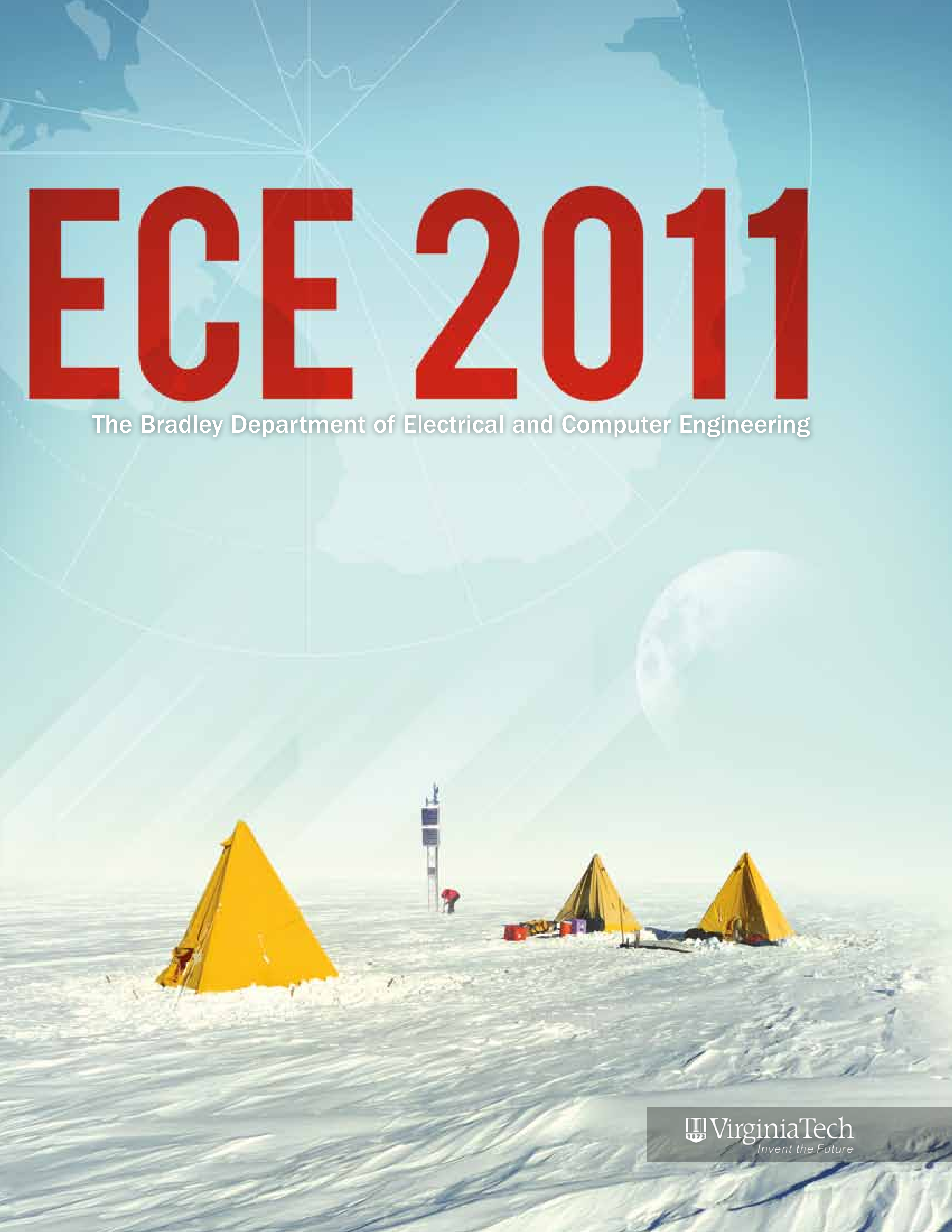
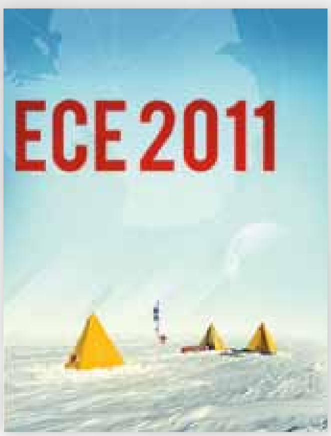
ECE 2011

The Bradley Department of Electrical and Computer Engineering



Virginia Tech
Invent the Future



COVER: When going out in the field, ECE researchers can find themselves anywhere from the waters of the Gulf of Mexico to the plains of Antarctica. This year, an ECE team of four, led by Bob Clauer, traveled to Antarctica as part of an effort to establish magnetometer stations to help with the study of space weather. Read about the expedition and other out-of-the-lab experiences inside. *(Photo illustration by Christina O'Connor)*

This report was produced with funds from the Harry Lynde Bradley Foundation.

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WHAT'S INSIDE

PERSPECTIVES from the Department Head

I continue to be honored and humbled to serve as department head of the Bradley Department of Electrical and Computer Engineering. I am still amazed by the accomplishments, creativity and dedication of our students, staff and faculty. And, I remain energized by the loyalty of our alumni, the support of our corporate and other friends, and the enthusiasm of the many employers that want to hire Virginia Tech ECE graduates. Although this annual report includes only a small sample of the many exciting activities in ECE over the past year, I hope that it conveys to you at least some of the quality, impact, innovation and, especially, potential of our ECE Department that I have the good fortune to experience every day.

Scott Midkiff
Department Head

When I interviewed for the position of department head in February 2009, I put forward five principles that I would use, and have used, to guide me in this position. These are to: (1) strive for quality; (2) maximize impact; (3) be innovative; (4) look outward; and (5) ensure integrity. The fourth principle, to look outward, may seem of lesser importance. Indeed, with wonderful colleagues around campus, outstanding ECE laboratory facilities and the surrounding beauty of Hokie stone buildings, the Duck Pond, and the Blue Ridge Mountains, looking "inward" is easy and rather satisfying. However, we must look outward for new ideas and to set benchmarks in our quest for even higher quality. We must collaborate with others, go beyond campus to conduct research, and cultivate our research and educational programs beyond Blacksburg to maximize our impact. And, the more that we look outward, the more that others will look at us, which will further enhance our reputation and attract the best students and faculty to consider joining Virginia Tech. It is also the new reality for higher education that we must also look outwardly for a larger part of the financial support needed to provide a first-class ECE education and enable cutting-edge research.

This year's report features ways in which some of our faculty members are looking outward — from space science research in the extremes of Antarctica, to facilitating citizen science in response to environmental disaster in the Gulf Coast, and beyond. There are many other examples of ECE faculty and students being deeply engaged beyond campus that are described only briefly or not at all in this report. The ECE faculty members and students based in

PERSPECTI

from the Department Head

Continued

the National Capital Region and at the National Institute of Aerospace near NASA Langley Research Center are tangible evidence of our engagement beyond the confines of campus. We also teach courses, in person or via distance learning, to students across the Commonwealth of Virginia, in Egypt, and elsewhere in the nation and the world. Many ECE faculty members are key leaders in international technical societies, journals and conferences, including Dushan Boroyevich, the President of the IEEE Power Electronics Society. These are all examples of how ECE is making a difference around the world, and how we are bringing those experiences back to Virginia Tech to improve and expand all that we do.

Beyond campus and on campus, much has happened within ECE during the past year. I would like to highlight a few particularly important milestones. University Distinguished Professor Fred Lee was one of 68 new members elected to the National Academy of Engineering. As described on page 26, this is a significant and well deserved honor, and a call to service, for Fred. Virginia Tech is particularly proud of Fred as he is truly a “homegrown” NAE member. Joseph Tront has been named the W. S. “Pete” White Chair for Innovation in Engineering Education. This two-year rotating chair was established by American Electric Power to honor Pete White, a 1948 electrical engineering graduate of Virginia Tech. Joe is being recognized for his long-term and continuing contributions to the use of technology in the classroom. Joseph Baker was named the Steven O. Lane Junior Faculty Fellow. This fellowship was established in memory of the late Steven O. Lane, a 1978 electrical engineering graduate of Virginia Tech, and recognizes a junior faculty member for teaching and research excellence in electromagnetics and antennas. Masoud Agah and Allen MacKenzie were granted tenure and promoted to the rank of associate professor and Bob Clauer was granted tenure at the rank of professor.

We welcome two new members to our faculty, Jules White and Dennis Sweeney. Jules’s expertise is in the area of cyber-physical systems, which are systems with closely linked computational and physical aspects. Dennis is ECE’s new Director of Instructional Laboratories and is responsible for facilitating innovation in and ensuring the efficient operation of our teaching laboratories.

I also note the passing of Ira Jacobs on August 11, 2010. Ira was truly a gentleman and a scholar. His wisdom, service and unwavering optimism are greatly missed.

In closing, I wish to thank our many friends and supporters, both on campus and beyond. The support of the Bradley Foundation, industry partners, research sponsors, alumni and other friends is particularly important as we strive to further improve our education and research programs. I especially want to thank the members of the ECE Advisory Board and the members of advisory boards for our research centers and groups for their wise counsel and support. I am personally grateful for the dedicated service of Gino Manzo, past ECE Advisory Board chair, and Mike Hurley, our current chair. On campus, Dean Richard Benson and the rest of the College of Engineering team continue to be of great assistance to me and others in ECE. Most importantly, I greatly appreciate the faculty, staff and students who are the Bradley Department of Electrical and Computer Engineering.

Scott Midkiff
Department Head

NEW FACULTY

Jules White

Jules White joined the ECE faculty as an assistant professor. White’s research focus is cyber-physical systems, which are systems with closely linked computational and physical aspects. This emerging field is rooted in embedded systems but focuses on the interactions between the physical and computational aspects. White comes to Virginia Tech from Vanderbilt University, where he was a research assistant professor. White received his Ph.D. from Vanderbilt in 2008 and his M.S. in 2006. He earned a B.A. from Brown in 2001.

from the Chair of the Advisory Board

"Ut Prosim— That I May Serve"

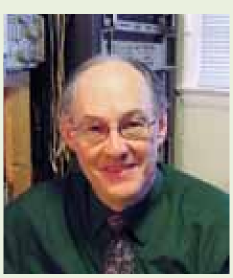
I have always been proud of Virginia Tech's motto. It reminds us of a greater purpose for our education and research and for overcoming their associated challenges. Both as individuals and as a university department we must strive first to obtain a sound education and then apply what we've learned in theory and research to improve our community and ultimately our world.

In this annual report, you will see many great examples of field-leading research being applied to address all sorts of issues and to improve people's lives. The Bradley Department of Electrical and Computer Engineering's (ECE) faculty and students have been doing their part to continue the department's tradition of academic excellence with practical results.

Improving the energy situation at the local level and at the global scale is an area of interest for me as well as an area in which I believe the ECE department is well-positioned to contribute. With benefits ranging from reducing individuals' utility bills to enabling worldwide sustainability, this area of research is notable for its many technical challenges and for potentially huge benefits to society: an exemplary fit for our academics and research.

Two trends that continue to require the department and the university to be adaptive are the increased emphasis on application-oriented research (driven largely by the continued shift to direct research funding, now 48 percent of the College of Engineering funding) and the increased need for multi-disciplined research and development in order to successfully address complex problems. These are two areas in particular where members of the Advisory Board, as well as others in industry, should be well positioned to lend their expertise, professional connections, and funding support. There are many ways to get involved. Please consider ways you can contribute. Personal contributions and service to others, coupled with strong education and technical know-how, are a powerful combination that makes the Virginia Tech community exceptional.

Michael Hurley
Chair, ECE Advisory Board



Dennis Sweeney

Dennis Sweeney joined ECE this spring as Director of Instructional Labs. In this role, Sweeney will oversee the creation, operation, and ongoing improvement of instructional laboratories. He will also partner with faculty members to develop and deliver original and cutting-edge laboratory and design courses. Sweeney earned his BSEE ('71) from Virginia Tech, received an Master of Arts in religious studies ('76) from the Catholic University of America, and obtained his Master of Science ('86) and Ph.D. ('92) degrees in EE from Virginia Tech.

DEEP FREEZE

SPACE SCIENCE TAKES ECE TO ANTARCTICA

PHOTO ILLUSTRATION BY CHRISTINA O'CONNOR

The research team combatted the altitude, long days, and extreme cold weather as they worked to troubleshoot and install data collection stations. The team labored to install and protect their equipment, which was designed to withstand the grueling Antarctic weather.

PHOTOS COURTESY OF BOB CLAUER, HYOMIN KIM, JOSEPH MACON, AND KSHITIJA DESHPANDE

A Virginia Tech research team is working to understand space weather — from the South Pole. As part of a $2.39 million grant from the National Science Foundation (NSF), the team is deploying seven autonomous data collection stations in Antarctica within the next four years. There are unique difficulties associated with the project, but also a unique payoff: these are measurements that no one has taken before.

Each system is autonomous and designed to operate unattended for at least five years on the east Antarctic plateau. Data are acquired at Virginia Tech in near real time using satellites.

When fully deployed, the chain of data platforms will help with studies of global phenomena from the solar wind/magnetosphere interaction. Specifically, researchers will be able to observe the changes in the electrodynamic circuit formed by the solar wind coupled to both polar ionospheres by magnetic field lines.

The seven stations will be roughly along the 40° magnetic meridian (longitude) — the same magnetic meridian where researchers already have magnetometers in the northern hemisphere along the coast of Greenland. Once they have a similar chain in Antarctica, the team can see how the data from the two hemispheres relate. “We have models of the global magnetosphere, but we’d like to validate those models,” explains Robert Clauer, the ECE professor who heads the team. “Since these are all new measurements, that are coordinated between both Northern and Southern hemispheres, maybe we will see something that lets us understand a new phenomenon.”

There are SuperDARN radars in the South Pole area as well, so scientists can also measure the electric fields over the new platforms. “Eventually,” Clauer says, “we’ll put all the data together to start understanding it, then relate it to the Northern hemisphere.”

This winter, Clauer, with post-doctoral researcher Hyomin Kim and graduate students Joseph Macon and Kshitija Deshpande, traveled to

"Because these systems are made to be deployed in such a harsh environment as the South Pole, there are some unusual design considerations."

Left: The team flew a Virginia Tech pennant at the stations being tested at South Pole. From the left, Bob Clauer, Kshitija Deshpande, Joseph Macon, and Hyomin Kim. Bottom right: The data stations run on standard lead-acid batteries during solar winter.

Antarctica to troubleshoot an existing station that had failed and to install two new stations as test systems at the South Pole research station. If the new stations function well for a year, they will be deployed next year to remote locations a few hundred kilometers from the South Pole.

The Stations

Each platform includes three devices: a fluxgate magnetometer, a search-coil magnetometer, and a dual-frequency GPS receiver. The fluxgate magnetometers measure background magnetic fields, which are associated with electrical currents in the ionosphere, while the search-coil magnetometers specifically measure the changing magnetic fields and low frequency (ULF) waves.

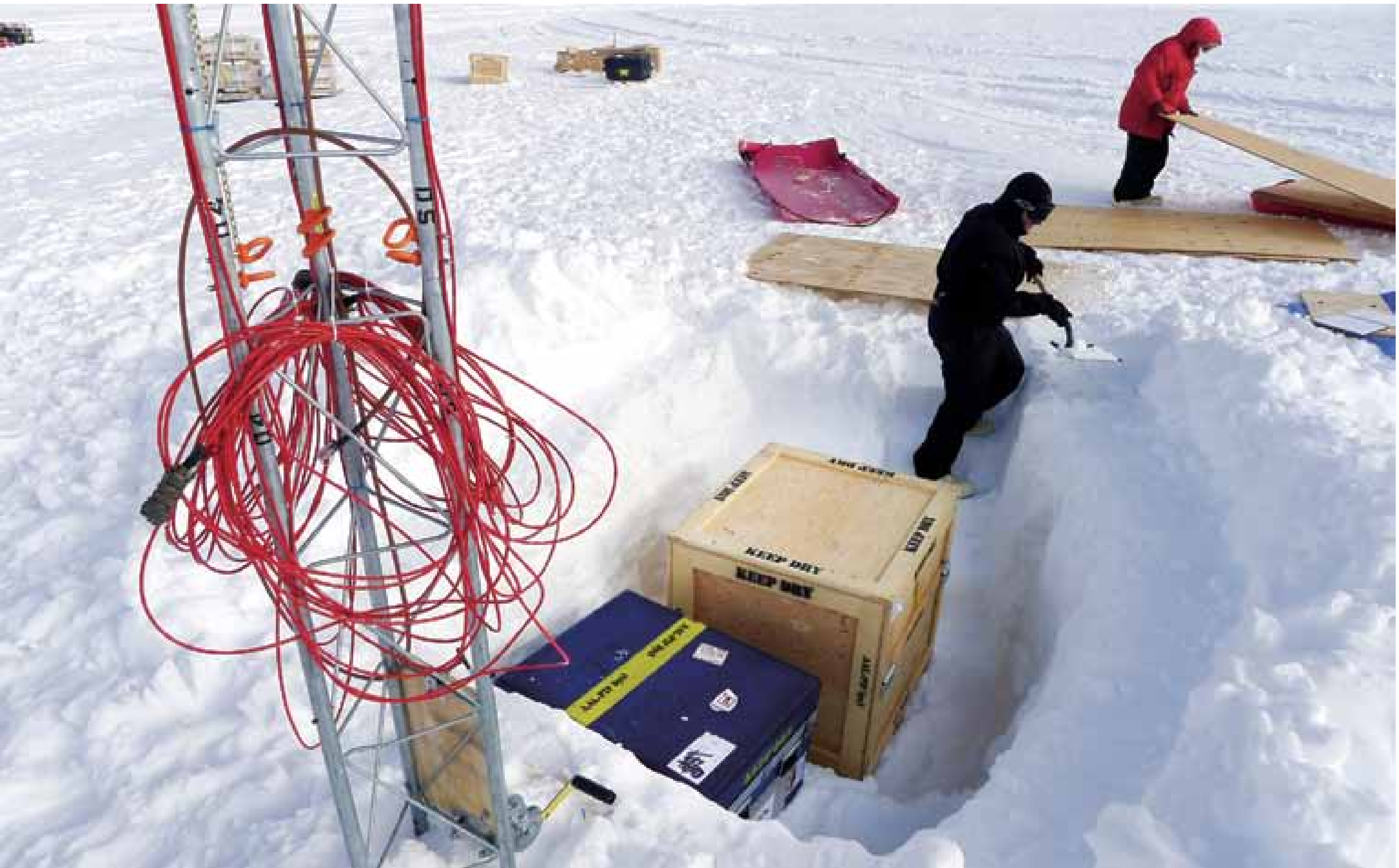
The GPS receivers can measure how a signal changes from movement through the ionosphere, and can calculate the number of electrons that the signal has moved through. This is very new technology, according to Clauer, who calls it risky but very flexible. The GPS receivers were originally designed at Cornell and customized by Brent Ledvina, a former ECE assistant professor, and Todd Humphries from the University of Texas at Austin. "It's ideal for us to get such a nice instrument tailored to our needs in the polar regions," Clauer notes.

Because these systems are made for deployment in such a harsh environment as the South Pole, there are some unusual design considerations. The only way to transport the systems in Antarctica is by small aircraft, so weight and size is important. Yet, the systems require enough battery power to operate through the winter.

Design for a Harsh Environment

Clauer explains that it is also important for the systems to be simple and reliable. "Lots of exotic solutions may work, but they are very risky,"he says. "Lead-acid batteries are very robust; they have been around a long time and they work. Solar cells run the system during the summer, lead-acid batteries during the winter."

The electronics are housed in a super-insulated box, custom-made from vacuum panels for minimal thermal loss. Energy loss from the electronics is sufficient to heat the box, but the Iridium radio and the GPS receiver cannot be operated for long at the same time, or the box becomes too hot. When the outside temperature is around -20° F, the temperature in the box is around 104° F (40° C) and can get up to 80° or



90° C very quickly with both devices running. Clauer, however, isn't concerned about this. "It's something we can deal with," he says.

The Iridium radio transmissions also cause some interference for the GPS receiver. The team is working with positioning the GPS antenna to minimize this interference. "This is a prototype for testing," Kim explains, "and we'll debug the problems for a year before we move the systems to actual locations. So it's not too surprising that we have some small issues to resolve."

