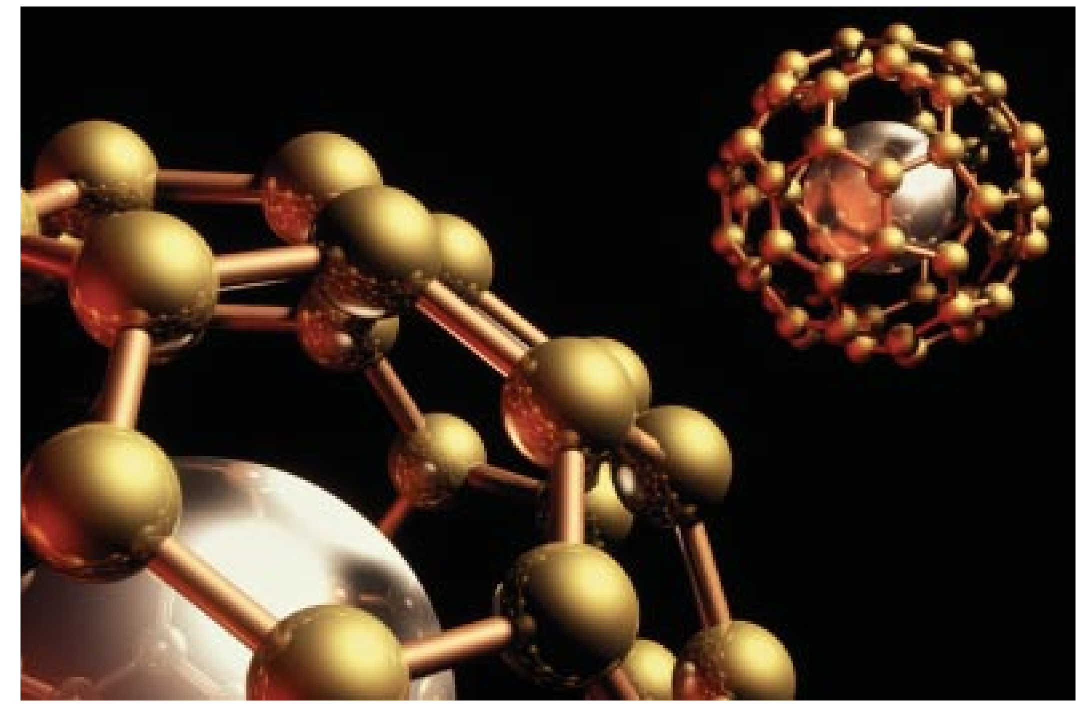
Fleetwood came to Vanderbilt in 1999 from Sandia National Laboratories, where he was a Distinguished Member of the Technical Staff.

Named associate dean for research in July 2001, he is the author of more than 200 journal publications on radiation effects and low-frequency noise in microelectronic devices and materials.

A Fellow of the Institute of Electrical and Electronics Engineers and the American Physical Society, Fleetwood obtained his bachelor's, master's, and doctoral degrees from Purdue University. His research is in thin-solid films, microelectronics, reliability and radiation effects.


Professor Fleetwood

Training tomorrow's nanoengineers



Vanderbilt and Fisk Universities have won a highly competitive $2.9 million national grant to conduct research and to train materials science and engineering doctoral degree students in the rapidly growing multidisciplinary field of nanoscience and nanoengineering.

The five-year Integrative Graduate Education and Research Traineeship (IGERT) grant from the National Science Foundation (NSF) will fund an innovative educational and research program centered on the strange world of nanoscale solids. Such research will lead to the creation of nanoscale materials to be used in a wide variety of enterprises, particularly medicine and the computer industry.

"Nanoscale" is considered to fall between 1-100 nanometers in size. A nanometer is about four atoms long, or roughly 1/1000th the diameter of a human cell.

The Vanderbilt-Fisk IGERT in the Nanosciences brings together the expertise and efforts of more than 30 Vanderbilt and Fisk faculty members already involved in nanoscale research. The doctoral degree program, to begin in fall 2004, will give students unprecedented cross-disciplinary immersion in nanoscience and nanoengineering.

"Materials behave differently at the nanoscale level," says Program Director Leonard C. Feldman, Vanderbilt professor of materials science and engineering and Stevenson Professor of physics. "Nanotechnology is based on discovering those distinctive behaviors and leveraging their characteristics to accomplish such technological goals as continued miniaturization of computer components and genetic engineering."

"The educational goal of this new program is to provide doctoral students with a complete background in the interdisciplinary materials sciences, which comprise the underpinnings of nanoscience and nanoengineering," he says.

The cross-disciplinary effort will include Vanderbilt faculty in biomedical engineering, chemical engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, and physics, and Fisk faculty in physics and chemistry.

In addition to involving professors from a diverse array of academic disciplines, the new program will depart from traditional graduate education by rotating students through research team assignments and offering course modules of 10 weeks (rather than full semesters), to allow students to tailor the curriculum to their needs. Students will also have opportunities to intern with domestic and international technology firms as well as national research laboratories.

The program is the second NSF-sponsored IGERT in which Vanderbilt is the lead organization. The first, Reliability and Risk Engineering and Management, directed by Sankaran Mahadevan, professor of civil and environmental engineering, is in its third academic year of operation on campus.

"We will draw from the pioneering work done by the Reliability IGERT in managing a multidisciplinary research-education program," Feldman says. "This new IGERT will also leverage the laboratory resources and faculty expertise of the recently created Vanderbilt Institute for Nanoscale Science and Engineering."