The team built four stations this year. Two are at the South Pole for a year of testing in Antarctic conditions; one is at Ann Arbor, Michigan; and one is at Virginia Tech. If the two stations established this year at the South Pole work reliably, they will be deployed in the field next year and the stations from Ann Arbor and Virginia Tech will go for testing at the South Pole.

Two stations have already been deployed at locations in the field: PG1 and PG2. These stations are based on an earlier model of the platform, and have only one magnetometer each. PG1 was tested at the South Pole for a year before being set up at its location, but PG2 was not tested before deployment and is the one that failed and returned to Virginia Tech. "We think it may be a communication failure," says Macon, who attempted to fix the station in December.

Macon notes that there will be some difficulties to overcome while setting up the system for testing in Blacksburg. "The platform can't be set up with liquid precipitation," he explains, "because it's designed for dry and cold weather. We have to figure out how to deal with that if we're going to set it up here in Blacksburg. It will work just fine, but we have to make sure it's protected for a different environment. There are a lot of wires to be buried in snow, and we can't do that here. Something might run over it, or some rodent might decide it's tasty."

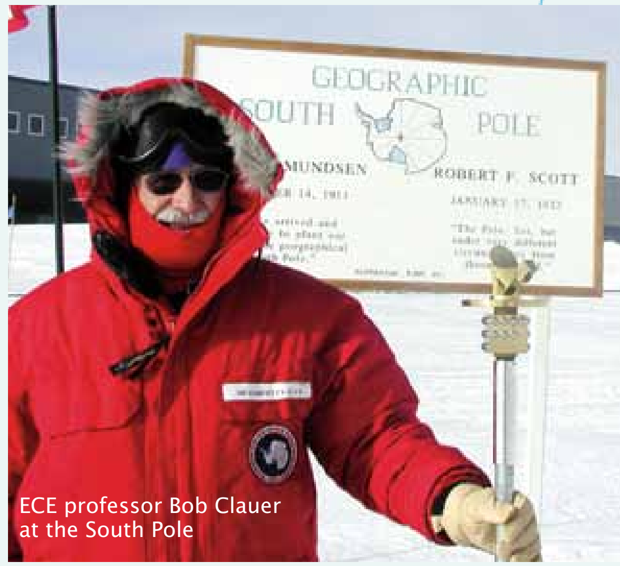
The stations consist of a tower, a main vault for batteries and electronics, and instruments. The tower holds only the solar cells and Iridium radio

The team prepares to cover the vault of one of the South Pole stations with plywood to protect it from drifting snow.

GREENLAND

Earlier in his career, Clauer worked with the magnetometer array in Greenland. This array, along the west coast of Greenland, is equipped with enough stations to allow only a few hundred kilometers between them. Scientists have been collecting and analyzing data from this array for years, and are hoping that the new South Pole array will furnish them with similar data.

Clauer relates one of his favorite experiences from his work in Greenland, when researchers saw small spikes in their data that needed to be explained. Using data from the Greenland magnetometers, they found that all vectors pointed to a single point because a field-aligned current and a radial electric field caused the ionosphere to move in a circle around the current. "I really appreciate clever displays of data; they open your eyes to understand what is happening. It's rare that you see data come out that looks so perfect."



ECE professor Bob Clauer at the South Pole

Below: The field camp established on the Antarctic Plateau to recover malfunctioning station PG2 (84.42°S, 57.96°E). Next page: Team members from the left are Joseph Macon, Hyomin Kim, and Kshitija Deshpande. The picture is taken at the "Happy Camper" training course given at McMurdo Station prior to deployment to the South Pole.

antennas — everything else is buried to protect it from the environment. The main vault containing the batteries and electronics is buried about four feet deep, while the instruments are buried in shallower pits.

Every pit is covered with plywood to make it safer for the devices and easier to dig up again. Precipitation deposits snow for the team uncovering the devices. However, when Macon and Kim were digging up PG2 they found that they had to shovel 2.5 feet of snow to uncover the main vault.

"The equipment is specifically designed to be set while wearing gloves, except for the coax cable for the radio. You still have to take your gloves off to attach that," Clauer says. "The best thing I found was the chemical hand warmers. Even in Antarctica, they last about seven hours," he adds.

"We were lucky that there wasn't much wind," he reports. "If there's wind, then it's even colder and you can't keep the snow shoveled."

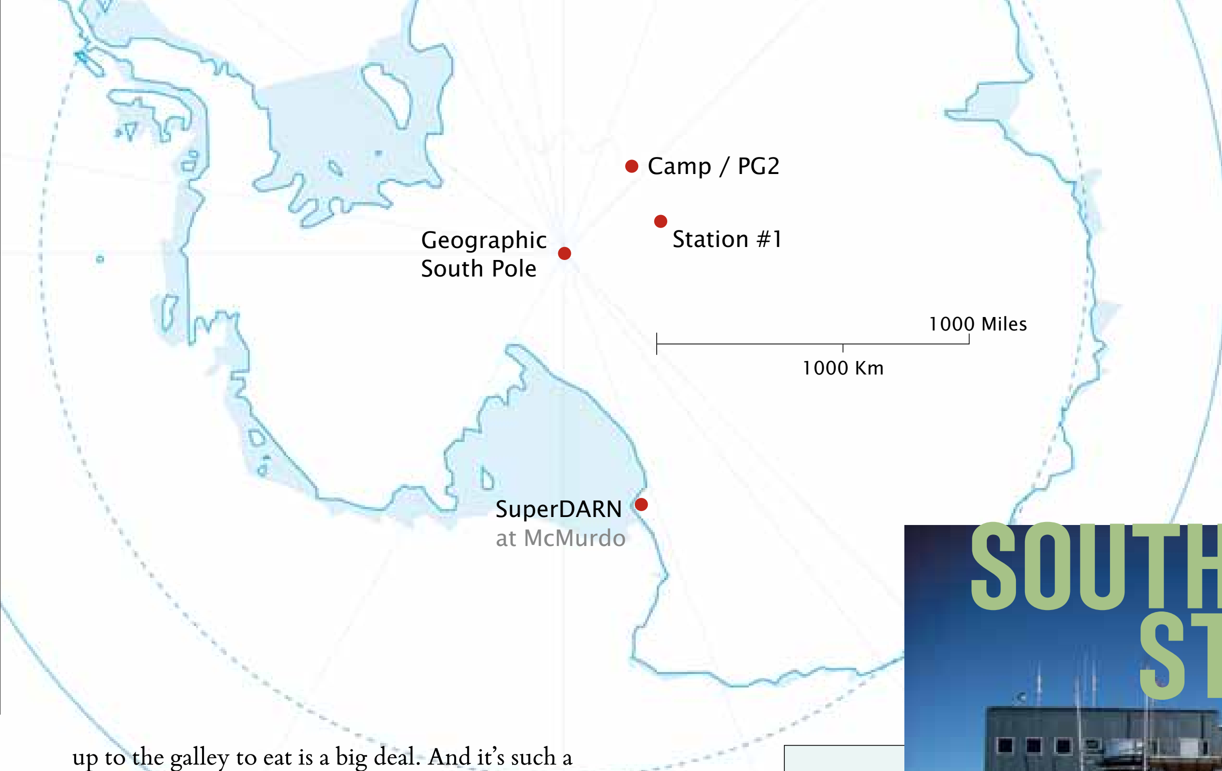
The stations also are affected by the extreme dryness. "Because it's so dry, our electric tower gets a lot of electrical potential produced by the blowing snow," Clauer says. Static electricity is a big problem. "You're on 3 km of ice, so grounding is nearly impossible. We ground our stuff to the tower, which is floating and changing potential all the time."

The Trip

Of the four, Kim is the only one with previous experience at the South Pole. This was his fourth trip to Antarctica and third to the Pole, and he even recognizes some of the same people from previous trips. "I think there are two different types of people; one type really loves to be back, for others one time is fine," he says, "but whenever I go, I see some of the same faces." He finds something different every time, however. Not only was this his first time camping on the remote Antarctic Plateau, but it was also his longest trip so far. "Staying for so much longer was very physically challenging. There was much more work involved and even very simple tasks could be a challenge," he says.

Clauer's previous experience had been in Greenland, which he says was a "smaller, simpler operation. Antarctica is huge by comparison — there is a much bigger learning curve. Greenland is not quite as high, and not quite as cold."

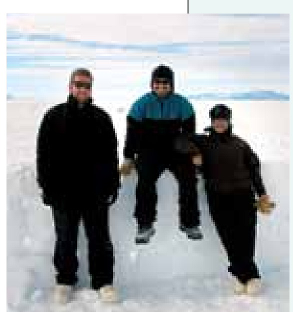
Travelers are advised to spend their first days at the South Pole acclimating to the altitude. Deshpande explains, "if you get serious altitude sickness, you may have to be evacuated. You already are short of breath, and it's cold, so your body doesn't really work normally at all. Just walking around is a pain. Climbing stairs to get



up to the galley to eat is a big deal. And it's such a cold air that it just cuts your throat. You have to fight your own body to get stuff done."

"What struck me the most," Macon declares, "was realizing how treacherous the continent is. As you get out to the South Pole, it hits you that this place is really cold. Antarctica really just doesn't care if I make it out of here or not. It inspires a certain amount of respect." But Macon admits that the experience was worth it. "This wasn't a super-fun field trip," he says, "It took a lot of effort and commitment to get through it, but I'm proud of our team."

By the second day, the team was ready to start installing the two platforms. One of the locations was 3/4 of a mile from the station. "It would take at least an hour to walk there, and you'd arrive totally exhausted," says Macon, so they traveled by snowmobile. It took about five days to get the first system set up, at which point the team split. Macon and Kim went camping out to PG2 while Clauer and Deshpande stayed to install the second platform.



Camping

Although being inside the elevated station was comfortable, out in the field it was extremely cold. Macon, Kim, and a professional mountaineer went camping by PG2 to try to fix the system or, failing that, to pack it up and bring it home.

THE SOUTH POLE STATION

South Pole Station is a permanent research station located in the center of Antarctica, only about 350 meters from the Geographic South Pole. Clauer notes, "it has many scientific applications, including a clean air sector, a dark sector where no lights are allowed, and a seismic research sector."

With all this research around, finding a location to set up sensors in the surrounding area can be tricky. To get out on the plateau to set up sensors, people and equipment are flown to their site in small planes. "You need good GPS coordinates for each station so that the plane can find it again," according to Clauer. "We accidentally put one of our stations in the middle of the ski trail, but it wasn't a problem to move the trail over a bit," he says.

The only way to access South Pole Station is to take a plane from McMurdo Station, which is located on the coast of Antarctica. There is only one type of plane coming from McMurdo to South Pole Station: a C130, which is a military plane with skis that is mostly for cargo. Five firefighters must be on the runway every time it takes off or lands.

"Antarctica really just doesn't care if I make it out of here or not. It inspires a certain amount of respect."

"It's quite an experience," says Kim, who had never camped out during any of his previous trips. "The South Pole is already high, so everyone has some altitude sickness. Where we were camping was 2000 feet higher than the South Pole. We were okay, but we had to breathe harder."

It took the first day to set up the camp. The second day they tried to troubleshoot the system, then packed it up. By the end of that day, the three were ready to be picked up. But that evening the wind picked up.

"When we first got out there, we could see forever, it's just this ocean of white. But when the wind gets up strong enough to kick up the snow, it just starts closing in on you and turns into a gray soupy mess," Macon reports.

The trio had plenty of supplies, since campers in Antarctica are required to take enough food to last for seven days longer than they think they will need to be out. According to Macon, "it was just kind of a mental struggle. There's nothing to do."

Kim adds, "it's not like you're stuck at an airport. You're in the middle of nowhere, only three people doing nothing with no civilization around." Luckily, the plane was able to make the trip the following day.

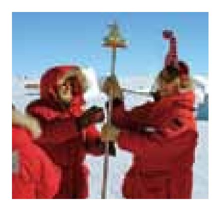
Celebrations

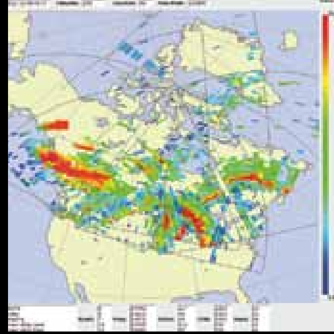
Celebrating the winter holidays at the South Pole was a unique experience. "They had a really nice Christmas dinner for us," says Deshpande. "They put the blinds down so that it looked like evening in spite of the 24-hour sunlight. Everyone was dressed up, and the food was good. There was even a Yule log on the flat-screen televisions!"

Because the ice sheet and South Pole station move, the location of the actual rotational pole shifts relative to the station over time. A surveyor is brought to the station each year and on New Years Day, a new pole is placed at the proper location of the south rotational pole. The team was part of the moving of the pole ceremony, a yearly New Year's event.

This year, however, marks the 100th year since the South Pole was first visited, and there is a special centennial pole to mark the occasion. Everyone resident at the station forms a line from the old pole to the new location and passes the new pole hand-to-hand to the new location. ■

Below left: group picture of the "Happy Camper" students around the dinner table that they constructed in the snow. Center: The team celebrates New Year 2011 at the South Pole. Right: Bob Clauer passes the 2011 South Pole marker in the annual pole moving ceremony.



SUPERDARN

Researchers at the Virginia Tech SuperDARN laboratory have been working on adding four new radars to the Super Dual Auroral Radar Network (SuperDARN). SuperDARN is an international collaboration involving scientists and engineers in more than a dozen countries. High frequency (HF) radars are positioned around the world and operated continuously to provide global, instantaneous maps of plasma convection in the Earth's ionosphere. Scientists around the world use SuperDARN data to help understand the many effects of space weather, according to Joseph Baker, who is part of the Virginia Tech SuperDARN team, along with Ray Greenwald, J. Michael Ruohoniemi, and Lasse Clausen.

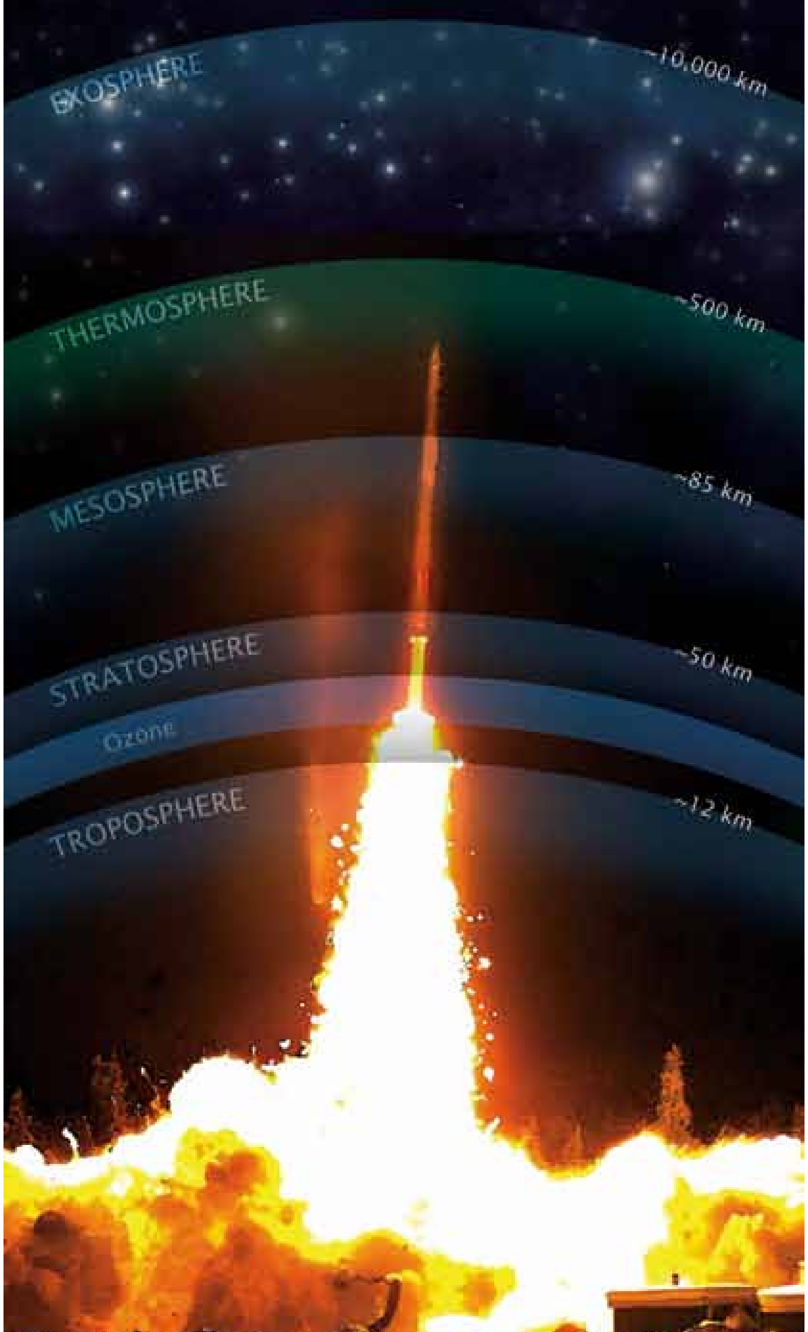
Originally, SuperDARN measurements were available only for the far northern and southern latitudes, but in recent years SuperDARN researchers have been adding new radars to the network to extend its coverage to middle latitudes. In the past two years, the Virginia Tech SuperDARN team has worked on building four new radars at two separate sites: Ft. Hays, Kansas, and Christmas Valley, Oregon. Dartmouth College is the lead institution for the two Christmas Valley radars and Virginia Tech is the lead institution for the two Hays radars. Over the next couple of years, the Virginia Tech team will be involved in adding two radars in the Aleutian Islands of Alaska, and two more in the Azores Islands of Portugal.

From left: Kevin Sterne inspects electronics hardware; a monitor showing combined data from all SuperDARN sites; the new site located in Oregon, and the new site located in Kansas.

TOP LEFT: CHRISTINA O'CONNOR, OTHERS COURTESY OF SUPERDARN LABORATORY

REACHING FOR THE STARS

To study our own atmosphere



In the polar night of early February, at the Poker Flat Research Range north of Fairbanks, Alaska, a Virginia Tech team launched a rocket into an aurora. The team included ECE associate professor Scott Bailey, Chris Hall of aerospace and ocean engineering, two students and a postdoctoral associate, plus colleagues from three other institutions. The 10-minute flight took the rocket 200 miles above the ground and represented the first time a sounding rocket was used for pointing at a star near the horizon and using attenuation of starlight to determine atmospheric constituent concentrations.

Some measurements are harder to obtain than others, and Bailey's team sometimes must take their measurements by sending special equipment up on rockets. With funding from NASA, the team was aiming at Spica, 260 light years away, in an effort to measure the amount of nitric oxide in the upper atmosphere.

Nitric oxide is important because it can destroy ozone. One of the chemical byproducts of the aurora, nitric oxide is usually found in the thermosphere — at a far higher altitude than the ozone in the stratosphere. However, "in the polar night, there are no solar photons to break up the nitric oxide," Bailey explains, "so the aurora keeps building it and there's nothing to take it away. Then it has time to flow downward and destroy large amounts of ozone."

According to Bailey, "we've observed the ozone destruction that we believe occurs from aurorally produced nitric oxide, but we've never measured the nitric oxide itself at night, when it must be flowing down. The methods we use for nitric oxide in the daytime don't work at night."

The team aimed the sounding rocket at Spica because it shines exceptionally well at wavelengths that only nitric oxide absorbs. With the star in occultation (covered by Earth's atmosphere), they hoped to measure the density of nitric oxide molecules along the path from the rocket through the atmosphere. They used an ultraviolet spectrograph designed at the University of Colorado to measure the starlight. The more nitric oxide between the rocket and the star, the more the spectrograph signal decreases when viewing through the atmosphere. "It's tricky to find a star that's bright at the UV wavelengths that only nitric oxide absorbs."

It's also hard to get the rocket pointed at the star, he explains. NASA has equipment that can take the rocket up to space and point it within two arcminutes (one arcminute is 1/60 of a degree), but this only works when the rocket is pointing at a star sufficiently high in the sky. However, to study the atmosphere, the rocket had to actually look toward the Earth's horizon. To compensate for this, they planned for the rocket to first lock onto a star higher in the sky, then use a gyro system to scan it down mechanically. An internal camera system would then help align it more precisely. "When you look at the whole system, it's very complicated, but on the other hand, except for the looking near the horizon, this pointing approach is well within the team's experience," says Bailey.

Building the Hardware

Building the hardware presented a number of challenges. The experiment was led by Virginia Tech, in collaboration with researchers from the University of Colorado, Utah State University, and Artep Inc. (a small company in Maryland). "It was an interesting challenge bringing together hardware when it came from four different places," says Bailey. The telescope they used, for example, had been flown on rockets in the 1980s and 1990s, but had been on display in Colorado.

The team performed all the testing and integration at Virginia Tech, and then integrated with NASA's systems at the Wallops Flight Facility on the Eastern shore of Virginia, and then integrated the entire payload with the rocket motors once in Alaska. "It's a big success for Virginia Tech to get it together and get it launched."

In addition to Bailey and Hall, the team includes master's student Padma Thirukoveluri, Ph.D. student Justin Carstens, and postdoctoral associate Brentha Thurairajah.

Even with all the lab tests, Bailey explains that field trials are a vital part of the research. "You think it's only a small difference from what you've done before, but all the new variables come together to make it something different. A failure in the pointing system prevented us from getting pointed at the star," Bailey explains. Even though this year's launch didn't return with the data they had hoped to collect, he remains optimistic. "We're a long way from being done," he says.

"We learned a lot about pointing at a star close to earth. It's the first time a sounding rocket had done that." The team would like to try again, and hopes in the future to expand the effort to include measurement on the same star, but from a satellite.

Top: The team tested and integrated all the hardware for the experiment at Virginia Tech, then integrated with NASA subsystems at Wallops flight facility, and installed the motors in Alaska. Center left: Bailey's team involved a number of undergraduate and graduate students over a couple-year period. Shown here from the left are Brentha Thurairajah (postdoc), graduate students Cissi Lin, Justin Carstens, and Padma Thirukoveluri, and Bailey. The space monkey is a good luck tradition for Artep (not flown). Center right: The star tracker camera mounted inside the rocket skin. Bottom: The rocket was launched from Poker Flat Research Range during a beautiful aurora.

PHOTOS COURTESY OF SCOTT BAILEY

TAPPING MULTI-CORE

With the current trend of multi-core processing, software is struggling to keep up with the new hardware. We are all familiar with the dual- and quad-core systems common in new off-the-shelf desktop and laptop computers, but some time-critical applications are beginning to be run on machines with up to 50 cores, compounding the difficulty.

ECE associate professor Binoy Ravindran is leading a team of students to confront some of the unique challenges of multi-core computing — managing time constraints of dynamic time-critical applications on multi-core hardware, and automatically modifying existing time-critical code for use on the new hardware. Working with the U.S. Navy, the team is also successfully applying their theories and experimental software systems to real production systems.

Real-Time Systems

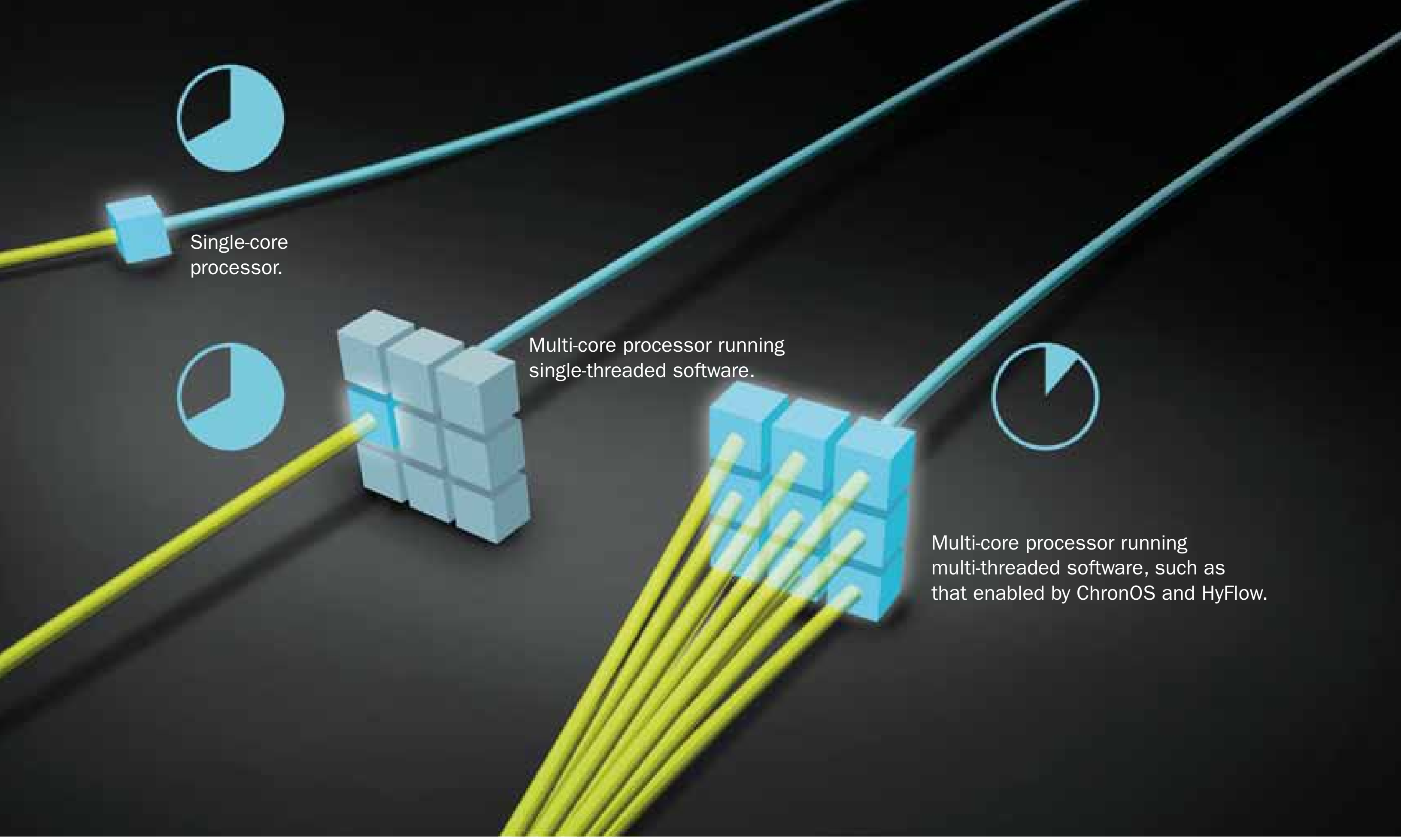
Ravindran and his team are investigating real-time systems applications. They must figure out how to satisfy application-level time constraints on the new multi-core hardware. "We have fairly mature theory and techniques for understanding how to satisfy application time constraints on machines with only one processor," Ravindran acknowledges, "but comparatively little is understood about doing this on multi-core platforms."

One challenge for the group is satisfying time constraints for dynamic applications. According to Ravindran, conventional real-time concepts and techniques are largely focused on static, device-level monitoring and control, in which the software operates in a largely predictable environment — real-time system's historical niche.

> Real-time capability without rewriting **millions** of lines of code

Dynamic application contexts, however, involve situations where no one knows when events will trigger computations, what resources computations will need, or how long computations will take to execute. "In spite of this," Ravindran explains, "we still have to meet application time constraints as best as we can, in a way that makes sense to the application, given the current situation and circumstance."

Ravindran has worked on the devel-



opment of real-time resource management techniques for such dynamic real-time applications for the past 15 years. “We have developed multiple generations of algorithms and system software (including operating system kernels, Java virtual machines, and middleware) for this problem space in the past, but none have looked at the multi-core challenge,” he says.

The team is developing both the underlying theory and system software to meet this challenge. The group has recently developed the ChronOS real-time Linux kernel, the Linux operating system modified to support dynamic real-time applications on multi-core hardware. ChronOS is open source and available via *www.chronoslinux.org*.

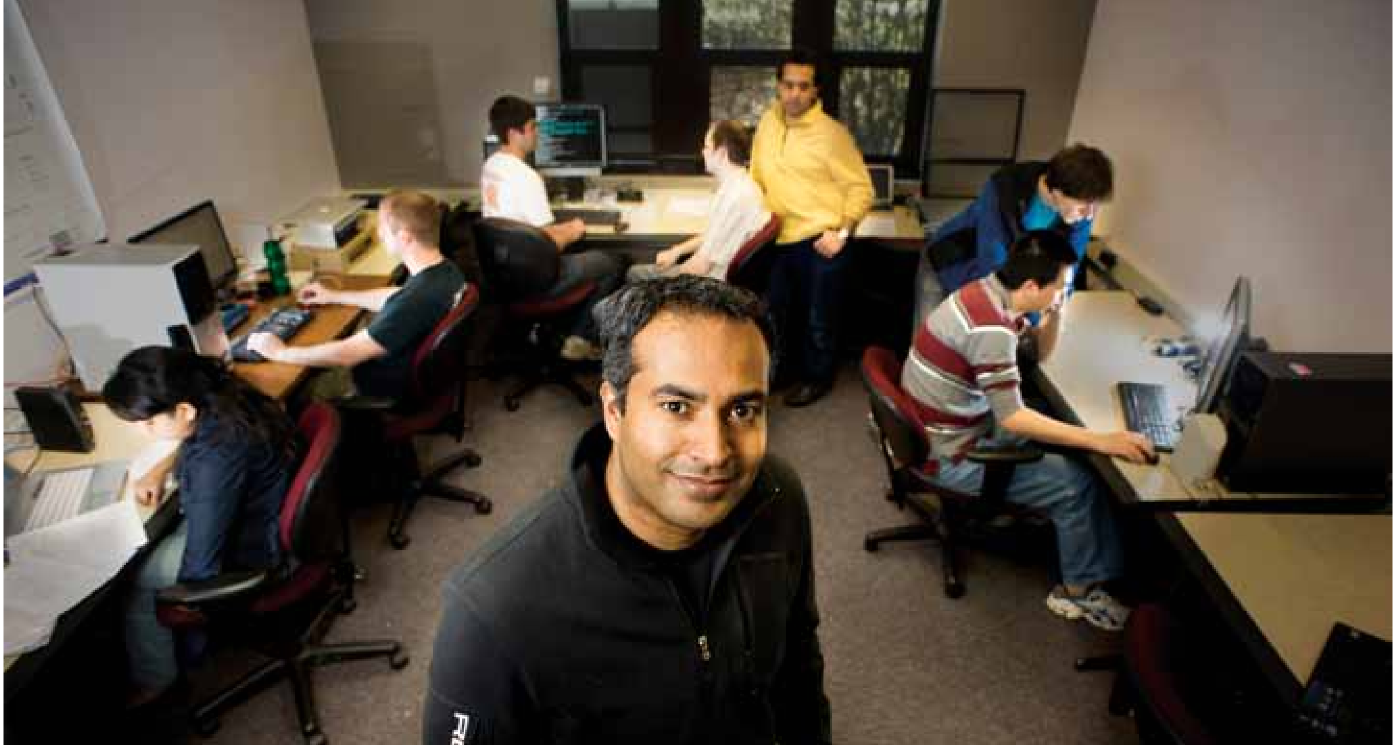
Modifying Existing Real-Time Software

The team is also tackling the related challenge of modifying existing real-time software, or “legacy” real-time code, for use on multi-core platforms. They are working on automated concurrency refactoring: techniques that introduce greater concurrency into legacy real-time code to exploit the parallelism of new multi-core hardware, without manually rewriting large portions of existing code. Concurrency occurs when multiple computations execute simultaneously on physically separate computing cores on multi-core hardware, often resulting in greater application throughput and enhanced timeliness.

“The challenge is to transform existing real-time software to support emerging multi-core platforms,” according to Ravindran. “Real-time software poses particular difficulties because time constraints that were met in the earlier code must continue to be met after the transformation, while greater concurrency is being exposed. This is a significant problem for many organizations with enterprise-class legacy real-time software, running into millions of lines of code, as they confront a hardware technology refresh challenge.”

The team is working to develop a suite of automatic and semi-automatic techniques that can take an existing real-time code base and introduce greater concurrency to exploit the parallelism of the multiple cores, while still meeting time constraints. “For this to work, program transformation techniques backed by real-time scheduling and concurrency theory must be designed,” emphasizes Ravindran, “we are developing such theory, as well as modified compilers and runtime systems, which can take legacy real-time code in the front and crank out transformed code for multi-core platforms at the other end.” For this purpose, the team is exploiting a technique called software transactional memory or STM, which has recently gained significant traction in the concurrency community due to its programming ease and scalability on multiple cores.

In addition to ChronOS, the team is developing a Java-based distributed software system called HyFlow to aid with distributed multi-core real-time programming. “Many real-time (and non real-time) sys-



Binoy Ravindran and some of the students in the Real-Time Systems Laboratory. From left: Sonal Saha, Peter DiMarco, Aaron Lindsay, Matthew Dellinger, Mohamed Saad, Alex Turcu, and Bo Zhang.

tems are networked computers, each with potentially multiple cores. Programming such hardware is challenging, as reasoning about multicomputer concurrency adds an extra level of complexity," says Ravindran. He adds that "STM is not a silver bullet, but it is a promising solution for some fundamental multi-core concurrency problems. HyFlow extends STM for networked computers, encapsulating STM's programming ease and scalability as an easy to use Java programming interface." More information on HyFlow can be found at *www.hyflow.org*.

Ravindran and his team are devoted to building their experimental software as open-source projects. "I want to keep ChronOS and HyFlow open source," he says, "I think that's the way to build robust software and increase innovation. You have to get the larger community involved."

Applying Theory and Software in the Real World

Ravindran and his students aren't just developing theory and experimental software systems, though — they are working with the U.S. Navy to put their ideas into practice. Their work, funded in part by the U.S. Naval Surface Warfare Center (NSWC) Dahlgren and the Naval Engineering Education Center (NEEC), allows them to target Navy production systems for testing their ideas at the Navy's Dahlgren laboratory. "The Navy's Aegis Combat System, a highly complex computer system, has been a big inspiration for us in the dynamic real-time problem space," Ravindran emphasizes. For two years, Ravindran has been working at Dahlgren during the summer as an Office of Naval Research Faculty Fellow and taking his students with him to Dahlgren to test their ideas.

Last summer at Dahlgren was very successful he says. "At the end of the summer, preliminary versions of ChronOS and HyFlow were able to support key components of Aegis on new multi-core hardware and demonstrate improvement. We were able to understand what works and what doesn't and why, and we came back with a new set of difficult problems to work on." Ravindran continues, "Additionally, students were incredibly excited about the Navy and work in the national security arena, which are the central goals of NEEC."

"Experimental software is just that — a software proof-of-concept to demonstrate ideas. ChronOS, HyFlow, and other artifacts down our pipeline are not products by any stretch. We are in the business of doing academic research: answering interesting fundamental questions," Ravindran explains. The emerging multi-core challenge, working with a complex system like Aegis, access to a production system, collaboration with NSWC, and the on-site testing of their research keeps the team highly motivated, he says.

"Part of the reason the dynamic real-time problem space is so little understood," he continues, "is the lack of access to nontrivial applications for academic researchers. Our work with NSWC has solved that problem for us."

Ravindran enjoys the connection to his own introduction to dynamic real-time systems, "My own graduate theses, which were in the dynamic real-time space, were inspired by Aegis and work at NSWC Dahlgren. It is incredibly satisfying for me to pass those experiences to my students and see them get similarly excited." ■

PHOTO BY JOHN MCCORMICK

WHEN HARDWARE & SOFTWARE HIT DEEP WATER

Whether they are adding brains to existing systems or designing entirely new robots, researchers in the Autonomous Systems and Controls Laboratory (ASCL) don't just simulate — their systems dive into real waters.

Applying its expertise to both surface and underwater vehicles, the ASCL team analyzes each situation and adds whatever is necessary to achieve the autonomy required. Sometimes this means developing fundamentally new algorithms and integrating them with an existing boat, sometimes creating a new robot with added physical capabilities, and frequently integrating both physical and software features of the projects.

Research that is so dependent on successful fieldwork presents special challenges. According to ECE associate professor Dan Stilwell, director of the ASCL, "there's a big difference between working in the lab and working in the field, and that gap is huge. There are all sorts of new failure modes, and all sorts of risks. Our vehicle disappears on purpose, so if it doesn't work right we won't know. It just won't come back. In our case, that means we've just wasted two years of work, so our tolerance for risk is very low."

There are also special challenges posed by field work. "A team may spend long days in the hot sun or the bitter cold, depending on the season. In these circumstances, effective teamwork is a necessity." But, as Stilwell says, "we do get to go out to the Gulf of Mexico and hang out in a boat." His team has tested systems not just in the Gulf, but also in coastal and fresh water rivers and lakes of Virginia, the rivers of Louisiana, and the Chesapeake Bay.

Unmanned Surface Vehicles

In collaboration with the Naval Postgraduate School and Craig Woolsey of aerospace and ocean engineering (AOE), Stilwell and his team are adding intelligence to existing surface vehicles. They are developing a sensing and autonomy package that can make any boat autonomous, giving the Navy the option to let their boats transition from manned to unmanned at the flip of a switch. Stilwell explains the project as "the ability to make a boat smart, not the design of a new boat. The Navy doesn't need another robotic boat," he continues, "the Navy needs to make its boats smart."

A large part of this project is the development of new classes of guidance algorithms. "At some point, the vehicle has to decide where to go and how to get there," says Stilwell. Their new algorithms allow an autonomous vehicle to operate in extremely large and mostly unknown environments.

"We can't run global algorithms in real-time, because the domain is just too big," Stilwell explains. "The amount of time needed to run calculations is consistent with how large an area you're planning over." To deal with this, Stilwell continues, "our algorithms switch between thinking globally and thinking locally." The global domain is a big picture of the larger area, while the local domain includes trajectories for where the vehicle needs to go immediately,



From left to right: The team tests an unmanned surface vehicle (ASV) on the water. Christian Sonnenburg (left) and Aditya Gadre use wireless communication to monitor the ASV. The AUV's sail, hull, and propeller. This autonomous drifter can operate in rivers. A diver tests the AUV in during a trial in Panama City, Fla.

at a very detailed level, and can be computed in real-time.

Incorporating information from the global domain, the local algorithms can make decisions rapidly. "The vehicles start with a map, but that map will have lots of errors," according to Stilwell. As long as the local trajectories and data correspond relatively well to what is known of the global information, the vehicle will continue based on the local trajectories.

"We don't have to process globally until we see that what we're doing locally and what we would have done globally are different in a meaningful way," says Stilwell. "We don't have to think globally very often," he continues, "not until the theory says it absolutely has to be done, and in practice that turns out to be seldom. The vast majority of the time we're only looking ahead a minute or two. We're able to effectively combine global and local in a smart way."

Working with surface vehicles also presents challenges the team doesn't face in their work with underwater or ground robots. "Dynamics count for a boat," explains Stilwell, "A boat can slip around a corner. It can go sideways. We had to develop some new theory that deals with the fact that dynamics really matter."

Self-Mooring AUV

Most autonomous vehicles are closely monitored during operation, but Stilwell and Wayne Neu of AOE are leading a team that has built a different kind of autonomous underwater vehicle (AUV), in collaboration with the Naval Oceanographic Office (NAVO). This new AUV operates alone and can go long periods of time without communication. Even more unusual, the AUV is self-mooring. It can anchor itself in a precise location of the ocean without drifting.

"This AUV can travel a long distance to a specified location, anchor itself to remain in that location for an extended period of time, then return home when its mission is complete," says Stilwell, who, with Neu, oversaw a successful deployment of the AUV in Panama City, Fla. last summer.