VINSE is currently constructing a new nanoscience and engineering complex to include five laboratories specializing in single-molecule and biomolecular devices, inorganic nanocrystal and quantum dot synthesis, buckyball and nano-tube fabrication, nanoscale optics, and silicon preparation. The laboratory and its equipment will be an essential component of the new IGERT program.

Fisk University students will have the opportunity to obtain their master's degrees at Fisk and then transfer automatically to Vanderbilt to complete their doctoral degrees.

"This partnership enables us to attract and retain more under-represented minorities to this important work," Feldman says. "The multidisciplinary, multi-institutional effort strengthens our current offerings in nanoscience and nanoengineering by giving students the educational foundations of the field, to provide a deeper and more adaptable understanding of the many facets of nanoscience and nanoengineering. This award is ideal for Vanderbilt at this time, as it knits together our interaction with Fisk, our science and engineering focus on the nanoscale, and innovative graduate education, three important elements on the Vanderbilt horizon."

— Vivian Cooper-Capps

CHEMICAL

First Wilson Professor Conducts Mars Research

Professor M. Douglas LeVan has been named the first J. Lawrence Wilson Professor of Engineering, one of five named professorships in the School of Engineering.

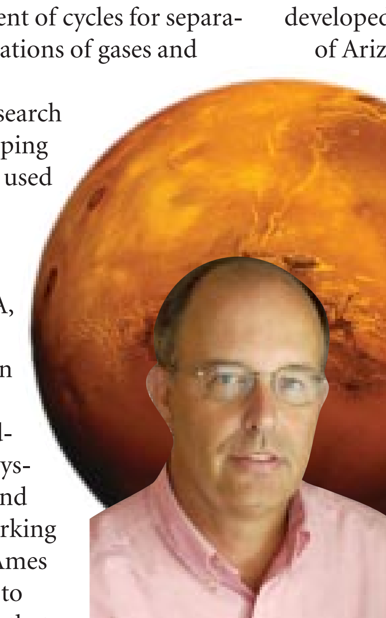
Created through the generosity of the Wilson family, the Rohm & Haas Company, and members of the Haas family, the chair honors Vanderbilt alumnus, business executive, civic leader and philanthropist J. Lawrence Wilson, BE'58.

LeVan is chair of the Department of Chemical Engineering and, prior to his appointment to the Wilson Chair, was Centennial Professor of Chemical Engineering. He has edited and authored numerous books and articles on adsorption and ion exchange, adsorption processes for gas separation, and fixed-bed adsorption. Adsorption involves the use of solids for removing substances from either gases or liquids. Applications include separating air into oxygen and nitrogen and removing trace impurities from air and water.

After obtaining his bachelor of science degree in chemical engineering from the University of Virginia in 1971, LeVan received his Ph.D. degree in chemical engineering from the University of California at Berkeley in 1976. He became assistant professor of chemical engineering at the University of Virginia in 1978 and achieved full professor status there in 1989. He came to Vanderbilt in 1997.

LeVan works on several projects in the field of adsorption. They range from fundamental studies of equilibria, to the development of cycles for separations and purifications of gases and liquids.

He and his research group are developing equipment to be used to make oxygen from the atmosphere on Mars. Funded by NASA, this research was awarded to LeVan because of his expertise in fixed-bed adsorption systems dynamics and design. He is working with the NASA Ames Research Center to develop a system that will take carbon dioxide from the Martian atmosphere and separate it into oxygen and carbon monoxide. Vanderbilt's equipment conducts the third and final step of the process and recycles any unreacted carbon dioxide back into the system. The device he has designed will take a mixture of carbon monoxide and carbon dioxide, produced in the two preceding stages by equipment developed by NASA and the University of Arizona, into an adsorption bed containing material that adsorbs carbon dioxide. The by-product carbon monoxide expelled from this adsorption bed can be used for fuel as well as for the production of other materials needed on Mars.



In other pro-jects, LeVan and his research group are working on prediction of adsorption equilibria, measurement of adsorption rates, advanced life support for long-duration space missions, and development of new nanoporous adsorbent materials for gas storage.

J. Lawrence Wilson has been a member of the Vanderbilt University Board of Trust since 1987, and he serves on the School of Engineering Shape the Future Campaign Committee. He also was one of the vice chairmen for the Campaign for Vanderbilt. Selected in 1988 to receive the School of Engineering Distinguished Alumnus Award, he served as president of the Engineering Alumni Council in the 1985–86 academic year.

After receiving an MBA from Harvard in 1963, Wilson joined Rohm & Haas in 1965 as an operations research analyst. He held a variety of positions with the company before becoming chairman and CEO in 1988. He is married to Barbara Burroughs Wilson, BA'58. His two sons, Larry and Alex, are also Vanderbilt alumni. Rohm & Haas is one of the world's largest producers of specialty chemicals.

ISIS: Improving 'Smart' Systems from Cell Phones to Jet Planes

A computerized system that can detect the precise location of a sniper in a crowded, noisy city. Unmanned flying vehicles that can locate the source of enemy radio waves. Software that can navigate fighter planes safely through hostile airspace and cut the task of scheduling air operations and aircraft maintenance from hours to minutes.

"Smart systems" like these Vanderbilt products are not limited to high-tech defense systems. They are everywhere, from our cell phones and cars, to factory robots, to critical infrastructures such as the national power grid and air traffic control.