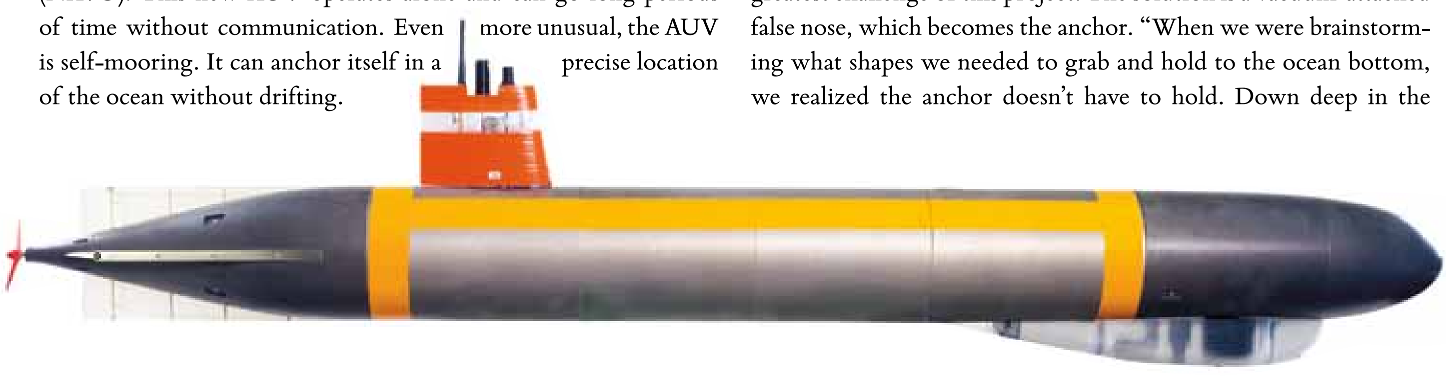
Six feet long with a diameter of seven inches, the new AUV weighs almost 100 pounds and is more than twice the size of the 475 AUV, which has been used for many applications since 2007.

The main weight of the AUV is its battery payload. Because of its independence, the AUV must tote all its power onboard. "The AUV's efficiency was a big concern for the hydrodynamic design," says Neu. "We designed the shape to reduce drag and the propulsion system is as efficient as possible." Approximately half of the battery power is used in traveling to the destination and back; the AUV reserves the remaining power for operating sensors while anchored and collecting data.

For surface communications and navigation, the AUV is outfitted with a GPS receiver, an RF modem with a couple-mile reach, and a satellite communications system. The AUV has an acoustic modem for communication while submerged, but a ship needs to be nearby to talk to it.

To get a GPS reading, the AUV surfaces periodically while traveling to its assigned location. Upon reaching its destination, the AUV must rapidly anchor itself — before it has time to drift.

According to Neu, developing the mooring system was the greatest challenge of this project. The solution is a vacuum-attached false nose, which becomes the anchor. "When we were brainstorming what shapes we needed to grab and hold to the ocean bottom, we realized the anchor doesn't have to hold. Down deep in the



ASV PHOTOS BY JIM STROUP, UNCORK-IT, AND ASCL LAB

ocean, currents are small," notes Neu.

The team found that the anchor took too long to separate from the AUV if they merely released the pressure and allowed it to drop. So, a cartridge of compressed air is used to blow the anchor off.

The anchor release system is another crafty solution. When it's time to come home, the AUV uses a galvanic release to cut the wire attaching it to the anchor. A galvanic release relies on an anode and cathode separated by seawater and won't work in freshwater bodies. When a potential is applied to one side, the 3-4 mm stainless steel wire rusts through in about 10 minutes, freeing the AUV to return home. The anchor is left at its location. "The anchor is a cheap part," Neu explains, "It's just a hunk of steel appropriately shaped."

The control algorithms for this AUV were created via the same process developed for the 475 AUV, but the development timeframe was weeks instead of the many months it took before. "We have robust control architectures and a good development process," says Stilwell. Developing the process took time initially, but now the process is part of his laboratory's toolkit.

In addition to the military, applications for AUVs with these capabilities include environmental monitoring, acoustic monitoring for whales and other sea life, or taking readings during extreme events such as hurricanes, when it isn't safe for humans. Since the AUV can remain at rest for many months, it can conduct long-term marine life population assessments.

"What's cool about this kind of work," Stilwell says, "is that it's extremely cross disciplinary. We have hydrodynamics issues, we need level-headed mechanical design, we have cost constraints. We have issues with electronics components and need to get some custom designed — but not too much, and we need autonomy software that can operate robustly without human intervention throughout all phases of an extended mission."

"All these different disciplines come together in one vehicle and it turns into a real system. We take all this knowledge from aerospace and ocean engineering and electrical and computer engineering and actually see it fly." Students on the project leave with a great portfolio, he says. "They have taken a project from initial concept, through design, fabrication, and field trials. "It's great engineering."

Riverine Drifter

The Navy is also interested in a drifter that can operate successfully in rivers, and Barron Associates in Charlottesville, Va. has asked the ASCL to create one.

A drifter is mostly passive, taking measurements as it drifts. The specific challenge for drifting in rivers, however, is that all the drifters will converge to the same streamline — getting measurements from only one of many possible streamlines. "They would like to measure what's going on in the river," says Stilwell, "but they can only get this one streamline." So, working with Woolsey and Neu, Stilwell's team is building a drifter with an actuator that can sense if it is following the drifter ahead and change to another streamline.

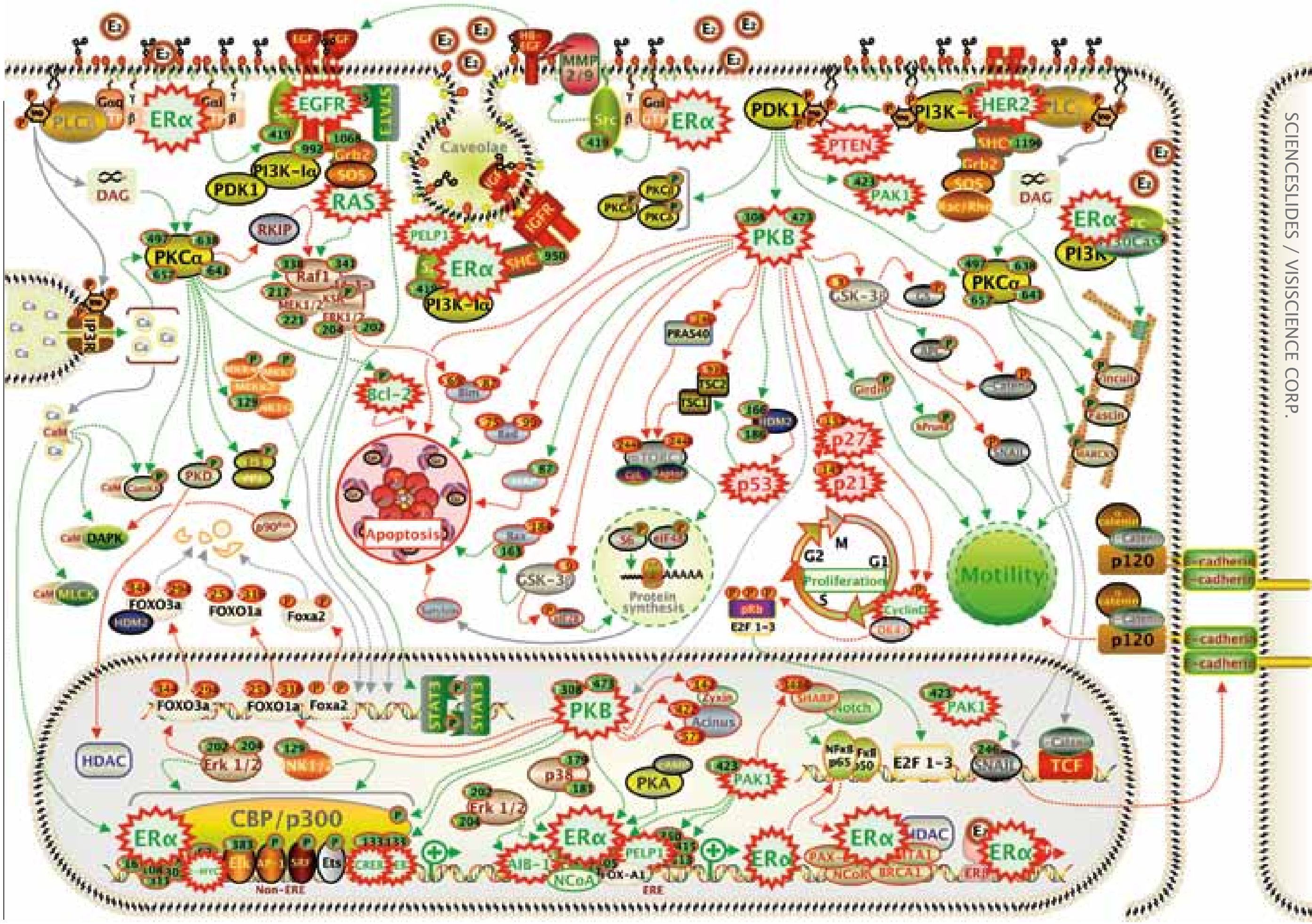
Dan Stilwell (left) and Brian McCarter work on the AUV electronics.

For this project, they cannot use flaps or fins because they would get fouled in a river. So the system includes only one propeller, carefully screened from "river muck," and a reaction wheel inside. The reaction wheel consists of a metal plate that spins to rotate the craft.

The drifter is mostly spherical, with nothing that could easily get caught by any debris in the river.

The challenge, according to Stilwell is "how to deploy several drifters and have them talk to each other and avoid each other's streamlines, and do it in such a way that it minimizes energy. The propeller should spin rarely. Half our program is making vehicles smart," he continues, "the other half is making new types of vehicles."

ERα signaling in breast cancer



Activating phosphorylation 419 Inhibiting phosphorylation 157 Altered Oncogene SRC Altered Tumor Suppressor p53

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Reverse engineering a network to fight breast cancer

Estrogen receptor signaling networks are very complex and little understood. There can be millions of interactions in the network of a single cell.

Armed with computer algorithms and data-mining techniques, Jason Xuan is diving into massive amounts of protein and gene data to fight breast cancer. The associate professor, who is posted at the Advanced Research Institute in Arlington, is seeking the key to breast cancer endocrine therapy resistance.

He has been awarded a $1.56 million grant for this work from the National Institutes of Health's (NIH) National Cancer Institute. He and Yue (Joseph) Wang, the Grant A. Dove Professor of Electrical and Computer Engineering, are working with colleagues from the Georgetown University Medical Center on the project.

The hormone estrogen and proteins called estrogen receptors play an important role in breast cancer. For cells that contain estrogen receptors, called ER+, estrogen is considered to be fuel for breast cancer, according to Xuan, who is also associate director of Virginia Tech's Computational Bioinformatics and Bioimaging Laboratory.

Estrogen can pass through the cell membrane. When estrogen enters a cell that is ER+, it triggers a series of biochemical pathways, referred to as the estrogen receptor signaling network, that causes cell growth and other behaviors, he explains.

Endocrine therapies (commonly called hormone therapies) for breast cancer, such as Tamoxifen, block the direct effect of estrogen and slow down the replication of breast cancer cells, Xuan says. "Only 50 percent of all ER+ tumors are responsive at first to antiestrogens such as Tamoxifen and many initially responsive tumors eventually become resistant to endocrine treatment, leading to tumor recurrence and death," he says.

Often, the cell finds a way around the block and the cancer becomes resistant to endocrine therapy. "When it comes back, then we have no cure for patients," says Xuan. "We have not yet found a drug to battle the recurrence. That's very troubling."

According to Xuan, "Evidence has begun to accumulate in our studies and others that ER-signaling can contribute, at least in part, to endocrine resistance. In this project, we hypothesize that new insights into ER-signaling can be discovered to circumvent endocrine-resistant tumor growth. We want to reverse endocrine therapy resistance."

Estrogen receptor signaling networks are very complex and little understood. The problem is huge: there can be millions of interactions in the network of a single cell. To discover these interactions, Xuan's team is developing new machine learning algorithms, or data mining techniques, to analyze the protein–protein interactions and gene expression data. From measurements of behavior, they are trying to reverse engineer the estrogen receptor signaling network and to build models of the network.

Xuan's goal is to first understand the network, then understand how it becomes resistant, so that eventually researchers can find targets for drugs that can reverse the resistance. "We will discover new knowledge of ER-signaling and ultimately use this information to identify new therapeutic targets for drug discovery," he says.

Xuan's project is part of Virginia Tech and Georgetown University Medical Center's Center for Cancer Systems Biology that focuses on treating breast cancer. Started in 2010, the center seeks to develop more advanced and better-targeted treatments for the disease. The center's specific focus is on the role of the estrogen receptor in breast cells.

Scientists at Georgetown are focusing on biology, examining cell cultures, mammary tumors in animals, and patient breast tumors to determine estrogen receptor-positive molecular signaling systems. Virginia Tech researchers are providing bioinformatics analysis of the Georgetown data and building mathematical models of the molecular control systems. William Baumann, ECE associate professor, and John Tyson, professor of biological sciences, are also involved in the center, and are tackling models from the molecular level. ■

Xuan is an expert in bioimaging, with research interests in intelligent computing, bioinformatics, computational systems biology, information visualization, advanced image analysis, cellular and molecular imaging, and image-guided radiation therapy.

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DID YOU KNOW?

- There were 209,060 new cases of breast cancer in 2010.
- There were 40,230 deaths from breast cancer in 2010.
- Breast cancer is the most common non-skin cancer in the United States.
- 70 percent of the 209,000 newly diagnosed cases of invasive breast cancer in the United States will be classified as ER+.
- Approximately 30 percent of all ER+ early-stage breast cancers eventually recur.

GETTY IMAGES /BACKGROUND: JEFF GENTNERS; SKYLINE: DON KLUMPP

APPING DISASTERS

Enabling citizen scientists to help collect disaster data

The 2010 Nashville flood was one of the triggers that prompted White and his team to develop an app for tapping citizen scientists.

By using civilians and their cell phones, White envisions developing an interface with visual layers that will allow scientist and users to have a better understanding of the before and after situations posed by natural disasters.

Instead of just taking pictures to show their friends during emergency situations, civilians with smartphones could be collecting necessary data for scientists and emergency responders. "The best pictures of the Nashville flooding were what people were taking on their phones," says Jules White, an assistant professor who joined ECE last fall as a specialist in cyber-physical systems. White and his students are working on an app for smartphones that will enable "civilian scientists" to use their phones to help during emergencies.

The National Science Foundation awarded White a $65,000 grant for this project, which was prompted by recent disasters — including the Gulf Coast oil spill and the Nashville flooding. In both situations, civilians already on site could have provided important information if they had a way to transmit it to a central location. Rising floodwaters can be determined from pictures, and dangerous areas can be marked using a phone's internal GPS. The phones have the tools, and White's team is working on the interface.

According to White, "emergency workers or scientists can deploy this system on people's phones. It will reconfigure the sensors on the phones to gather whatever information they need." People would have to download the app, but after that, their phones would tell these volunteers what to do.

"Ideally," White continues, "we could collect thousands of photographs." However, they also need to weigh the value of the photos against the need to use the cell network for

“The best pictures of the Nashville flooding were what people were taking on their phones.”

emergency response or other applications. Because of the limited bandwidth available during emergencies, one consideration for the team is the possibility of capturing and storing information that can be sent to scientists later using ad hoc techniques. “We have to manage the available resources,” says White.

Specific challenges the group faces include determining how many phones are needed for a given scenario, how to optimize power, and how to securely exchange information.

Power-aware computing is a large part of the project, according to White. “People may not be able to charge their phones during an emergency situation,” he explains. “So we’re optimizing sensors and communication to maximize battery life.”

Securely transferring information is another concern. One method the team is considering for transferring data from one phone to another at the same location simply requires both people to move their phones in a particular way.

The team is also working with civil engineering professor Mani Golparvar-Fard on high-precision augmented reality: how to overlay the position of dangerous areas on new photos using previous photos of the same place from a different angle. This is currently done with GPS and compass readings, but is imprecise, according to White. “You can tell buildings, but not doorways,” he explains.

The team is combining image-matching with GPS and compass data. “Image-matching is an offline process which takes a couple hours right now, but we want to get it done faster. This is a future direction for us,” explains White. “The context is all phases of construction. We want to overlay what the structure is supposed to look like and what it does look like, and use that to predict structural damage. I think it’s going to be a really interesting project.”

White’s team consists of six undergraduate researchers, three graduate researchers, Hamilton Turner, Paul Miranda, and Daniel Guymon, and some students at Vanderbilt University and the University of Alabama. The undergraduates are Adam Antonioli, Stephen Byle, Matt McGarvey, Joe Payne, Zach Rattner, Semere Sium, Abdulah Asiri and Avanash Sridhar. White expects two or three graduate researchers to join the team this summer.

White enjoys working with the students at both undergraduate and graduate levels.

“The most fun part of this work is seeing a lot of really smart students come up with creative ideas,” he says. ■

Below: Jules White (left) with Hamilton Turner, have been exploring low-power considerations for using cell phones during disasters.

POWER SAVING *with* SPOT

Power conservation, a critical issue for smart phone apps, becomes even more critical during an emergency. Power conservation for smartphones is made more difficult by the layers of middleware that come between the software and hardware — layers that are extremely difficult to simulate.

Graduate student Hamilton Turner has been working with White and a team at Vanderbilt on a method to emulate smartphone power consumption. The work received a best student paper and presentation award at the 1st International Conference on Pervasive and Embedded Computing and Communication Systems.

The paper, “Analyzing Mobile Application Software Power Consumption Via Model-Driven Engineering,” discusses the System Power Optimization Tool (SPOT) — a tool to automate these emulations. SPOT’s estimations come within 3-4 percent of actual smartphone power consumption.

Turner worked with White as an undergraduate at Vanderbilt University on a project that used smartphones to detect traffic accidents. He also started a team there to develop smartphone apps.

NANO GRIDS *for* sustainable buildings

With wind, solar and other clean energy sources gaining popularity worldwide, engineers are seeking ways to make renewable energy systems more affordable and to integrate them with existing ac power grids. Much research focuses on distributed power systems and the concept of microgrids, in which multiple electrical generation sources, energy storage, and loads connect as a single point on the grid.

Researchers from the Center for Power Electronics Systems (CPES) are tackling the issue from what they call a "nanogrid" perspective. Less extensive than a microgrid, a nanogrid can be as small as the energy management system for an entire building, explains ECE Professor Paolo Mattavelli. A nanogrid includes the generating source, in-house distribution, and energy storage functions — and can be extended to multiple buildings.

Mattavelli is working with professors Fred Lee, Dushan Boroyevich, and Khai Ngo, and research engineer Igor Cvetkovic and a team of graduate students on the effort. "We are focusing on energy conservation for buildings, because residential and commercial buildings represent 68 percent of U.S. electricity consumption and almost 40 percent of the country's carbon dioxide emissions," he explains. "We are applying power management to reduce electrical energy use and to make renewable energy more cost effective."

The team is investigating smart ac nanogrids for today's technology and dc nanogrids for the smart, sustainable homes and buildings of tomorrow. The ac nanogrids incorporate smart appliances, lighting and heating/ventilation/air con-

Nanogrids are being developed to manage energy in single or multiple buildings, in an effort to reduce electrical consumption.

ditioning (HVAC) with on-site power generation and an Energy Control Center (ECC). The ECC can communicate with the power system operator for energy trading purposes, while also acting as a data acquisition unit. The ECC can collect and record the power flow data not only from and towards the grid, but also from all the converters and smart appliances in the home.

CPES researchers have developed and demonstrated unidirectional and bidirectional inverters that operate with an ECC to isolate a house from the utility grid, work in stand-alone mode, and synchronize and reconnect the house to the grid without load power interruptions. The next step, Mattavelli says, is to integrate energy storage and renewable energy sources with cost-effective solutions"

Power management via ac nanogrids can achieve significant energy savings, he says. "However, if we change the architecture from a single ac system and go straight from dc renewable energy sources and storage elements to dc loads, we can significantly reduce power losses and cost," he adds.

A dc nanogrid would start with fewer power converters, higher overall system efficiency, and easier interface of renewable energy sources to a dc system. "There would be no frequency stability and reactive power issues, and less conduction loss," he says. "Moreover, the consumer electronics, electronic ballasts, LED lighting, and variable-speed motor drives can be more conveniently powered by dc."

CPES researchers envision a dc nanogrid with two dc voltage levels: a high-voltage (380 V) dc bus powering HVAC, kitchen loads, and other major home appliances, and "a multitude of low-voltage (48 V, 24 V, etc.) dc buses powering small tabletop appliances, computer and entertainment systems, and LED lighting."

There are many challenges for implementing the ac and dc nanogrids, the main one being fault current interruption in higher voltage dc systems. Communication, control and optimization also present challenges, Mattavelli says. "This is a very complex system. We want to control the overall system at the same time we are controlling at the component level. How do we optimize each part? How do we implement a cost-effective communication that enable system energy optimization?"

Power management with ac and dc nanogrids is not an entirely new concept, Mattavelli says. "Similar systems have already been applied in the transportation area, with the all-electric ship and the more-electric airplane." Experience with such standalone systems gives power electronics researchers confidence in their success.

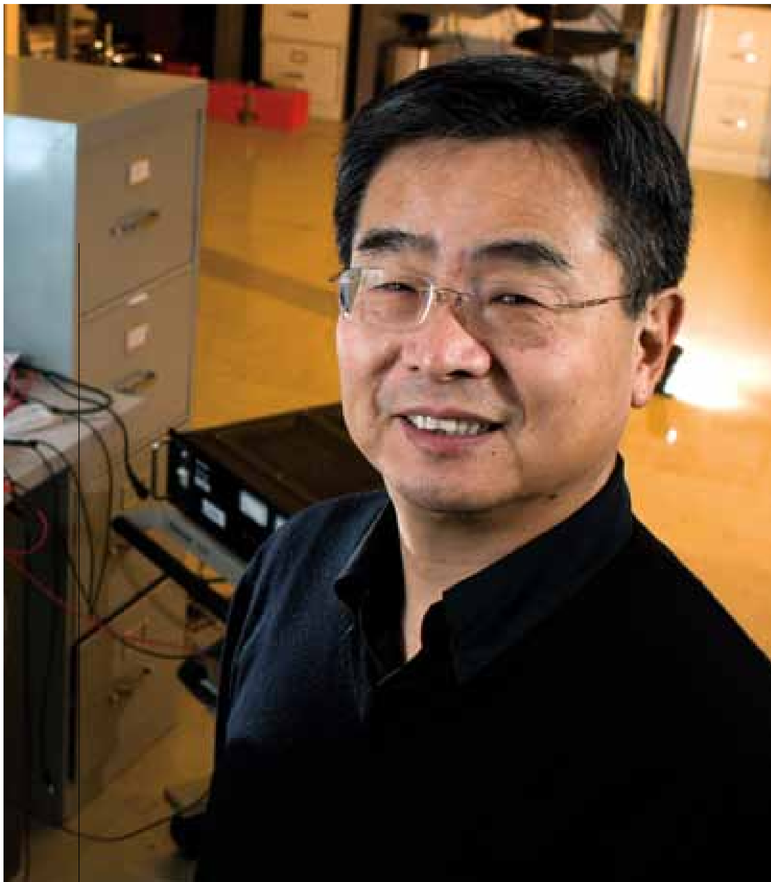
"Many of the same concepts are also used in low-power applications," he says. "A notebook computer, for example, has different load converters, source converters and even a single mother board. A dc nanogrid could potentially have even a higher level of power management as a notebook — of course at a different power level."

Ultimately, Mattavelli says, the sustainable home will have the net-zero energy consumption from the utility grid and zero-emissions. "This is our goal," he says. ■

Left: Paolo Mattavelli is part of the power electronics team developing technology for nanogrids to manage the power for today's and tomorrow's smart buildings.

Below: Igor Cvetkovic presents results to the Renewable Energy Mini-Consortium. The CPES mini-consortiums offer industry partners the opportunity to participate in research at a pre-competitive level.

ILLUSTRATION: JAIME DE LA REE. PHOTO TOP: JOHN MCCORMICK; RIGHT: CHRISTINA O'CONNOR



FRED LEE ELECTED *to* NATIONAL ACADEMY *of* ENGINEERING

University Distinguished Professor Fred Lee has been elected to the National Academy of Engineering for his contributions "to high-frequency power conversion and systems integration technologies, education, industry alliances, and technology transfer." Membership in the academy is one of the highest professional honors accorded to an engineer.

Lee, who directs the Center for Power Electronics Systems, is the third ECE professor to attain this honor, joining Arun Phadke and James Thorp.

Lee has an international reputation not only for developing novel power electronics technology, but also for promoting the use and effectiveness of power electronics and helping to develop the field. Power electronics, he says, is an enabling technology that can reduce electrical consumption by up to 33 percent.

"Almost everything a consumer touches has power electronics in it. It is really an enabling technology that is not often visible," he says. To help the field achieve that promise, he has built strong industry–university collaborations and has been an innovator in breaking barriers to technology transfer.

Technical Breakthroughs

He first came to Virginia Tech to build the university's power electronics program in 1977 — the year after the first commercial power MOSFET was introduced. He had served for three years as a Member of the Technical Staff of the Control and Power Processing Department at TRW Systems.

As electronics became ubiquitous and consumed more power, problems with overheating, switching losses, energy efficiency, electromagnetic interference (EMI), and packaging of power conditioning systems grew in importance. To overcome these problems, Lee and his students pioneered various soft-switching techniques in the 1980s and 1990s, such as zero-voltage (ZV) quasi-resonant, ZV multi-resonant, and ZV pulse-width modulated converters.

These soft-switching techniques eliminate virtually all switching losses and stresses and reduce switching noise and EMI. Soft-switching technology has become the mainstay of modern power electronics equipment, leading to reduced size and weight, with improved reliability and efficiency. Lee holds 19 U.S. patents in soft-switching technology.

Lee and his graduate students also have made their mark on computer processors. In 1997, his team developed a multi-phase voltage regulator (VR) module for the then-upcoming generation of Intel Pentium microprocessors. Today, every microprocessor is powered with this multi-phase VR. It is easily scalable to meet ever-increasing current consumption, clock rate, and stringent voltage regulation requirements. Its use has been extended to telecommunications networks, and all forms of mobile electronics equipment. Lee's team has generated 25 U.S. patents in VR technology, addressing key areas such as power delivery architecture, modularity and scalability, control and sensing,

PHOTO LEFT: JOHN MCCORMICK; RIGHT: MICHAEL KIERNAN

"Almost everything a consumer touches has power electronics in it. It is really an enabling technology that is not often visible."

integrated magnetics, and advanced packaging and integration.

Developing the Field

Lee has been a strong proponent of university-industry collaboration, believing that with industry involvement, university researchers can pursue research that can have the greatest impact on society.

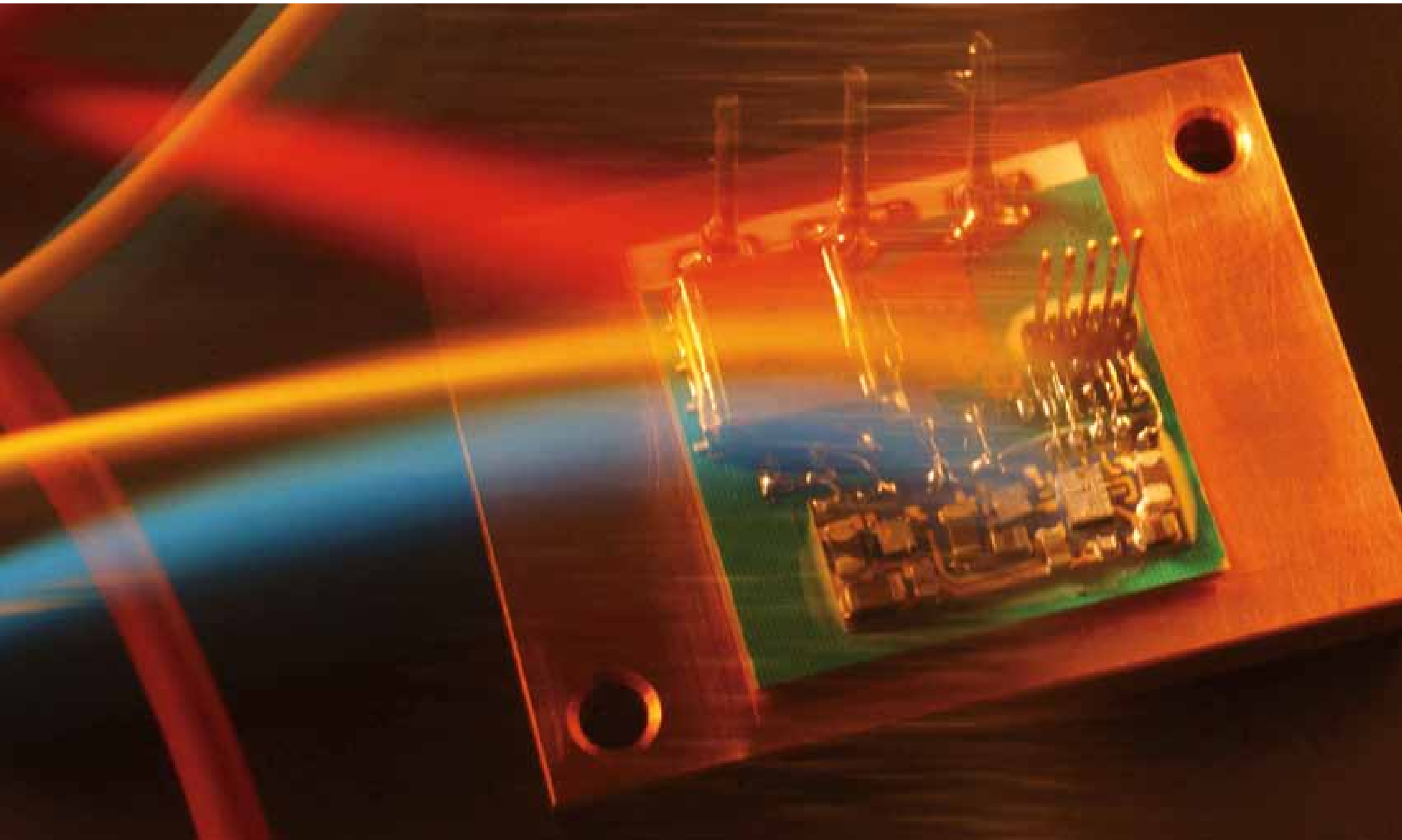
In 1983, he founded the Virginia Power Electronics Center, which later became a Technology Development Center for the Virginia Center for Innovative Technology. Under Lee's leadership, this center became the largest university-based power electronics research group in the country. More than 90 firms became associated with the world-renowned center.

In August of 1998, Lee and Dushan Boroyevich were successful in competing for a National Science Foundation Engineering Research Center called the Center for Power Electronics Systems, with total National Science Foundation funding that exceeded $30 million.

Lee directed this government center, comprising five universities and more than 100 corporations, for 10 years, the maximum number allowed by the scientific agency. The center participants included Virginia Tech, the University of Wisconsin-Madison, Rensselaer Polytechnic Institute, North Carolina A&T State University, and the University of Puerto Rico-Mayagüez. During its 10-year tenure, the Center was cited as the model ERC for its industry collaboration, technology transfer, and education and outreach programs.

Lee's research interests include high-frequency power conversion, distributed power systems, renewable energy, power quality, high-density electronics packaging and integration, and modeling and control. He has supervised to completion 80 master's level and 71 Ph.D. students. He holds 69 U.S. patents, and has published 236 journal articles and more than 585 refereed technical papers.

He earned his master's and doctoral degrees in electrical engineering from Duke University in 1972 and in 1974, respectively. He earned his undergraduate degree from the National Cheng Kung University in Taiwan in 1968.



Spectrum sensing ALGORITHMS for cognitive radio

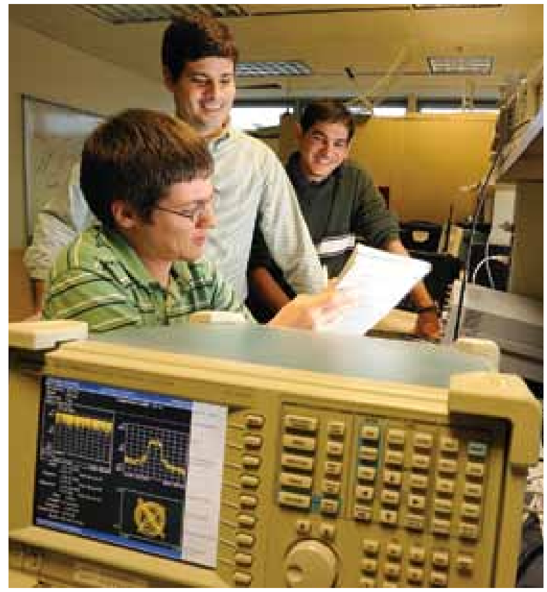
In the first phase of a more than two-year study funded by InterDigital, Claudio da Silva's team of wireless researchers have made great strides in developing more reliable and efficient spectrum sensing techniques that will be needed to meet the ever-expanding demand for wireless technologies.

Their techniques can be used in cognitive radio systems, devices that first identify underutilized spectrum with the use of spectrum databases and/or spectrum sensing and then, following pre-defined rules, dynamically access the "best" frequency bands on an opportunistic and non-interfering basis.

During the first phase of the study, "by exploiting location-dependent signal propagation characteristics, we have developed efficient sensing algorithms that enable a set of devices to work together to determine spectrum opportunities," said William Headley, one of the Ph.D. students working on this project.

For the second year of the study, the focus is changing to the design of spectrum sensing algorithms that are robust to both man-made noise and severe multipath fading. "The vast majority of sensing algorithms were developed for channels in which the noise is a Gaussian process," said Gautham Chavali, a Ph.D. student who also works on this project. "However, experimental studies have shown that the noise that appears in most radio channels is highly non-Gaussian," Chavali added.

—*Lynn Nystrom*



From left: Ph.D. student William Headley, Claudio da Silva, and Ph.D. student Gautham Chavali.

PHOTO BY JIM STROUP

Cognitive radios that perform well while learning

A cognitive radio that determines its own best communications method for a situation is closer to reality, thanks to recent results from an ECE wireless communications research team.

Postdoctoral associate Haris Volos (Ph.D. '10) and associate professor R. Michael Buehrer have developed cognitive radio techniques that enable a radio to perform well while learning and selecting its optimal configurations.

Typically, radio designers analyze each communication method in terms of goals and will arrive at a set of adaptation rules for the radio, according to Volos. "The analysis is time-consuming and if the channel models used do not hold, or in an unexpected situation, the design becomes irrelevant," he says. Cognitive radios using a cognitive engine (CE) have been proposed that find the optimal configuration. However, learning speed and performance during learning have been big challenges, he says.

Funded by an NSF grant, Volos and Buehrer have demonstrated if there is a moderate number of methods that meet minimum performance requirements, that a CE can reach near-maximum performance in a relatively short number of trials. They have also developed a Robust Training Algorithm (RoTA) that attempts to maintain a minimum performance level while trying possibly better-performing methods.

"Our training algorithm makes the link stable during learning," Volos says.

"A soldier attempting to use a radio during a critical operation would rather have a slowly improving connection that a connection that erratically fluctuates," he explains. "Likewise, a mobile user streaming a favorite show prefers a slowly improving connection than a link that pauses at crucial moments."

The work was honored in November with the Fred Ellersick Award for Best Paper in the Unclassified Technical Program at MILCOM 2010.

Distributed computing in a wireless environment

The Defense Advanced Research Projects Agency (DARPA) is funding a proof-of-concept study by ECE's wireless communications researchers, along with the Virginia Bioinformatics Institute to develop highly connected computer systems that operate in a wireless environment.

Small handheld devices and other computers that are smart enough to work in a wireless setting would allow military personnel and other users to pool computing and communication resources for gathering intelligence more easily, analyzing information more efficiently, and, ultimately, making better decisions in a wide range of locations.

"Traditional wired distributed computing has been around for many years, allowing computationally intensive tasks to be performed efficiently via many, physically connected computers," said Jeffrey Reed, principal investigator for the project. "Our effort will focus on developing distributed computer systems that work in a cable-free environment, which will bring a new level of flexibility to users who need to work in rapidly changing, often challenging, mobile environments."

The initial project will demonstrate the feasibility of wireless distributed computing using the Defense Advanced Research Projects Agency's Wireless Network after Next (WNaN), an established program that looks to develop flexible and scalable communication networks that use very inexpensive yet flexible software radios.

—Barry Whyte

Virginia Tech officially launches Smart Grid Information Clearinghouse Web portal

Virginia Tech released its full version of the Smart Grid Information Clearinghouse Web portal in September.

The Web portal is the platform for direct sharing and dissemination of relevant smart grid information, ranging from background documents, deployment experiences, technologies, and standards, to ongoing smart grid projects around the world. It is designed to serve as the first stop for smart grid related information and acts as the essential gateway that connects the community to various information sources scattered on the worldwide web.

"The full version of the Smart Grid Information Clearinghouse as released today contains information about more than 200 smart grid projects in the United States and more than 50 projects overseas," said Saifur Rahman, director of the Virginia Tech Advanced Research Institute, National Capital Region, and principal investigator for the portal.

"The portal has upwards of 1,000 smart grid-related documents and multimedia, which provide both background and in-depth information, such as use cases, lessons learned, cost-benefit analyses, business cases, legislation and regulation activities, detailed information on standards, and list of smart grid technologies and sample vendors," he said.

The Virginia Tech Advanced Research Institute was awarded a $1.25 million five-year contract by the Department of Energy in October 2009 to develop the portal with content assistance from the IEEE and the EnerNex Corporation.

—Barbara L Micale

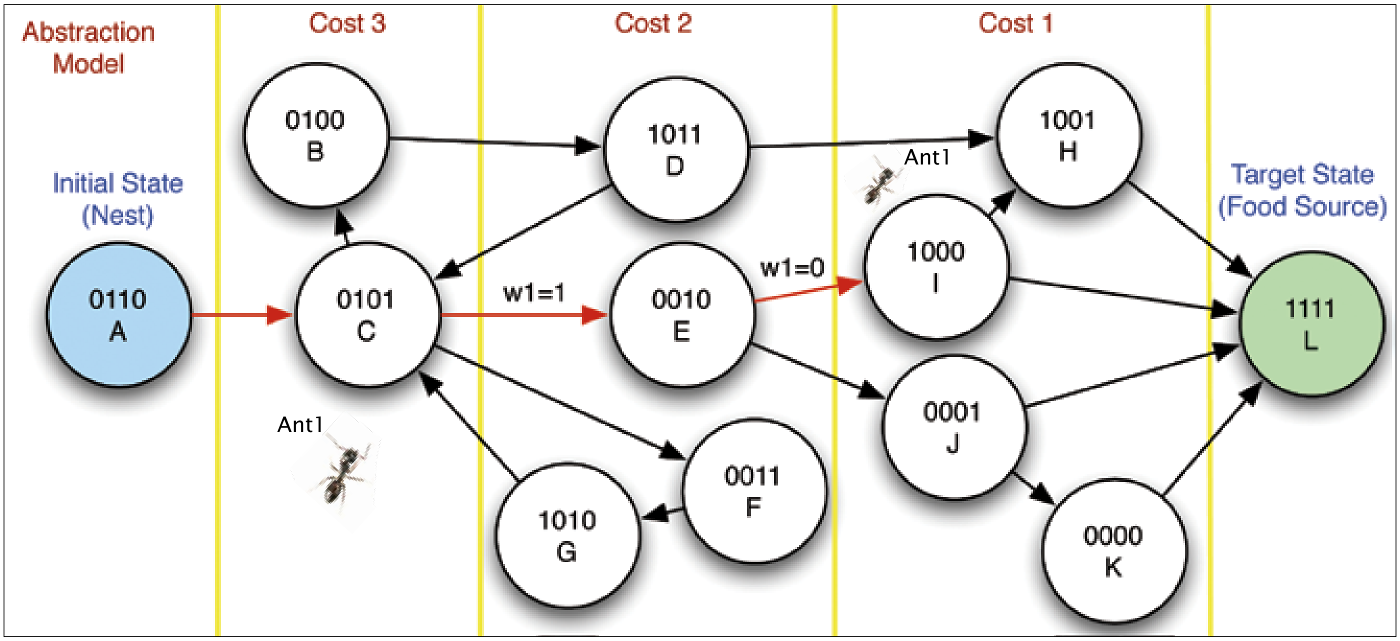
ECE research projects on IPv6 addresses, auroral spiral win GSA awards

Two ECE students won awards at this year's Graduate Student Assembly (GSA) Research Symposium: Matthew Dunlop won a first place award for his poster presentation, "Dynamic Obscuration of IPv6 Addresses to Achieve a Moving Target Defense," and Nathaniel Frissell won a second place award for his poster presentation, "Characteristic Energies in an Auroral Spiral."

Dunlop and other researchers in the Information Technology Security Office and Laboratory have developed a more secure method for assigning Internet Protocol version 6 (IPv6) addresses. Their secure dynamic solution, he explains, "provides a powerful moving target solution that preserves both users' privacy and security."