All of these cutting-edge applications have one thing in common. They are made possible by increasingly complex "embedded computer intelligence."

The Vanderbilt Institute for Software Integrated Systems (ISIS) is one of the leading institutions in the nation in the embedded computing field. ISIS researchers not only are developing amazing systems, but they also are pruning, streamlining and, in essence, creating new mathematical approaches to make all embedded computing systems work more reliably and effectively.

As might be expected, this is no small task. Smart machines must integrate computer hardware and software with the physical world in order to operate physical components. Bringing the digital world of computing in sync with the "analog" world of physical reality requires nothing less than creating a completely new mathematical model and tool infrastructure.

Bringing the digital world of computing in sync with the "analog" world of physical reality requires nothing less than creating a completely new mathematical model and tool infrastructure.

Managing this complexity is one of the grand challenges in computer science today, according to Janos Sztipanovits, the E. Bronson Ingram Distinguished Professor of Engineering and director of ISIS.

"Many of the abstractions that have been so effective at improving our computational capabilities are either indifferent to or at odds with the requirements of software that interacts with physical processes," Sztipanovits says.

"That worked fine as long as the system stayed in the box. But physical reality is less tidy and predictable. Today, with the ubiquitous presence of embedded computing, computers must work hand-in-hand with physical reality."

The ABS (anti-lock brake system) on your car is a good example of embedded computing controlling an important physical system. After you press the brake pedal once, the anti-lock system senses when a wheel is locked and electronically pumps the brakes 10 or 20 times faster than you could, bringing you to a straight stop without skidding, even on ice.

In a situation like that, you can't afford a computer system "crash."

The issue of embedded computing reliability becomes more challenging as these systems proliferate and become more complex.

Sztipanovits and his ISIS colleagues — along with faculty members at the University of California, Berkeley (UC Berkeley) — are engaged in a truly challenging task: the re-integration of computer science with the physical sciences.

"We need new research to obtain a much deeper understanding of the nature of embedded software design, and we need to use this understanding to develop new abstractions and new design technology," Sztipanovits says. "Otherwise, we will not only be unable to take technology to the next level, but we also will be plagued by 'glitches' that can incapacitate whole systems or cause disasters."

ESCHER: Uniting Industry, Research, Government

Sztipanovits, Vanderbilt Professor of Computer Science Douglas C. Schmidt, and Professor Shankar Sastry, chair of the Electrical Engineering and Computer Science Department at UC Berkeley, are working to harness the efforts of government, academia and industry to facilitate development of next-generation design technology for embedded systems.

Sztipanovits is one of the leaders in developing a private, non-profit organization to advance embedded computing. That organization, ESCHER (Embedded Systems Consortium for Hybird and Embedded Research), was created by an academic/industry/government consortium. Established last fall and currently incubated at ISIS, ESCHER promotes the fundamental role of embedded software systems in critical infrastructure, industrial competitiveness and scientific progress.

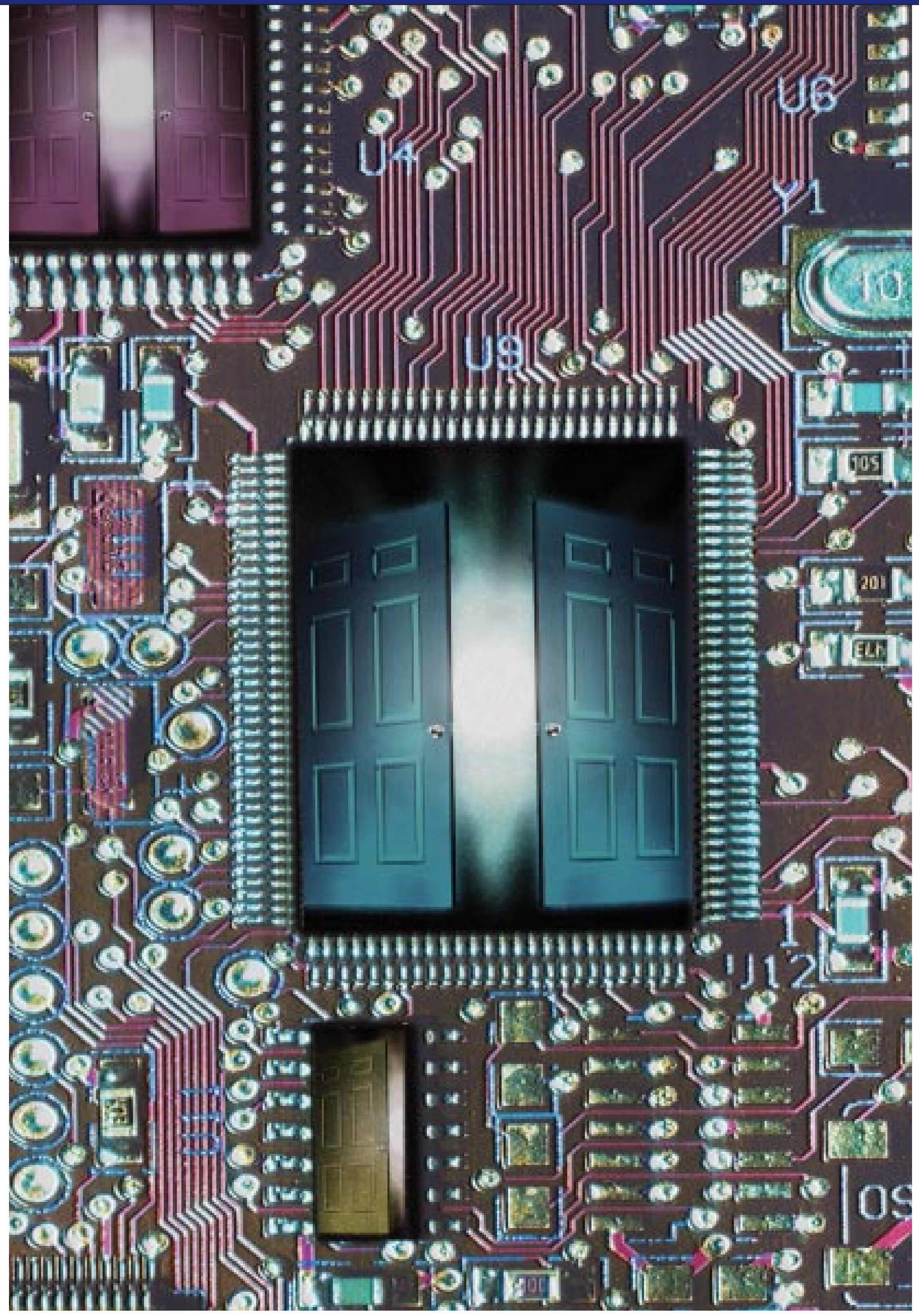
"For industry, [ESCHER] will help define common research needs and act as a clearinghouse for collaborative efforts," Sztipanovits says. "It will establish processes to transfer the research results quickly and efficiently to the industries that will be transformed by these efforts.