Frissell, who works in the Virginia Tech SuperDARN Laboratory, is studying the characteristic energies of auroral spirals. The team analyzed an auroral spiral that they observed from Longyearbyen, Svalbard (an archipelago north of the arctic circle) in February 2010. *(Read more at www.ece.vt.edu/news/articles/GSA)*

SWARM INTELLIGENCE
to validate designs



This graph illustrates how ant colonies use swarm intelligence to identify the best path to food sources.

The National Science Foundation has awarded Michael Hsiao a three-year $363,439 grant to apply swarm intelligence to design validation. According to Hsiao, "the likelihood of hidden, subtle bugs increases with growing design sizes, and reaching corner cases in large designs and systems in order to expose such subtle bugs has become a daunting task. Verifying the correctness of the design is now a tremendous bottleneck." Taking their inspiration from swarms of ants, the group is using swarm intelligence techniques to transfer individual knowledge acquired during a search to the collective consciousness. "The development of new theories and algorithms will allow for deeper understanding of semi-formal verification and state space exploration," says Hsiao.

Testing and diagnosis of embedded memory

ECE professor Michael Hsiao won a three-year, $180,000 Semiconductor Research Corp. grant for testing and diagnosing circuits with embedded memories. Circuits are increasingly utilizing embedded memories, according to Hsiao, "which makes traditional testing and diagnosis methods difficult."

Using Logic Built-In Self-Test (LBIST) and Satisfiability Modulo Theories (SMT) based techniques, the researchers will provide a cost-effective method to improve the diagnostic ability of these embedded memory circuits. "This research project aligns well with the semiconductor industry's strategic direction to drive test costs down," says Hsiao, "and in particular, fits well with LBIST strategy."

Fingerprint images

Lynn Abbott and Michael Hsiao are on an interdisciplinary team devoted to quality assessment of fingerprint images. Automated fingerprint identification systems typically depend on detecting the locations of "minutiae," which are the endpoints and bifurcations of friction ridges on a person's skin. Human examiners, in contrast, usually rely on properties in addition to minutiae locations, such as the shape of ridges themselves. The team is developing a novel approach that involves "extended feature sets," combining minutia and friction ridge properties with other data.

Left: Results in which a fingerprint image has been processed to detect a skeleton image (top right), then associations between ridges and minutiae have been detected (left). The same ridges have been color-coded (bottom right) to aid in visualization.

Evaluating cryptographic performance

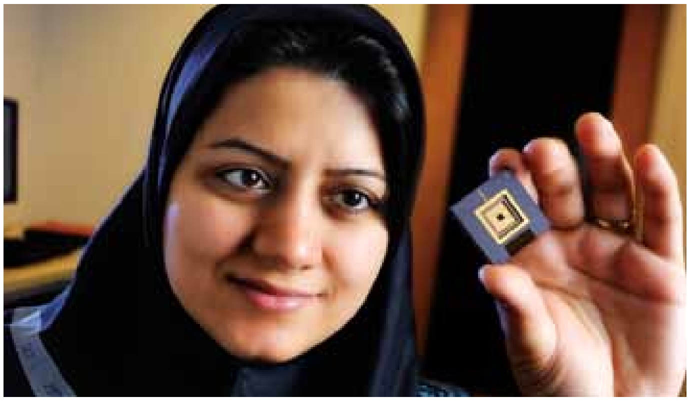
There exists no official standard for measuring hardware implementation cost, but three universities are combining forces to develop a new performance evaluation environment for cryptographic hardware and software. Teams from George Mason University (GMU), University of Illinois at Chicago (UIC), and Virginia Tech are working together to solve the problem.

The impetus for this effort is the National Institute of Standards and Technology (NIST) cryptographic hash algorithm competition, which is seeking a new hash algorithm to be called SHA-3. Security is one of the main criteria for this competition, but is also the most difficult to measure, according to ECE's Patrick Shaumont, who is leading Virginia Tech's team. Leyla Nazhandali is a co-principal investigator on the project.

The new evaluation environments created for this project will supply a way to measure hardware implementation cost, including circuit area and performance.

NIST is the organization that defines the standards, including encryption standards. For anything as large as the Internet, everyone has to use the same algorithm to make sure each person can read what someone else has posted.

NIST opened the SHA-3 competition in 2007, and everyone who wanted to enter sent in their hashing algorithm by October 2008. The judging is a three-year process. Fifty-one submissions were accepted into the contest, and the cryptographic community is now working together to break the entries, narrowing down the submissions to a few finalists. Meanwhile, the computer engineering community is looking at the algorithms as well — figuring out which ones can be mapped to software and to hardware. NIST will choose the winner based on cryptographic strength and implementation strategy.



From left: Dinesh Ganta, chief tester; Mike Henry, chief designer, and Lalleah Rafeei test chips for identifying fingerprints and function. Leyla Nazhandali and Patrick Schaumont encourage undergraduates to join their research teams. Rafeei was an undergraduate researcher who then chose to pursue a graduate degree. Right: Leyla Nazhandali displays an ASIC chip manufactured to amplify processing flaws without impacting function. The flaws can be used as unique chip identifiers for secure applications.

PHOTOS BY JIM STROUP

Magnifying processing flaws to make on-chip fingerprints

Random variations in chip manufacturing can be exploited to create unique, stable on-chip identification, according to a research team at Virginia Tech. ECE's Leyla Nazhandali and Patrick Schaumont, working with Inyoung Kim of statistics, have developed techniques to amplify naturally occurring manufacturing variations — without hurting chip functions.

Current chip identifiers are simple pieces of data that can be easily copied just like the social security number of an individual. "We would like to build chip identifiers that are like human fingerprints in nature, so that they cannot be copied" Nazhandali says.

Process manufacturing variations are caused by the limitations of photolithography, explains Nazhandali. "Because of that and non-uniform conditions during fabrication, no two chips are identical. They all have slight differences," she says.

Their team is using those typically undesirable traits to make unique, trustworthy electronic hardware fingerprints. They are magnifying the process variations to make it stable in spite of temperature changes that occur during chip operations. "We are going against the typical paradigm," says Nazhandali. "Manufacturers try to reduce process variation and we want to magnify it."

Using special circuits and techniques, the team has fabricated prototype ASIC chips with a magnified process variation effect. "Our results to date show we can improve the stability of the chip identification by a wide margin — about 18 percent," she reports. "Yet the chips still function to specifications."

Letting Computers Dream

ECE associate professor JoAnn Paul recently received a $191,709 grant from the National Science Foundation to research a new concept for parallel computing: designing computers based on the principles of human dreaming.

"When we dream, we shut off as many inputs as possible and, literally, stimulate our own minds internally and with nonlogical imagery," she says.

"The need to dream can be inferred from the brain's most striking physical and behavioral characteristics. These characteristics can be applied to computer organization and lend insight into how computation can reach results that cannot be reached in conventional computer organization."

Using the Dream Architecture for Lateral Intelligence (DALI), Paul is using two modes: awake and dreaming. While awake, some lateral processors will be active and some will be observers. In the dream phase, the processors will use condensed playback – simulating dreaming — to resolve which of the multiple models executing on the lateral processors should dominate under different circumstances. The initial application for this research is speech recognition in pervasive computing devices.

WIRES ON DEMAND

An ECE computer engineering team, led by Cameron Patterson and Peter Athanas was recently awarded a patent for work improving the adaptability and efficiency of Field Programmable Gate Arrays (FPGAs). According to Patterson, "The difficult aspect of hardware reconfiguration is not creating the computational blocks, which are generally available from FPGA vendors and third parties, but linking the blocks in a manner that suits each application's unique connectivity, bandwidth, and latency requirements."

They start with a dynamic module library, and reconfigure the FPGA using reconfigurable partial bitstreams. A bitstream is the format used to send configuration data to an FPGA. This project, called Wires on Demand (WoD) "is based on the insight that reconfigurable hardware's untapped strength is a just-in-time optimization of communication paths in datapath and multi-core architectures, providing global rather than just local optimization," explains Patterson.

Making chips smaller and faster

As part of the push to make chips smaller and faster in an era when simply adding more transistors is no longer feasible, Mantu Hudait and other researchers in the Advanced Devices & Sustainable Energy Laboratory (ADSEL) are working on fabricating smaller and faster transistors at lower supply voltage operation.

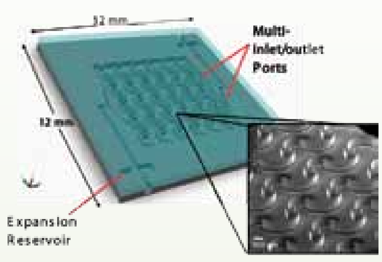
The team is heterogeneously integrating compound semiconductor materials and device structures on silicon substrate using their novel buffer architecture along with other materials to take advantage of the material properties of various elements. One project for the group involves mixed-anion and mixed-cation based quantum well field-effect transistors (QWFETs) on silicon (Si), which offer the potential for high-performance and ultra-low power applications, according to Hudait. The team is also developing tunnel field-effect transistors (TFETs), which allow sharp turn-on characteristics.

Moreover, the team is working towards the demonstration of high-efficiency compound semiconductor solar cells on Si substrate for sustainable energy.

Breath analysis with MEMS

Gas chromatography, the separation of a gaseous mixture into its components, currently requires bulky tabletop instruments — requiring samples to be acquired, stored, and transported to a laboratory. In collaboration with Andrea Dietrich of civil and environmental engineering, Masoud Agah and other MEMS researchers are working on micro gas chromatography: making the gas chromatography systems small enough to be handheld for applications such as accurate breath analysis systems.

Their specific focus is a micropreconcentrator, which is the part of the device that collects samples of a gas. According to Agah, "The micropreconcentrator's high performance is attributed to the multiple inlets/outlets, novel high-aspect-ratio (360 m) parabolic reflectors, and cobweb configuration of absorbent films, all of which promote the absorption of chemical species. The performance of the new design was compared with solid phase microextraction (SPME), a commonly used sample preparation method in breath analysis."



Left: 3-D rendering of the micropreconcentrator, inset are SEM micrographs of the fabricated microstructures.

Cooling ICs with microchannels

Researchers in ECE's Microelectromechanical Systems (MEMS) lab are working on a new way of cooling three dimensional integrated circuits (ICs). According to Masoud Agah, who leads the project, "stacking of silicon layers to create three dimensional integrated circuits has been considered a promising approach to reduce interconnect delays, increase transistor density, and reduce chip area."

However, the heat produced by these new three-dimensional ICs is an obstacle. The heat of an IC increases with the number of layers, but the surface area available for cooling remains unchanged. The team is investigating how to cool these ICs by integrating microchannels into the design.

The microchannels "require fewer masks and fewer process steps than previous methods," says Agah, "furthermore, three different channel geometries were simulated using computational fluid dynamics to prove that channels fabricated using this method could adequately cool future integrated circuits." Physical testing verified these simulations. Of the three geometries they are working with, the micro-fin geometry has the highest heat transfer capability and lowest simulated substrate temperatures.

ANTENNAS INSIDE

"A lot of times, your advisor's weird ideas really work," says masters student Jacob Couch, who is working with ECE professor Peter Athanas on a new use for a field programmable gate array (FPGA): a transmitter using the routing resources of an FPGA.

The transmit-only mechanism uses an oscillator to communicate binary data to an external antenna via amplitude shift keying (ASK). ASK works by keeping frequency constant while varying the amplitude of the signal. In this case, as in most ASK applications, the signal is either "on" or "off," denoting logic 1 or logic 0.

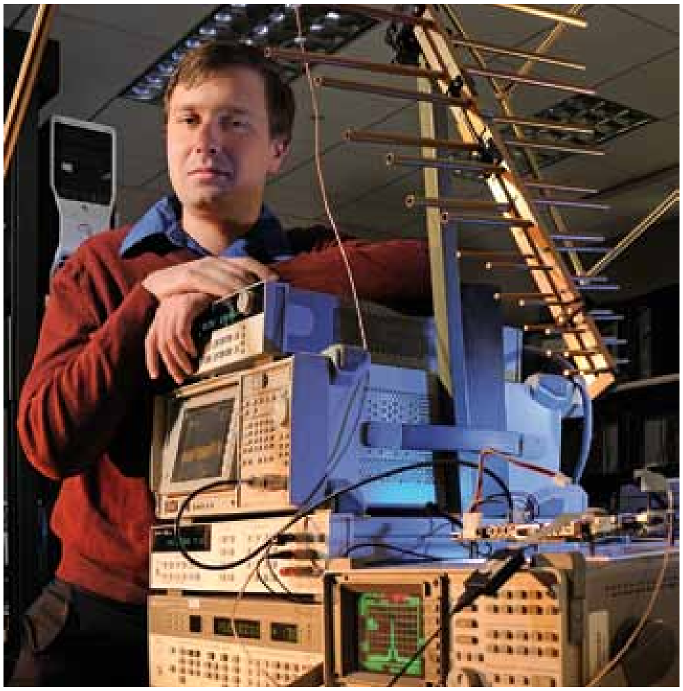
Couch explains that "we're redoing the routing on an FPGA to take an existing design and attach a geometric shape to it. If this shape oscillates at a high frequency, we can pick up the radiation."

Once the oscillator is in place, Couch looks for unused routing resources to build the antenna. One of the most successful antenna designs uses a fractal design, which allows for the maximum wire length and number of corners. "Everything on the FPGA is so small that we are trying to make it bigger," explains Couch. Also, longer antennas allow him to use a lower frequency: the frequency range he's looking at now is in the hundreds of MHz.

"This is all done from within the FPGA," Couch stresses, "there are no external ports. This is a mechanism to release data from the FPGA." He is testing the designs on a Xilinx FPGA, which is less than one inch by one inch.

For testing purposes, Couch has borrowed a wideband antenna from ECE professor Bill Davis with the Virginia Tech Antenna Group (VTAG). "It has relatively uniform gain from 50 MHz to 2 GHz, so it's good for testing," explains Couch.

What data can this design transmit? Anything. "We could expose any data on the FPGA," according to Couch. The project is



funded through the Defense Advanced Research Projects Agency (DARPA) Trusted Integrated Circuits (TRUST) project, and the CCM lab is a subcontractor of USC ISI, which has a branch in Arlington. The TRUST project is making sure that the technology going into U.S. weapons systems is reliable. "We're funded to insert black hat things into an FPGA, such that another group on this project can detect what we have done to the FPGA. But we're also looking to do white hat applications from the tools we have developed," says Couch.

"In the FPGA community we're constantly looking at slight improvements here and there, but very few big picture ideas. This is something kind of off-the-wall that no one has ever tried before."

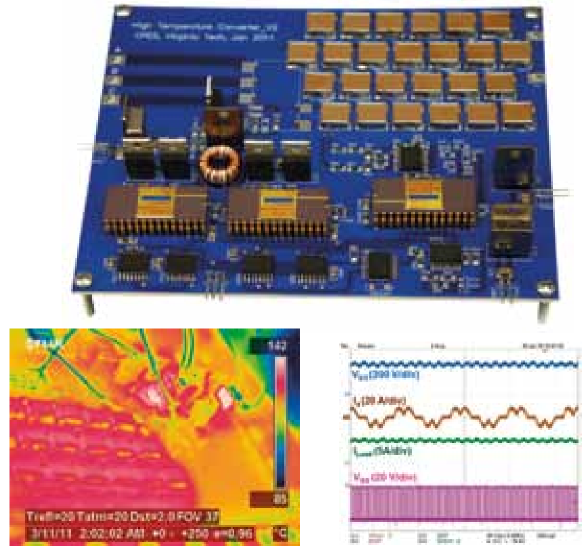
And it works.

PHOTOS BY JIM STROUP

3-phase ac-dc converter tolerates HIGH-TEMP ENVIRONMENTS

A CPES research team has developed a three-phase ac-dc converter for harsh industrial environments that preliminary tests show operates in up to 150° C ambient temperatures. Converters for industrial harsh environments require not just high-temperature semiconductor devices, but also high-temperature gate drive, passive components and control electronics, according to Ruxi Wang, a Ph.D. student on the project.

With a high-temperature SiC power module and high-temperature mother board implementing the required functions, the 1.4 kW prototype converter has been tested to operate between -50° C and 150° C ambient temperatures, with the junction temperature of the SiC power module reaching 250° C.



From top: This prototype ac-dc converter can operate in ambient temperatures up to 150° C; a heat map showing the temperatures on the converter; a graph showing the converter's performance.

Modeling EMI behavior for aerospace

Power electronics researchers have developed fast, accurate, behavioral EMI-modeling techniques for higher frequencies (>10 MHz) that previously were not easily modeled.

"EMI models should be simple enough so that simulations can run on most computers," says Hemant Bishnoi, a Ph.D. student who worked on the project. The models should also be accurate in the interested range of frequencies, he notes. "Unfortunately, with state-of-the-art in EMI modeling, these two goals cannot be met simultaneously at higher frequencies. A new breed of EMI models is needed that can facilitate size reduction of EMI filters, that usually take up to 30 percent of volume in a typical aerospace power supply.

The team solved the problem with behavioral modeling, involving a noise model with linear noise source and impedance, then fit the terminal behavior of the system at high frequency. The model was successfully tested on dc-fed half-bridge and three-phase inverter systems using measurements from outside the system on positive, negative, and ground terminals. The model runs in the frequency domain and simulations are very fast — usually lasting only several seconds.

New high-frequency core loss measurement

Estimations of magnetic core loss are of great interest to power electronics engineers and magnetic material scientists. However, conventional measurement methods, like four-wire and calorimeters are typically not accurate at high frequency, or are too complicated and time consuming.

A CPES research team has developed a series of new methods to measure high-frequency magnetic core loss that are simple, fast, accurate and adaptive for any excitation waveform and dc flux level. The new methods compare the core being tested with air core by using reactive cancellation concept, explains Mingkai Mu, a Ph.D. student who invented these methods. "Since the air core is lossless," he says, "the difference in the two cores represents the loss for the core being tested."

The measurement accuracy of the new method is more robust with phase discrepancy, which is the major problem for high-frequency core loss measurement, he notes. The new methods are appropriate for high frequency (1 MHz–100 MHz, or even higher) measurement. "With these new methods, core loss for different flux waveforms can be accurately measured and many magnetic phenomena and models can be verified," he says. The new methods can be the standard methods for high-frequency magnetic materials loss characterization, and be built as high-accuracy measurement instruments."

CHRISTINA O'CONNOR

Large-area CO_2 detection network

Researchers in the Center for Photonics Technology (CPT) are developing a long-term, large-area, fiber-optic sensor network that can detect and locate carbon dioxide (CO_2) leaks. These sensors, which use laser spectroscopy to detect gases, can operate over a large area and have low power needs: they can be operated for multiple years either by battery or solar panel. The data from each sensor will be transmitted wirelessly to a central receiver, which can generate a CO_2 spatial distribution in real time.

Anbo Wang, CPT director, explains that "each sensor node operates on CO_2 absorption in the near infrared where low cost tunable DFB lasers are commercially available." Laser spectroscopy, according to Wang, is immune to interference from other chemical species, which makes it ideal for operation in environments such as CO_2 sequestration sites.

The project is funded by the Department of Energy (DOE) National Energy Technology Laboratory.

Fully-distributed sensing platform

The Center for Photonics Technology was recently awarded a three-year project by the National Science Foundation to developing a fully distributed fiber-optic chemical and biological sensing platform.

This platform, according to ECE's Anbo Wang, "can detect and monitor a variety of chemicals and biological agents continuously along the fiber and can cover a large spatial range." These fibers can operate continuously over hundreds of meters, and they provide high sensitivity at a low cost. "This platform," Wang continues, "is particularly attractive for applications such as pollution detection in rivers and lakes; chemical-bio terrorism agent detection in stadiums, airports, buildings, and other public venues; and hydrogen detection in today's aerospace fuel tanks and tomorrow's hydrogen stations and factories."

Advancing the quest for clean coal

Using Ultra Super Critical (USC) steam cycle designs, coal power plants can gain a 10 percent increase in efficiency and a 25-30 percent decrease in CO2 emissions. ECE's Anbo Wang is helping make this improvement a reality with a grant of more than $1 million from the Department of Energy's National Energy Technology Laboratory (NETL) to develop fiber-optic strain, temperature, and pressure sensor technology.