"For government, ESCHER will open up the research field not only for larger agencies, but also for smaller government groups who will have access to both technology services and to an industry liaison program.

"For researchers, ESCHER will help establish criteria for software tools and will act as a repository for technology services, becoming a code, model, tool and component warehouse."

ESCHER is funded by government and industry ($1.4 million for incubating the not-for-profit consortium), and is headed by CEO Norm Whitaker, who is based in Washington, D.C.

"Industry and government will find that ESCHER has a tremendous value in transitioning embedded systems technology to practical use," Sztipanovits says.



Software in the Middle

Sztipanovits credits the "open source" movement in the computing software community for making efforts such as ESCHER possible. Open source software systems (such as Linux and Apache) and applications make computer code accessible and allow programmers to read, redistribute and modify source code, without locking them into expensive, proprietary solutions. Unlike the closed model of conventional software development, where code is proprietary and inaccessible, open source software evolves through standardization, constant improvement and adaptation by the worldwide programming and user communities.

Schmidt has been one of the pioneers in the open source movement since 1987. He currently leads the development of software that helps a wide range of computing systems work together more smoothly and efficiently.

Schmidt's work has focused on large-scale distributed computing systems for telecommunication, electronic medical imaging, avionics and aerospace, financial services, and other arenas.

Schmidt says that he was motivated early in his career by the "countless hours and dollars companies and agencies spend to write software from scratch for applications, despite the fact that most of the software functions share many common features that were not being exploited."

"What was needed was a core software infrastructure — called *middleware* because it sits in the middle of distributed systems — that could be reused over and over again with diverse operating systems, networks and hardware," he says.

Schmidt and his colleagues have developed two widely used middleware packages: ACE and TAO. Research and product groups around the world are using this middleware, including the U.S. Armed Services, CERN in Switzerland, Boeing Advanced Avionics Systems, Siemens Medical Instruments, and Raytheon and BAE Systems Software Defined Radios, among many others. The ACE and TAO middleware enables programmers to develop new applications that can interface with a variety of otherwise incompatible operating systems, programming languages, hardware and networks, without locking them into proprietary code.

With the help of 30 core developers, more than 1,750 contributors, and eight companies that provide commercial support via an open source business model, the portable ACE and TAO middleware is being used by developers, project leaders and end-users all over the world.

"Everything we've done with ACE and TAO and many of our other projects is available on the Internet," Schmidt says. "People regularly download the software we've built and make their own adjustments. We then integrate the best of their contributions, resulting in better research and products. We work with some of the brightest people around the world in every time zone, every hour of the day."

Improving Military Intelligence

With the technologies of national intelligence gathering coming under intense scrutiny recently, Assistant Professor of Computer Engineering T. John Koo's work with small Unmanned Aerial Vehicles (UAVs) for intercepting and locating enemy broadcast-communications systems in urban environments is getting serious attention.

Koo, together with researchers from UC Berkeley, Southwest Research Institute and ISIS, explores the feasibility of using swarms of lightweight and highly maneuverable Micro UAVs such as small helicopters to perform autonomous navigation around buildings. Equipped with radio receivers designed by Theodore "Ted" Bapty, research assistant professor of electrical engineering at Vanderbilt, the UAVs can detect transmissions from broadcast communications systems such as radios, as well as radar and other electronic systems. Intercepting such transmissions can provide information on the type and location of even low-power transmitters, such as hand-held radios.

While the UAVs perch, radio receivers listen to relevant radio frequency signals. These signals arrive at slightly different times at each sensor antenna of the UAVs. Synchronized by the global atomic clock provided by the Global Positioning Satellite (GPS) system, the mobile receivers send the signal timing data to a fixed-base computer that compares and computes the times to generate the location for the signal source. Then, the UAVs move to other locations to reduce uncertainty on localizing the signal source.

Working with the Berkeley Aerial Robot team affiliated with the Center for Hybrid and Embedded Systems and Software, the Center for Intelligent Systems at UC Berkeley, and the Southwest Research Institute, Koo and his colleagues will field-test the capabilities of multiple UAV modules this spring.

Pinpointing Snipers

ISIS has developed a similar distributed-network acoustic-localization system to pinpoint the location of a sniper.

A team from Vanderbilt University, under the direction of Research Assistant Professor of Electrical Engineering Akos Ledeczi, developed the technology behind the "shooter localization" application. The system uses multiple, small, networked sensor nodes that can be scattered throughout any given area — a checkpoint, a building, a city square. The nodes enable the system to locate a shooter's position along with the projectile trajectory, by tracking the muzzle blast and the ballistic shockwave.

Ledeczi says that the system is more robust and less expensive than other sniper-location systems.

"Our system contains a large number of cheap sensors — possibly hundreds or thousands — communicating through a self-assembling wireless network," he says. The sensors are small enough and rugged enough to be tossed randomly onto any terrain.

"By using a large number of simultaneous measurements at different locations, we can achieve much better coverage than with just a few sensor units," Ledeczi says. "This solution is not sensitive to single points of failure and is very robust against ambiguous signals resulting from such challenging environments as dense urban terrain."

In a recent field experiment, says Ledeczi, "the ISIS shooter localization system was able to pinpoint the actual window the sniper shot from, in less than two seconds. The presence of echoes in the urban jungle test site makes this accuracy remarkable. This demonstration used 60 nodes. In the next 18 months, we'll scale up to 200 nodes."

Shooter localization research is supported by the DARPA/IXO — the Information Exploitation Office of the Defense Advanced Research Projects Agency (DARPA) — Network Embedded Systems Technology (NEST) program, which is managed by Associate Professor of Computer Science Vijay Raghavan, who is currently at DARPA on leave from Vanderbilt.

CACE Software Keeps Harrier Jets Flying

Since August of 2002, Marine Corps squadrons of AV8-B Harrier jets flying missions in Afghanistan and Iraq have tested a pioneering software system created by ISIS and the University of Southern California School of Engineering Information Sciences Institute (ISI).

The software system, named Coherent Analytical Computing Environment (CACE), greatly simplifies the complex task of scheduling air operations and aircraft maintenance. What would normally take an experienced scheduler a full day to create a schedule that balances all the variables involved, now can be accomplished in four minutes with CACE.

Recently the Office of Naval Research announced that it would spend $5.74 million to expand the use of CACE to the entire inventory of Marine Corps tactical aircraft, as well as the next-generation Lockheed-Martin Joint Strike Fighter.

"We are very excited about this opportunity that allows the application of our research ideas to a wide variety of aircraft," says Gábor Karsai, associate professor of electrical engineering and computer engineering, who directs the effort at Vanderbilt. "We envision that our technology will also be extended to commercial aviation."

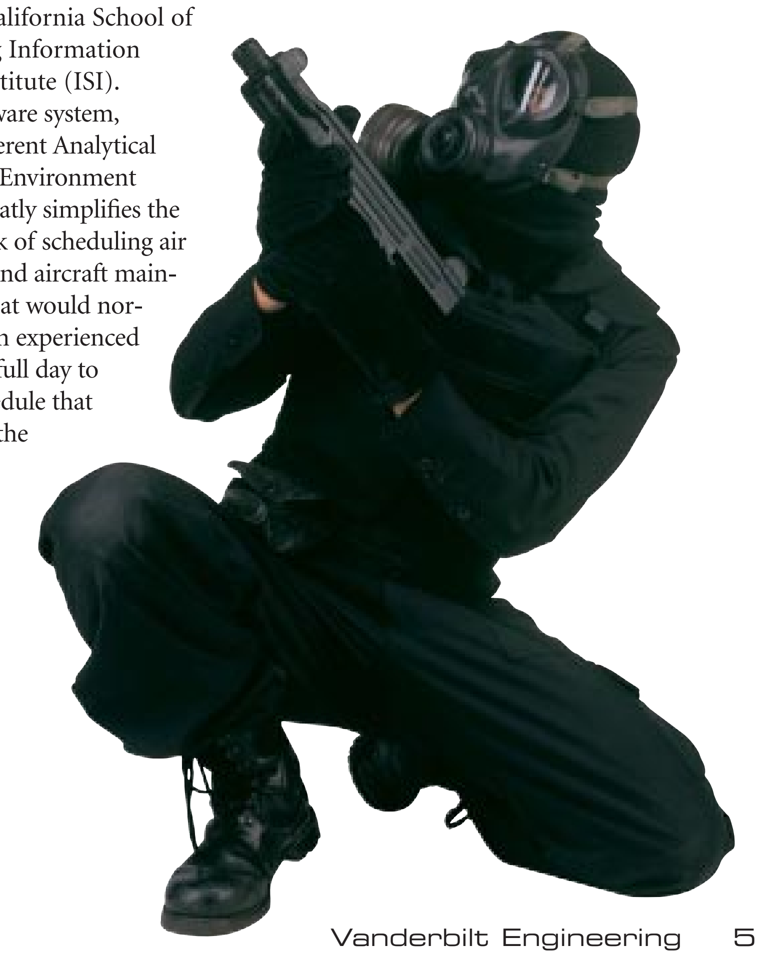
The ISIS/ISI team will also supply versions of the software to Lockheed Martin Aeronautics Company to transfer the technology for use in the company's next-generation Joint Strike Fighter aircraft.