The USC efficiency depends in part upon keeping the plants continually operational while staying within equipment and material limitations. The new USC boilers are designed to operate above 700°C and several thousand psi for steam, and higher for gas. According to Wang, "these higher temperatures and pressures require local measurements rather than the global process operation and control measurements available from the current generation of sensors. The local measurements are needed to assess equipment health or impending problems over and along the entire components area." And none of the existing distributed sensor networks are rated for the necessary in-furnace conditions of a USC boiler.

Because of the higher operating temperatures, USC components degrade more rapidly. Although a component's mean degradation can be predicted with existing systems, the precise state of each component is unknown. The estimates are overly conservative and susceptible to unanticipated component failure, Wang says.

The new sensors must operate at higher temperatures and pressures than the existing technology without sacrificing any accuracy or long-term operating reliability. They will also have multiplexed capability for a distributed sensor network, allowing for more accurate identification of those operating conditions that will adversely impact boiler reliability — and therefore plant operation.

Wang's team is working with Gary Pickrell of materials science and engineering, who leads a team developing the sensor packaging and protection, and Alstom Power, which will identify the necessary environmental conditions and evaluate sensor attachment and placement.

Making solar energy affordable, efficient

Jason Lai's team at the Future Energy Electronics Center, is analyzing how power conditioning can make solar cells more efficient. The team has set up three different arrays of solar cells on a solar house built by Virginia Tech students 10 years ago for the Solar Decathlon. The team is analyzing data via three separate communication platforms Pachube.com (*www.pachube.com/feeds/16184*), Google PowerMeter, and EPRI.

One array measures a common configuration where all the panels are placed in for a centralized inverter. The other two arrays measure variants of the FEEC's proposed topology: one uses an individual dc-dc converter for every two panels and links to the grid with a centralized inverter, while the other links every two panels into a separate micro-inverter. The study shows highest energy production with the micro-inverter approach, but cost-effectiveness must be studied. The project is part of a $3.2 million grant from the Department of Energy's High Penetration Solar Deployment effort.

2009/2010 PH.D. DEGREES AWAR

Ahuja, Sumit
High Level Power Estimation and Reduction Techniques for Power Aware Hardware Design
Committee Chair: Shukla, S. K.

Arana, Andrew Jex
Power Systems Analysis in the Power-Angle Domain
Committee Chair: De La Ree, J.

Baisden, Andrew Carson
Generalized Terminal Modeling of Electro-Magnetic Interference
Committee Chair: Boroyevich, D.

Bank, Jason Noah
Propagation of Electromechanical Disturbances Across Large Interconnected Power Systems and Extraction of Associated Modal Content from Measurement Data
Committee Chair: Liu, Y.

Bernabeu, Emanuel Ernesto
Methodology for a Security-Dependability Adaptive Protection Scheme Based on Data Mining
Committee Chair: Centeno, V. A. & Thorp, J. S.

Castles, Ricky Thomas
A Knowledge Map-Centric Feedback-Based Approach to Information Modeling and Academic Assessment
Committee Chair: Kachroo, P.

Chen, Qinqin
Cognitive Gateway to Promote Interoperability, Coverage and Throughput in Heterogeneous Communication Systems
Committee Chair: Bostian, C. W.

Cheng, Danling
Integrated System Model Reliability Evaluation and Prediction for Electrical Power Systems: Graph Trace Analysis Based Solutions
Committee Chair: Broadwater, R. P. & Hsiao, M. S.

Cheng, Xueqi
Exploring Hybrid Dynamic and Static Techniques for Software Verification
Committee Chair: Hsiao, M. S.

Dong, Junwei
Microwave Lens Designs: Optimization, Fast Simulation Algorithms, and 360-Degree Scanning Techniques
Committee Chair: Zaghloul, A. I.

Dong, Yan
Investigation of Multiphase Coupled-Inductor Buck Converters in Point-of-load Applications
Committee Chair: Lee, F. C.

El-Nainay, Mustafa Yousry
Island Genetic Algorithm-Based Cognitive Networks
Committee Chair: MacKenzie, A. B.

Fahmy, Sherif Fadel
Collaborative Scheduling and Synchronization of Distributable Real-Time Threads
Committee Chair: Ravindran, B.

Feinauer, Lynn Ralph
Generic Flow Algorithm for Analysis of Interdependent Multi-Domain Distributed Network Systems
Committee Chair: Broadwater, R. P.

Francis, Gerald
An Algorithm and System for Measuring Impedance in the D-Q Coordinates
Committee Chair: Boroyevich, D.

Fu, Dianbo
Topology Investigation and System Optimization of Resonant Converters
Committee Chair: Lee, F. C.

Gandhi, Mital Arun
Robust Kalman Filters Using Generalized Maximum Likelihood-Type Estimators
Committee Chair: Mili, L. M.

Ge, Feng "Andrew"
Soft Radio-Based Decentralized Dynamic Spectrum Access Networks: A Prototype Design and Enabling Technologies
Committee Chair: Bostian, C. W.

Gong, Ting
Computational Dissection of Composite Molecular Signatures and Transcriptional Modules Using Microarrays
Committee Chair: Xuan, J.

Hambrick, Joshua Clayton
Configurable, Coordinated, Model-Based Control in Electrical Distribution Systems
Committee Chair: Broadwater, R. P.

Han, Kai
Scheduling Distributed Real-Time Tasks in Unreliable and Untrustworthy Systems
Committee Chair: Ravindran, B.

Howells, Christopher Corey
The Modeling and Analysis of the BAD/tBID/BAK Pathway as a Chemical Reaction Network
Committee Chair: Baumann, W. T.

Jia, Tao
Collaborative Position Location for Wireless Networks in Harsh Environments
Committee Chair: Buehrer, R. M.

Kim, Jae Hyuck
Variable-Speed Switched Reluctance Motor Drives for Low-Cost, High-Volume Applications
Committee Chair: Ramu, K.

PATENTS AWARDED

"*Wires on Demand: Run-Time Communication Synthesis for Reconfigurable Computing*," C. Patterson, P. Athanas, J. Bowen, T. Dunham, J. Rice, M. Shelburne, J. Pletri, J. Graf.

"*Method and Apparatus for Mobility Enhancement in a Semiconductor Device*," M. Orlowski and S. Venkatesan.

"*Analog Fourier Transform Channelizer and OFDM receiver*," M. Lehne and S. Raman.

"*Digital Power Supply Control*," J. Li, Y. Qiu, M. Xu, F.C. Lee.

"*Multi-Element Resonant Converters*," D. Fu, F.C. Lee, Y. Liu, M. Xu.

"*Non-Isolated Bus Converters with Voltage Divider Topology*," M. Xu, J. Sun, F.C. Lee.

"*Asymmetrical Interleaving Strategy for Multi-Channel Power Converters*," C. Wang, M Xu, F.C. Lee.

"*Coupled-Inductor Multi-Phase Buck Converters*," M. Xu, F.C. Lee, Y. Ying.

"*Reducing Common Mode Noise of Power Factor Correction Converters Using General Balance Concept*," S. Wang, F.C. Lee, P. Kong.

"*Multiphase Voltage Regulator Having Coupled Inductors with Reduced Winding Resistance*," Y. Dong, M. Xu, F.C. Lee.

"*Quasi-Parallel Voltage Regulator*," M. Xu, J. Sun, Y. Liu, F.C. Lee

"*Apparatus and Methods for Forming a Modulation Doped Non-Planar Transistor*," R. Pillarisetty, M.K. Hudait, M. Radosavljevic, W. Rachmady, G. Dewey, J. Kavalieros.

"*Group III-V Devices with Multiple Spacer Layers*," M.K. Hudait, M. Radosavljevic, R. Pillarisetty, G. Dewey.

DED & PATENTS

Kim, Rae-Young
Improved Renewable Energy Power System Using a Generalized Control Structure for Two-Stage Power Converters
Committee Chair: Lai, J.

Kleppinger, David Lawrence
Prioritized Reconfiguration of Interdependent Critical Infrastructure Systems
Committee Chair: Broadwater, R. P.

Lai, Shouwen
Duty-Cycled Wireless Sensor Networks: Wakeup Scheduling, Routing and Broadcasting
Committee Chair: Ravindran, B.

Lally, Evan Michael
Fourier Transform Interferometry for 3D Mapping of Rough and Discontinuous Surfaces
Committee Chair: Wang, A.

Lee, Cheewoo
Analysis and Design of a Novel E-Core Common-Pole Switched Reluctance Motor
Committee Chair: Ramu, K.

Lee, Jong-Suk
FleXilicon: A New Coarse-grained Reconfigurable Architecture for Multimedia and Wireless Communications
Committee Chair: Ha, D. S.

Liu, Chu-Chuan
Advanced Projection Ultrasound Imaging with CMOS-based Sensor Array: Development, Characterization, and Potential Medical Applications
Committee Chair: Wang, Y. J.

Liu, Jia "Kevin"
MIMO Wireless Networks: Modeling, Theory, and Optimization
Committee Chair: Hou, Y. T.

Morales-Tirado, Lizdabel
An Approach to Using Cognition in Wireless Networks
Committee Chair: Reed, J. H.

Ning, Puqi
Design and Development of High Density High Temperature Power Module with Cooling System
Committee Chair: Ngo, K. D. T. & Wang, F.

Park, Sung Yeul
A Wide Range and Precise Active and Reactive Power Flow Controller for the Fuel Cell Power Conditioning Systems
Committee Chair: Lai, J.

Rajagopalan, Vidya
Increasing DBM Reliability Using Distribution Independent Tests and Information Fusion Methods
Committee Chair: Wyatt, C. L.

Shaban, Heba Ahmed
A Novel Highly Accurate Wireless Wearable Human Locomotion Tracking and Gait Analysis System via UWB Radios
Committee Chair: Buehrer, R. M.

Silvius, Mark Daniel
Building a Dynamic Spectrum Access Smart Radio With Application to Public Safety Disaster Communications
Committee Chair: Bostian, C. W. & MacKenzie, A. B.

Skolthanarat, Siriya
The Modeling and Control of a Wind Farm and Grid Interconnection in a Multi-Machine System
Committee Chair: Centeno, V. A.

Suris Pietri, Jorge Alberto
Rapid Radio: Analysis-Based Receiver Deployment
Committee Chair: Athanas, P. M.

Thacker, Timothy Neil
Control of Power Conversion Systems for the Intentional Islanding of Distributed Generation Units
Committee Chair: Boroyevich, D.

Wang, Chuanyun
Investigation on Interleaved Boost Converters and Applications
Committee Chair: Lee, F. C. & Xu, M.

Wang, Ying
Dynamic Cellular Cognitive System
Committee Chair: Bostian, C. W.

Xia, Tao
Frequency Monitoring Network (FNET) Algorithm Improvements and Application Development
Committee Chair: Liu, Y.

Xu, Bin
Fast Path Planning in Uncertain Environments: Theory and Experiments
Committee Chair: Stilwell, D. J. & Kurdila, A. J.

Zhang, Di
Analysis and Design of Paralleled Three-Phase Voltage Source Converters with Interleaving
Committee Chair: Boroyevich, D. & Wang, F.

Zheng, Yexin
Circuit Design Methods with Emerging Nanotechnologies
Committee Chair: Huang, C.

Zhu, Yitan
Learning Statistical and Geometric Models from Microarray Gene Expression Data
Committee Chair: Wang, Y. J.

"*Thin Transition Layer Between a Group III-V Substrate and a High-K Gate Dielectric Layer*," W. Rachmady, J. Blackwell, S. Datta, J. T. Kavalieros, and M.K. Hudait.

"*Quantum Well Field-Effect Transistors with Composite Spacer Structures, Apparatus Made Therewith, and Methods of Using Same*," M.K. Hudait, R.S. Chau, M. Radosavljevic, R. Pillarisetty, G. Dewey.

"*Dislocation Removal From a Group III-V Film Grown on a Semiconductor Substrate*," M.K. Hudait, P.G. Tolchinsky, J.T. Kavalieros, and M. Radosavljevic.

"*Buffer Layers for Device Isolation of Devices Grown on Silicon*," M.K. Hudait, M.A. Shaheen, L. Chow, P.G. Tolchinsky, J.M. Fastenau, D. Loubychev, A.W.K. Liu.

"*Semiconductor Buffer Architecture for III-V Devices on Silicon Substrates*," M.K. Hudait, M.A. Shaheen, D. Loubychev, A.W.K. Liu, J.M. Fastenau.

"*High Hole Mobility p-Channel Ge Transistor Structure on Si Substrate*," M.K. Hudait, S. Datta, J.T. Kavalieros, P.G. Tolchinsky.

"*Dopant Confinement in the Delta Doped Layer Using a Dopant Segregation Barrier in Quantum Well Structures*," M.K. Hudait, A.A. Budrevich, D. Loubychev, J.T. Kavalieros, S. Datta, J.M. Fastenau, A.W.K. Liu.

"*Replacement Gate, Self-Aligned Process for Fabrication of Enhancement Mode III-V QW Devices*," P. Majhi, M.K. Hudait, J.T. Kavalieros, R. Pillarisetty, M. Radosavljevic, G. Dewey, T. Rakshit, W. Tsai.

"*Methods of Forming Buffer Layer Architecture on Silicon and Structures Formed Thereby*," M.K. Hudait, P.G. Tolchinsky, L.A. Chow, D. Loubychev, J.M. Fastenau, A.W.K. Liu.

"*Selective High-K Dielectric Film Deposition for Semiconductor Device*," W. Rachmady, M. Radosavljevic, M.K. Hudait.

"*Fabrication of Miniature Fiber-Optic Temperature Sensors*," Y. Zhu, A. Wang.

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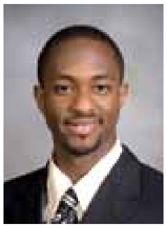
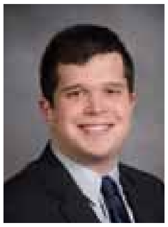
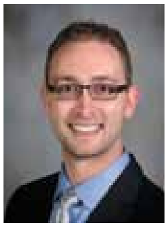


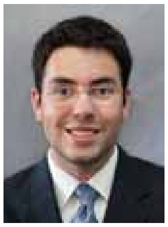
Uchenna Anyanwu
BSEE '09, San Jose State University
Advisor: Allen MacKenzie
Research: He is exploring wireless communication and reconfigurable devices to develop inexpensive, flexible software-defined radios. High-speed random access data networking is the ultimate goal.
Career aspirations: To be lead researcher or CTO at a communications company.



Matthew Bailey
BSEE/BSCPE/ Math '09, Virginia Tech
Advisor: Dan Stilwell
Research: Development of a robot to navigate/examine the interior of Navy ships. Corrosion inspection is a major cost. We are developing an autonomous robot that can navigate through the tanks and voids of naval ships and examine more of the interior surface for corrosion than is now possible.



Matthew Carter
BSCPE '09, University of California, San Diego
Advisor: Christopher Wyatt
Research: Improving the accuracy of neural source localization from magnetoencephalography (MEG) recordings. The localization of these sources will help to investigate brain connectivity.



Thurman Deyerle
BSEE '10, Virginia Tech
Advisor: Dong Ha
Research: Integrated circuits currently have dedicated pins for the testing and diagnostic interfaces. He is working on an interface which will superimpose signals onto the power supply, enabling diagnostic communication without additional pins.

BRADLEY ALUMNI

JoAnn M. Adams (BSEE '94)
Co-owner, Big Fish Design
Centreville, Va.

Robert J. Adams
(BS '93, MS '95, Ph.D. '98)
Associate Professor, ECE
University of Kentucky
Lexington, Ky.

J. Shawn Addington
(BSEE '90, MSEE '92, Ph.D. '96)
Department Head, ECE
Virginia Military Institute
Lexington, Va.
He volunteers as a coach/assistant coach for several youth sports teams.

Sarah S. Airey (BSCPE '01)

Christopher R. Anderson
(BSEE '99, MSEE '02, Ph.D '06)
Assistant Professor, ECE
United States Naval Academy
Annapolis, Md.

Matthew Anderson (BSCPE '04)

Francis Aphrem

Nathaniel August
(BSCPE '98, MSEE '01, Ph.D. '05)
Mixed Signal Design Engineer
Advanced Design Group, Intel
Portland, Ore.
Current project is an all-digital PLL.

Carrie Ellen Aust (BSCPE '98)

William Barnhart (BSEE '00, MSEE '02)
Raytheon
Denver, Colo.

Stephen P. Bachuber

Mark W. Baldwin
(BSEE '93, MSEE '05, Ph.D. '08)
Engineer, Dominion
Glen Allen, Va.
Working in control and protection of power generation equipment.

William Barnhart

Benjamin Beasley (BSEE '09)
Associate
Zeta Associates
Fairfax, Va.
MSEE in progress at Virginia Tech

Brian L. Berg (Ph.D. '01)
Director of Software Engineering
DTS
Agoura Hills, Calif.
Has started a new role investigating DTS' strategies in digital entertainment such as audio, video, and 3D.

Ray A. Bittner, Jr.
(BSCPE '91, MSEE '93 Ph.D. '97)
Senior Hardware Engineer
Microsoft Research
Redmond, Wash.
Working on topics such as FPGAs and portable devices.

Aric D. Blumer (Ph.D. '07)
SDG Systems

Bryan Browe

Kirsten Brown (BSEE '94)
Chief of Staff to the CEO
MicroStrategy, Inc.
Alexandria, Va.

Steve Bucca
(BSEE '87, MSEE '90)

Mark Bucciero
(BSCPE '01, MSCPE '04)

R. Michael Buehrer (Ph.D. '96)
Associate Professor
Virginia Tech

Charles F. Bunting (Ph.D. '94)
Associate Professor
Oklahoma State University
On IEEE EMC Society Board of Directors for 2011–2013.

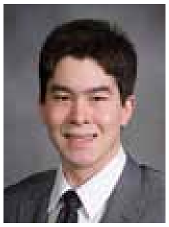
Carey Buxton (Ph.D. '01)
Electronics Engineer
FBI ERF
Quantico, Va.

Scott C. Cappiello (BSCPE '94)
Senior Director
of Program Management
MicroStrategy, Inc.
San Marcos, Calif.

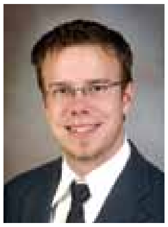
J. Matthew Carson (BSEE '98)
Engineer, Engine Dept.
Joe Gibbs Racing
Huntersville, N.C.
Working to improve engine reliability and power.

Ricky T. Castles (BSCPE '03, MSCPE '06, MSISE '08, Ph.D. '10)
Engineering Faculty Member
East Carolina University
Greenville, N.C.
Working to develop curriculum for a new EE concentration.

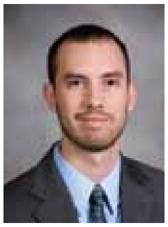
Eric Caswell (Ph.D. '02)



Michael Fraser
BSEE '09, Virginia Tech
Advisor: Anbo Wang
Research: As part of the Center for Photonics Technology, he is designing fiber optic sensors fit for physical, chemical, and biological measurements. Fraser is developing a novel gas detection system based on dual measurements of absorption and refractive index change.



Kelson Gent
BSECE '10 University of Texas at Austin
Advisor: Michael Hsiao
Research: General purpose computing on graphics processing units (GPGPUs) can give a 20x speed boost. He is working on developing and modifying algorithms for important tasks in microprocessor testing and verification to map them to a GPGPU environment.



Michael Hopkins
BSEE '09, Virginia Commonwealth University
Advisor: Lynn Abbott
Research: He is investigating methods to encode visual information using haptic and audio interfaces for the blind. In addition, he is working on the adult-size humanoid robot, CHARLI, for Virginia Tech's entry into the 2011 RoboCup competition.

Kevin Jones
BSEE '09, Virginia Tech
Advisor: Virgilio Centeno
Research: Currently working with Dominion Power and the DOE to develop a three phase tracking linear state estimator on Dominion's 500 kV network using phasor measurements.
Career aspirations: To spend 20–25 years in the electric power industry before returning to a university to teach during retirement.

Dae Hee (Daniel) Cho (BSEE '06)
Attorney
Dickstein Shapiro LLP
Los Angeles, Calif.
Recently graduated from NYU School of Law.

Jeffrey R. Clark

Ross Clay (BSCPE '09)
M.S. student
North Carolina State Univ.
Raleigh, N.C.