The Vanderbilt/USC team is also working with the 45th Space Wing at Patrick Air Force Base (Cape Canaveral, Fla.) to demonstrate the application of the CACE technology in spacecraft launch operations.

— Charles Conte and Vivian Cooper-Capps

"In a recent field experiment, the ISIS shooter localization system was able to pinpoint the actual window the sniper shot from, in less than two seconds."

— Assistant Professor Akos Ledeczi



E car

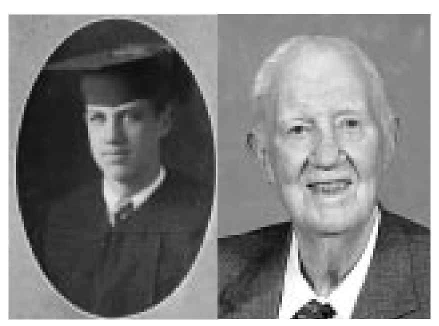
Engineering students at Vanderbilt received one of the world's most energy-efficient production automobiles in the world as GM presented the school with a sleek, green EV-1 car. Dean Kenneth F. Galloway, left, and Mark Reuss, BE'86, executive director of the GM Architectural Engineering & the GM Performance Division, participated in the donation ceremony in November 2003 at the Adams Atrium in Featheringill Hall. Not at risk of being taken for joy rides, the zero-emissions automobile will be used in mechanical engineering and design courses but does not include its battery pack. The all-electric EV-1 made history in 1996 as the first consumer-marketed electric car.

ALUMNI

Remembering Wilbur Creighton Jr.

On February 7, Wilbur Creighton Jr., BE'29, the School of Engineering's most senior alumnus, died in Nashville. He was 97.

Before his death, he reminisced about the school and about his career in civil engineering during the first half of the 20th century. He recalled being a freshman when "Fireball Lewis" became dean of engineering, attending class with some of the Fugitive poets, going to Vanderbilt football games before Dudley Field was built, and witnessing the East Nashville Fire of 1916.



Wilbur Creighton Jr.

Wilbur Creighton's family has had close ties to Vanderbilt University ever since his father earned his B.E. degree in 1904. His son, Wilbur III, also received an engineering degree from Vanderbilt in 1953.

In 1980, Wilbur Creighton Jr. received the school's Distinguished Alumnus Award. He was president and CEO of his family-owned construction company, Foster and Creighton. The company built several buildings on campus, including the original football stadium, Memorial Gymnasium, the Jean and Alexander Heard Library, Alumni Hall, Neely Auditorium, and the Round and West wings of the Medical Center.

Here are some of his memories as told to Bill Carey and Joanne Beckham.

Q: What was the School of Engineering like when you were a student?
A: We didn't have as many students. There were 65 in my class, but only seven graduated. Most of us were civil engineering students. The school was very tough. Dr. Sherman was head dean when I started, but Dean (Fred) Lewis came in during my freshman year and he was a godsend. He was a good engineer.

Q: Which professors were your favorites?
A: My best professor was Dean Lewis. I knew him for years after that because we lived near each other in East Nashville. But I also had Eddie Mims for English. He was great.

Q: As engineering students, did you feel like you were part of the University student body?
A: We were part of the whole student body, but we also had our own group. Some of my classmates were Charlie Hawkins Jr. and Ed Thacker.

Q: Tell me about your time at Vanderbilt.
A: I spent most of my time at the Sigma Chi house. We'd have dances over there [whenever we could get] two or three instruments together. We'd try to go to all the out-of-town football trips. We had good teams in those days, and we managed to go to New Orleans and Birmingham. Usually we'd take the train, but sometimes we'd take the bus.

Q: Your father, your son and you were all Sigma Chis. I understand there's a funny story about that.
A: Well, when my father went to Vanderbilt, it was pretty hard to get fresh fruit. But the Sigma Chi house always had a stalk of free bananas. The father of one of the students there was in the fruit business, and he would send bananas up to Nashville on the train. So that's why my father pledged Sigma Chi.

Q: Did you pull any pranks in college?
A: I remember one in particular. I was president of the sophomore engineering class, and we weren't invited to the junior prom. So we decided to break up the prom, which was taking place in the Old Gym. My job was to go into the power plant and be sure that the power line was disconnected. "Bulldog" (Julian H.) Mayo climbed up a pole and shut the lights out. It worked. And we were caught and kicked out of school. But [Dean Madison] Sarratt finally let us back into school, and I graduated.

Q: What do you remember about the Fugitives?
A: I knew Merrill Moore very well. Several others were Sigma Chis, and so I knew them too. But I didn't try to go to any of their meetings. I was an engineer, and engineers considered ourselves way above that. But some of the things that we heard about the Fugitives were amazing. For instance, they said that Merrill Moore could write a sonnet while waiting for a light to change in traffic.

Q: Tell me what it was like to work in engineering during the last century.
A: I worked as a general contractor all of my life and retired from our family company, Foster-Creighton, in 1985. Nearly all of our employees were engineers.

The company was founded in 1885 by my grandfather and Maj. Foster, who was a major in the Confederate Army. My grandfather went to the Western Military Institute, which is now Montgomery Bell Academy. He was an apprentice engineer to Maj. Foster. He was head of engineering for all the buildings of Nashville's Centennial celebration (in 1897). Our company built the foundation for the Parthenon back then, and built the present, concrete structure in the 1930s.

Foster-Creighton built many buildings at Vanderbilt including the stadium, the library, and the old hospital. We liquidated the company around 1989, and many of our employees went to work for the Parent Company.

Wilbur Creighton Jr. received his Eagle Scout badge in 1924. He recalled receiving a letter from the head of the Boy Scouts of America saying that Creighton was the oldest Eagle Scout living at that time. He also served in the U.S. Army corps of Engineers during World War II.

Vanderbilt Honors Perry Wallace

In February, Vanderbilt honored Perry Wallace, BE'70, by retiring his basketball jersey, only the third person so honored. Wallace made history as the first African American scholarship basketball player in the SEC. An electrical engineering and engineering mathematics major, Wallace went on to study law at Columbia University. He now serves on the law school faculty at American University in Washington, D.C. Pictured with Wallace are, left to right, Madani Adjali, BE'04, Vanderbilt Student Government Association president; Zach Thomas, BA'04; Chancellor Gordon Gee; and David Williams, vice chancellor for student life and University affairs.

Students Compete in 'Robot Rivals'

A team of three Vanderbilt engineering students has reached the semifinals of the DIY (Do It Yourself) network competition, "Robot Rivals," in which top engineering students from leading U.S. engineering schools, technical institutes and rival colleges vie against each other in a round-robin, tournament-style competition.

So far the Vanderbilt team, led by Michael C. Bono, a graduate student in electrical engineering, and including senior Guillermo Lagos and junior Kenneth Daniel Hooper, has competed with teams from Duke University and the University of Pittsburgh.

The show put the students in a large warehouse stocked with parts and gadgets and some household items, and challenged them to build robots that could perform specific tasks such as putting toys away, kicking a soccer ball, or cutting down trees. The Vanderbilt team built a "wall basher" in the first round of competition, and a miniature robot that played golf in the semifinals.

Pictured with their "wall basher" is Vanderbilt's "Robot Rivals" team: Daniel Hooper, left, Michael Bono, Guillermo Lagos, and DIY network's Buzz Dawson.

The Vanderbilt-Duke episode aired on April 2 on the DIY network, and the semifinal competition with the Pittsburgh team will air on June 11 at 9 p.m. EDT.

The final winners of the competition will receive the "Engelberger Trophy," named after Dr. Joseph F. Engelberger, considered by many to be the "father of robotics." The winning team will also receive a $2,000 scholarship for its school. The other 13 participating teams receive $500 scholarships donated to their engineering departments to use for future robotics parts and/or competitions.

The Vanderbilt team met through the student chapter of the IEEE (Institute of Electrical and Electronics Engineers).

When Washington, D.C., native Bono was three years old, he took apart a child's toy clock just to see how it worked. Since then, his interests have expanded to the study of radiation effects, plastic explosives and gasoline engines. His favorite pastimes include belonging to the IEEE, studying analog/digital design, and sailing. He believes the Honda Asimo robot is the most useful one to date.

Originally from Mexico and raised in Miami, Lagos is a senior pursuing a degree in computer engineering. His favorite area of study includes data networks. He believes the future of robotics lies in biotechnology. Lagos' interest in computer technology began when he took apart a computer when he was in ninth grade. At Vanderbilt, he and three fellow students worked on Sony's robot, Aibo, as an independent study project. His pastimes include the IEEE, golfing and cheering for his favorite teams, the Miami Dolphins and the Hurricanes.

Tennessee native Kenneth Daniel Hooper is a junior with a double major in electrical engineering and math. He believes that it will be commonplace in the future for robots to clean house or to fix a car. His interest in electrical engineering started at age six when he took apart an electrical can opener to see how it functioned. He recently worked on a robotic project called "Blinky," a line-tracing robot. He is also an active member of the IEEE. In his spare time, he sings with the Vanderbilt University Concert Choir and plays guitar.

ALUMNI

Bridge Over Troubled Waters

Alumnus helps students build bridges in Latin America.

Vanderbilt alumnus and Marquette Civil Engineering Professor Daniel Zitomer, MS'91, PhD'94, is co-founder and coordinator of an international service-learning project at that university. The program is called HEILA (Health, Environment and Infrastructure in Latin America).

The multidisciplinary initiative, cross-listed in the engineering and physical therapy departments, requires students to participate in — and be graded on — service activities related to their course work, performed in either Latin America or the Hispanic community in Milwaukee, Wis. The students gain an appreciation for other cultures through courses and lectures in engineering, history, culture, theology, philosophy, health issues and humanistic studies.

Engineering students have already built four badly needed bridges in remote areas of Guatemala.

"It's a hands-on experience, which is good in the engineering curricula," Zitomer explains. "It's important for the students to handle an engineering project from survey to finish and to see the practical applications of their work. Infrastructure development requires not only knowledge of local engineering and health care endeavors, but also the culture, ethics, environmental science, government, history and economics of the region."

In January, Zitomer's group built two small bridges on a rural road in the highlands of Guatemala, near the city of Tecpan. They also did the survey work for a bridge in another small town that virtually is cut off from civilization during the rainy season. They will build the bridge when they return in May and June.

"This community is located between two rivers, and they are cut off for a good part of the year so that a school teacher can't travel there," Zitomer says. "The materials to construct a school can't be brought there. People can't get to the hospital without a bridge. They can't readily get to other markets for any kind of economic development, so they are very strong proponents of getting this bridge built. When the students got there this year, the local people had a party for them and gave them gifts."

Zitomer said his own engineering educational experience at Vanderbilt "was definitely superb. I worked with professors internationally recognized in their field, including Richard E. Speece and W. Wesley Eckenfelder."

"Dick Speece was my mentor. Professor Ed Thackston taught me drinking-water treatment and that is something that we use in Guatemala. We're looking at doing sanitation and water treatment down there."

Speece, Eckenfelder and Thackston are now professors of civil and environmental engineering, emeriti.

Zitomer presented a short course in February at the Opryland Hotel in Nashville. The focus was on research he and Speece have conducted on anaerobic biological treatment — using microorganisms to break down wastes under lack-of-oxygen conditions. "At the most basic level, it's just like what happens at the bottom of a swamp, where the pollutants are typically converted to methane, carbon dioxide, gas and other products," Zitomer explains.

At Marquette, Zitomer works with his friend and fellow Vanderbilt alumnus, Marquette Bioengineering Professor Lars Olson, MS'89, PhD'93. Last May they traveled to El Salvador to conduct research measuring the breathing capacity of women who work in garment factories there. Olson is now analyzing the data they collected.

— *Lew Harris*

Above: American engineering students survey the site for a new bridge, while Guatemalans look on. Right: Alumnus and Marquette Professor Daniel Zitomer, far right, and one of his engineering students take a break from bridge building.

TECH TIME

DANIEL DUBOIS

Ronald D. Schrimpf, professor of electrical engineering and director of the Vanderbilt Institute for Space and Defense Electronics, is working with the "VAMPIRE" supercomputer, the Vanderbilt Multiprocessor Integrated Research Engine. Sometimes called a "Beowulf" system, it is a large-scale cluster of personal computers used by Vanderbilt researchers in a wide range of academic disciplines for high-performance computing.

Schrimpf and his colleagues in the Institute for Space and Defense Electronics study the effects of radiation on integrated circuits and electronic components in order to design devices and circuits that can survive harsh radiation environments in space and defense situations. They use computer simulation at the material, device and circuit levels to characterize and understand electronic systems' responses to ionizing and non-ionizing radiation.

Parker world leader in nuclear waste management

Nineteen-year-old Frank Leon Parker was among the first American GIs to enter Nagasaki after the U.S. dropped the atomic bomb in August 1945. The devastation has stayed in his memory, overshadowing every other kind of man-made or natural disaster. "A nuclear bomb makes everything else seem minor, because there is no defense against it after the fact," Parker says. "Biological and chemical weapons are serious, too, but we do have defenses against them."

DANIEL DUBOIS

Professor Frank Parker enjoys hiking in places as diverse as Tennessee and the Himalayas.

While he claims that horrendous experience had no effect on his choice of a career, the fact remains that this distinguished professor of environmental and water resources engineering has become an internationally acclaimed expert on the disposal of radioactive and other hazardous material.

Parker has won numerous awards for his work assessing and helping countries to dispose of and treat hazardous material from the Urals in Russia to the frozen tracts of Siberia and the mountains of Pakistan. Most recently, he became only the third person to receive the Wendell D. Weart Lifetime Achievement in Nuclear Waste Management Award. The award recognizes outstanding professional contributions to solving nuclear waste management problems over a lifetime.

Parker is also the only Vanderbilt faculty member ever elected to the National Academy of Engineering.

"Professor Parker is one of the most highly respected leaders in the world in the nuclear waste management field, and his expertise is unparalleled," says David S. Kosson, chair of civil and environmental engineering at Vanderbilt. "His achievements have made a tremendous difference to citizens in this country and worldwide."

After earning a bachelor's degree from the Massachusetts Institute of Technology and a master's and doctorate from Harvard University, Parker served as head of radioactive waste disposal research for the International Atomic Energy Agency and as director of radioactive disposal research at the Oak Ridge National Laboratory.

When he joined the Vanderbilt faculty in 1967, Parker initially focused on water quality issues. He has since concentrated on radioactive and hazardous waste problems, advising the U.S. and foreign governments and United Nations agencies on the national and world status of radioactive waste disposal.

Parker considers the risks of nuclear energy to be as low as or lower than that posed by other forms of energy, such as coal-fired power plants.

"My feeling is that we need to look at all options for energy, and we can't ignore nuclear energy," he says. "Everything has a risk. The question becomes, 'Do the benefits justify the risks?' The United States depends far too much on energy supplies from politically unstable regions."

Parker's international work has given him the opportunity to visit the world's great museums. While living in Vienna, Austria, he relished attending musical concerts in one of the world's great musical cities. One of his four children was born in Vienna, and he and his wife, Elaine, spend several months each year at an international think tank there.

All of the Parkers' four grown children live outside Nashville. That gives the couple many excuses to travel across America to see their extended family, which includes four grandchildren, ranging in age from 11 to 17.

Among his avocations are hiking and skiing, activities he has enjoyed in the Alps and the Himalayas. But perhaps his favorite places to ski are Colorado and New England, because of some very special skiing partners.

"I enjoy skiing with my grandchildren," he says, adding with a chuckle, "of course, I can't keep up with them."

In his mid-seventies, Parker shows few signs of slowing down. He continues his work on the faculty part-time, as well as his national and international consulting activities.

— Joanne Lamphere Beckham

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