Brittany Clore (BSCPE '10)
Graduate student
Virginia Tech

Patrick Coleman

Kevin Cooley (BSEE '02)

David C. Craven

Stephen Craven

Cas Dalton (BSCPE '03)

Phillip Danner (BSCPE '91)

Bradley A. Davis (Ph.D. '01)

Daniel Davis (BSEE '03)

Scott Davis (BSCPE '00)
Senior Software Engineer
Kollmorgen

Armando Delahostria

Joel A. Donahue (MSEE '94)
President
Janlee Services, Inc.
Professional engineering services for homeowner, legal, and academic sectors.

Brian M. Donlan (MSEE '05)

Thomas Drayer (Ph.D. '97)

Bradley D. Duncan (Ph.D. '91)
Associate Dean of Graduate, Continuing, and Professional Education
Professor, EE and Electro-Optics
University of Dayton
Dayton, Ohio

Gregory D. Durgin
(BSEE '96, MSEE '98, Ph.D. '00)
Associate Professor
Georgia Tech
Atlanta, Ga.

W. Ashley Eanes (BSEE '95)

Richard B. Ertel (Ph.D. '00)

Brian F. Flanagan
(BSEE '97, MSEE '98)

Kevin P. Flanagan
(BSCPE '00, MSCPE '01)
Design Engineer
Micron
Folsom, Calif.

Todd Fleming
(BSEE '94, MSEE '96)

Ryan J. Fong
(BSCPE '01, MSCPE '04)
Senior Firmware Engineer
ITT
Elkridge, Md.

Jayda B. Freibert (BSEE '98)

Daniel Friend
(BSEE, MSEE '98, Ph.D. '09)
Communication Systems Engineer
Northrop Grumman

Bradley H. Gale (BSEE '97)

Robert M. Gardner
(BSEE '03, MSEE '05, Ph.D. '08)
Engineer III
Dominion Virginia Power
Richmond, Va.
Lead engineer for Dominion's electric transmission smart grid program.

Daniel J. Gillespie (BSCPE '95)

Brian Gold
(BSEE/Math '01, MSCPE '03)
Senior Staff Engineer
Oracle; Redwood City, Calif.

Jonathan Graf
(BSCPE '02, MSCPE '04)
Director of Trust Technologies
Luna Innovations
Roanoke, Va.
Current focus on solving forward-looking security problems for the Defense Advanced Research Projects Agency.

Timothy Gredler (BSCPE '03)
Senior Design and Development Engineer
Lutron Electronics
Coopersburg, Pa.

Christopher R. Griger
(BSCPE '02)
Senior Digital Hardware Engineer
National Instruments
Austin, Texas

Daniel Michael Hager (CPE '08)
Embedded Software Engineer
Lockheed Martin Aeronautics
Was accepted into Lockheed Martin's Engineering Leadership Development Program.

Adam Hahn

Alex Hanisch (BSCPE/Math '03)
Modeling and Simulation Scientist-Joint Warfare Analysis Center
Dahlgren, Va.

Abigail Harrison (BSCPE '04)

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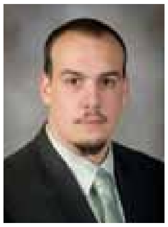
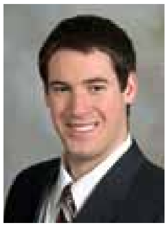
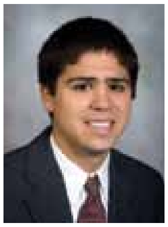


Nicholas Kaminski
BSEE/BSCPE '10
Virginia Tech
Advisor: Charles Bostian
Research: He is a lead developer on the Cognitive System Enabling Radio Evolution (CSERE) project to provide a development system to explore and enhance any aspect of a cognitive radio. CSERE will allow him to explore new ideas in cognitive radio, such as non-global decision making.



Nathan Kees
BSEE '08, Virginia Tech
Advisor: Jason Lai
Research: He is investigating common-mode electromagnetic interference soft-switching and hard-switching full-bridge single-phase inverters, especially the reduction in high-frequency shaft voltage caused by the doubly-fed three-phase inverter topology.

Amy Malady
BSEE '09, Virginia Tech
Advisor: A. A. (Louis) Beex
Research: Developed a robust cyclostationarity feature based classifier for analog and digital signals. Developed a low order cyclostationarity feature based detector for continuous phase modulated (CPM) signals. Continuing work on developing a CPM classifier.



Javier Schloemann
BSCPE '04, MSEE '07, Clemson University
Advisor: Michael Buehrer
Research: He is using Bayesian networks and inferencing techniques to fuse position estimates from multiple sensors to find accurate position data.
Career aspirations: To develop and market an original product, or to research and teach engineering as a professor.

BRADLEY ALUMNI
Continued

Nathan Harter (MSEE '07)

Jennifer J. Hastings (BSEE '96)

Dwayne A. Hawbaker (MSEE '91)

William C. Headley

Matt C. Helton (BSEE '01)
Plant Engineering
Eastman Chemical Co.
Kingsport, Tenn.
Team Lead for Coal Gasification Plant Engineering

Benjamin E. Henty (MSEE '01)

Jason Hess (BSEE '97, MSEE '99)
Manager, HW Engineering
Cisco Systems
Austin, Texas

H. Erik Hia (BSCPE '99, MSCPE '01)
Currently working on SHDSL optimization algorithms, including near-end cross-talk cancellation.

Daniel J. Hibbard

James Hicks (Ph.D. '03)

Hugh E. Hockett (BSCPE '03)

Janie Hodges (BSCPE '01)

Spencer Hoke (BSCPE '03)
Senior Software Engineer
Qualcomm
Raleigh, N.C.
Switched jobs last year to move closer to family. Now working for Qualcomm on Snapdragon cell phone software.

Russell T. Holbrook (BSCPE '03)

Andrew Hollingsworth (BSCPE '02)

Ellerly Lewis Horton

Keith Huie

Ryan Hurrell (BSEE '03)
Program Manager/Electrical Engineer
Northrop Grumman/Remotec
Working to provide an improved robotic manipulator to address specific challenges of vehicle based improvised explosive devices for EOD customer consideration.

John Todd Hutson (BSEE '93)

Ryan Irwin
Graduate student, Virginia Tech

Madiha Jafri (BSCPE '03)

Daniel A. Johnson (MSEE '01)

Amy M. Johnson

Edward Andrew Jones

Brian Thomas Kalb

Adam Kania (BSEE '01)

David A. Kapp (Ph.D. '96)

Dimosthenis C. Katsis
(BSEE '95, MSEE '97, Ph.D. '03)
President, Athena Energy Corp.
Bowie, Md.
Presently developing new products for the alternative energy market. Also busy consulting for the DoD and various defense contractors on power supply designs.

David Kleppinger (BSCPE '04)

Paul A. Kline (Ph.D. '97)

Gregory Kozick (BSCPE '03)

William B. Kuhn
(BSEE '79, Ph.D. '96)
Professor, EECE
Kansas State University
Recent research projects include infusing sustainability into the K-State ECE curriculum.

Zachary La Celle (BSEE '09)
Engineer
Robotic Research LLC
Gaithersburg, Md.
Working with ground autonomous robotics platforms for use in various military and civilian environments.

Evan Lally (BSEE '03, MSEE '06, Ph.D. '10)
Optical Scientist
Luna Innovations
Blacksburg, Va.

Jeffery D. Laster
(BSEE '79, Ph.D. '97)
Principal Technical Manager
Mentor Graphics, Addison, Texas

Mark A. Lehne (Ph.D. '08)
Together with ECE's Sanjay Raman, recently received a patent titled "Analog Fourier Transform Channelizer and OFDM receiver."

Charles Lepple
(BSEE '00, MSEE '04)
Senior Research Engineer
Johns Hopkins University APL
Laurel, Md.

Jason Lewis (BSEE '99)

Joseph C. Liberti (Ph.D. '95)

Zion Lo (BSEE '94)
Sr. Software Engineer/Architect
IQNavigator, Denver, Colo.

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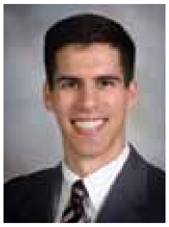
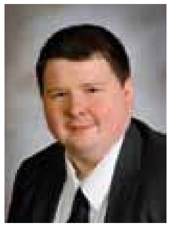
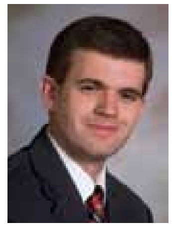


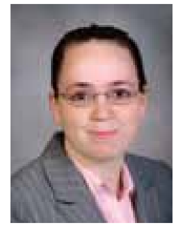
Benton Thompson
BSEE ’05, University of Tennessee-Knoxville
Advisor: Michael Buehrer
Research: In an indoor environment, GPS signals are faulty and sometimes non-existent. Collaborative position location is using a network of interconnected nodes that each know how far away they are from each other to pinpoint each node’s individual location.



Willis Troy
BS ’07, MS ’09, Baylor University
Advisor: Michael Hsiao
Research: His research is currently focused on satisfiability solvers, a known NP-complete problem. He is investigating the techniques currently utilized by well known satisfiability solvers to see if their performance can be improved.



Ben York
BSEE ’08, University of Alabama
MSEE ’10, Virginia Tec
Advisor: Jason Lai
Research: He is designing and implementing high efficiency power conversion for renewable energy and micro-grid applications. Current research involves system and battery management for bidirectional isolated supplies.



Anne Martin
BSECE ’10, F.W. Olin College of Engineering
Advisor: Michael Buehrer
Research: In communications, she is working on the secrecy capacity of MIMO systems, and how it can be approached in practice. In networking, she is looking at how the addition of femtocells can affect a cellular network.

Daniel L. Lough
(BSCPE ’94, MSEE ’97, Ph.D. ’01)

Andrew Love
Graduate student, Virginia Tech

Cheryl Duty Martin (BSEE ’95)

Stephanie Martin (BSEE ’04)
Jammer Techniques Optimization (JATO) Communications Electronic Attack Team Lead
Johns Hopkins University APL; Columbia, Md.

Michael Mattern (BSEE ’02)

Christopher Maxey (BSCPE ’02)

Eric J. Mayfield (BSEE ’97)

Patrick McDougle (BSEE ’03)

Brian J. McGiverin (BSCPE ’96)

John T. McHenry
(BSEE ’98, MSEE ’90, Ph.D. ’93)
Senior Electrical Engineer
U.S. Department of Defense

Keith McKenzie

David McKinstry (MSEE ’03)

James W. McLamara

Garrett Mears (BSCPE ’00)
Chief Software Architect
Open Vantage Ltd.
London, U.K.
Developing an innovative new mobile entertainment project.

Vinodh Menon (BSCPE ’02)

Michael Mera (BSEE ’03)
Technical Lead, Electrical Engineer
U.S. Army
Picatinny, N.J.

Carl Minton (MSCPE ’99)

John Morton (MSEE ’98)

Christian Murphy

Stephen Nash (BSCPE ’03)
Software Engineer Sr.
Lockheed Martin IS&GS
Rockville, Md.

Troy Nergaard (MSEE ’02)
Engineering Manager, Charging Systems
Tesla Motors
Palo Alto, Calif.

Michael H. Newkirk
(BSEE ’88, MSEE ’90, Ph.D. ’94)
Principal Professional Staff
Applied Physics Laboratory
Johns Hopkins University
ECE Advisory Board Member

Paul Erik Nguyen
(BSCPE ’98, MSCPE ’99)

J. Eric Nuckols
(BSEE ’97, MSEE ’99)

Neal Patwari
(BSEE ’97, MSEE ’99)
Assistant Professor
University of Utah
2011 University of Utah Early Career Teaching Award

Joseph Allen Payne (BSEE ’00)

My Linh Pham (BSCPE ’07, BS in Physics ’07)
Ph.D. student in Applied Physics
Harvard University
Cambridge, Mass.

W. Bruce Puckett (MSEE ’00)

Yaron Rachlin (BSEE/Math ’00)
Senior Member of Technical Staff
Draper Laboratory
Cambridge, Mass.

Parrish Ralston
(BSEE ’06, MSEE ’08)
Graduate Researcher
Virginia Tech

Christian J. Reiser (Ph.D. ’05)

Steve Richmond (MSEE ’01)

Jamie Riggins (BSEE/BSCPE ’04)
A captain in the U.S. Air Force, she was featured in Virginia Tech’s Spring 2010 *Corps Review*.

Pablo Max Robert (Ph.D. ’03)

David Gray Robertson

Thomas W. Rondeau
(BSEE ’03, MS ’06, Ph.D. ’07)
Rondeau Research, LLC
Philadelphia, Pa.
New maintainer of GNU Radio.

Thomas M. Rose (MSEE ’96)
Senior Engineer
Boeing
St. Louis, Mo.

Jon Scalera (MSCPE ’01)

Amy Schneider (BSCPE ’03)

Steven Schulz (MSEE ’91)

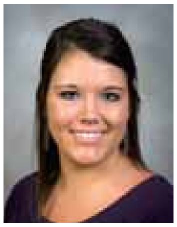
David C. Schroder (BSEE ’05)

Ian Schworer
(BSCPE ’03, MSEE ’05)
Associate, Global Technology Banking Barclays Capital, Investment Banking Division

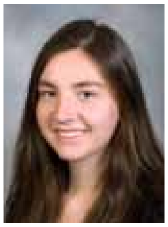
Jeff Scruggs (MSEE ’99)

Kashan Shaikh (BSCPE ’02)

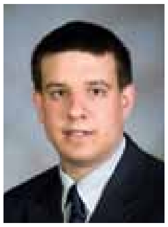
2010 2011 BRADLEY SCHOLARS



Allison Hofer
EE '14
Hartland, Wis.
Career goals: To become a patent attorney.
Why ECE: "The selling point for me on this major was the large amount of communication that takes place between electrical engineers and many other engineering majors."



Callie Johnston
CPE '14
Cleveland, Ohio
Career goals: To work with artificial intelligence or music technology.
Why ECE: "My internship at Rockwell Automation sparked my interest and inspired me to pursue a degree which can be applied in a variety of different ways."



David Mazur
EE '11
Pittsburgh, Pa.
Career goals: Ph.D., then manage group designing large electrical solutions for industry.
Research: Characterization and measurement of power angle on synchronous machines to prevent inter-machine oscillations.
Experience: Rockwell Automation internships.
Most memorable: "Ability to partake in design projects throughout my undergraduate career."

BRADLEY ALUMNI Continued

Adam Keith Shank

Raymond A. Sharp (BSEE '02)

Rebecca Shelton (MSEE '08)

Jacob Simmons (CPE '08)

Roger Skidmore
(BSCPE '94, MSEE '97, Ph.D. '03)

Jeff Smidler (BSEE '98)

Chelsy Wynn Smidler

Amanda (Martin) Staley
(BSEE '99, MSEE '01)
Senior Engineer
MITRE Corporation
McLean, Va.
Recently joined a project dedicated to identifying gaps in research for the FAA's NextGen programs

Graham Stead (BSCPE '93)

Neil Steiner (MSEE '02, Ph.D. '08)
Computer Scientist
USC Information Sciences Institute

Douglas R. Sterk (MSEE '03)
CPES Lab Manager
Ph.D. student, Virginia Tech

Scott Stern (BSEE '93)
Program Manager
Compunetix
Monroeville, Penn.
Manages development efforts for mission-critical conferencing systems.

Samuel S. Stone (BSCPE '03)

Anne (Palmore) Stublen
(BSEE '91)
Newark, Del.

Seema Sud (Ph.D. '02)

Erica Sundstrom

Juan E. Suris (Ph.D '07)
Assistant Professor
University of Puerto Rico
Mayaguez, Puerto Rico

Ethan B. Swint
Graduate Research Assistant
Ph.D. student at Virginia Tech

David Tarnoff (MSEE '91)
Associate Professor
Computer & Information Science
East Tennessee State University

Alexander J. Taylor

Daniel Tebben (Ph.D. '06)

Jerry Towler (BSEE '08)
Graduate Research Assistant
Unmanned Systems Lab
Virginia Tech

Rose Trepkowski (MSEE '04)

Christian Twaddle (BSCPE '01)
Program Manager, ITT Corporation
Columbia, Md.

Matthew C. Valenti
(BSEE '92, Ph.D. '99)
Professor, CS & ECE
West Virginia University
Morgantown, W.Va.

Michael Vercellino

Wesley Wade (BSEE '93)

Kristin Weary (BSEE '03)
Electrical Engineer
Bechtel-Knolls Atomic Power Laboratory
Niskayuna, N.Y.

Michael L. Webber (MSEE '03)

Jason Wienke (BSEE '02)

Thomas Williams (BSEE '00)

William J. Worek
(BSCPE '99, MSCPE '02)
Senior Engineer
SAIC
Arlington, Va.

Kai Xu (BSEE '95)

Matthew Yaconis

Jason Jon Yoho (Ph.D. '01)
Design Engineer
Picosecond Pulse Labs
Boulder, Colo.

Phillip A. Zellner

Richard Zimmerman (BSCPE '07)
Applications Programmer
Virginia Tech Transportation Institute
Blacksburg, Va.

Gregory A. Zvonar (MSEE '91)

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& Pauline H. Christian
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Ernest Dyson Crack
& Jackie A. Crack
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& Janet Crawford
Kenneth E. Cutler
& Lisa Cutler
Carl Lea Darron
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& Peggy ("Jean") Drumheller
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& Debbie J. Ellis
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& Dorothy Epperly
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& Danna J. Harras
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Roger Lee Hopkins
& Amelia Hopkins
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& Hui-Lein P. Huang
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& Edward L. Johnson
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& Karen Kise
Joseph Edward Kusterer
& Maryann W. Kusterer
Ting-Pui Lai
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Helene Lane
& William F. Lane
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Fangxing Li
& Erin Q. Zhou
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& Pauline R. Loftis
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& Ronald L. Marsh
Joseph Walter Matzen, Jr.
The Honorable Joe Turner May
& Roberta D. May
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& Carolyn Overby
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& Anne L. Pedin
Maj. Gen. Milton A. Pilcher
C. L. Purdy
& Carol T. Purdy
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& Michael J. Ratway
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& Frederica Reilley
Gerald F. Ricciardi
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Daniel M. Sable
& Pamela Sable
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& Richard E. Schmidt
James Franklin Schooler
& Nancy J. Schooler
Margaret Ficklen Schubert
& Thomas A. Schubert
Edith L. Schulz
Scott Yates Seidel
& Deborah Q. Seidel
Bernard Silverman
Michael Elliot Sockell
Charles S. Stevens
& Ann C. Stevens
Russell Alan Strobel
& Pam M. Strobel
Harvey Lee Sutton
& Agnes Sutton
Arthur D. Thompson
& Virginia Thompson
Catherine Gray Thorpe
& Michael A. Eades
Paul Turner Thurneysen
& Shirley A. Thurneysen
Deborah R. Tillotson
& Daniel H. Tillotson
Amanda M. Trussell
C. Hyde Tucker
& Gloria J. Tucker
Daniel E. Vogler
& Jean S. Vogler
Evan Michael Weiner
Ann P. Wingfield
& William A. Wingfield
Naveen Yadlapalli

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Blackwell Award

Many of this year's donations were earmarked for the Bill & LaRue Blackwell Graduate Research Paper Award, endowed in honor of former department head and professor William A. Blackwell, who died in March 2010.

Blackwell was born in Fort Worth, Texas, in 1920 and served in the U.S. Army Air Force during World War II. He joined the Virginia Tech faculty in 1966 and served as head of the Electrical Engineering Department until 1981. During his tenure as department head, the foundations of today's department were developed. Whitemore Hall was built and the department moved into the first three floors in 1971. During this period, the department doubled in size, from 21 faculty members in 1966 to 39 in 1981.


William A. Blackwell

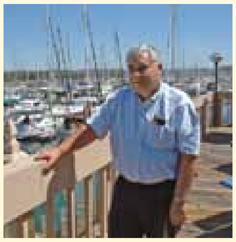
Blackwell stepped down as head in 1981 to serve as a professor. He remained active with the department after retirement, editing a textbook, encouraging young faculty members, and co-writing a history of the department.

Blackwell earned many honors in the field. He was a lifetime Fellow of the IEEE, and a regional IEEE Outstanding Educator. The University of Illinois named him a Distinguished Alumnus in 1979 and Texas Tech named him a Distinguished Engineer in 1990.

Donnie King Fund

Other donations this year were given to a scholarship fund endowed in memory of Donnie Marvin King (BSEE '69), who died in 2009.

King, an expert and technical leader in the small, but critical field of magnetometers, inspired many with his dogged determination to solve problems and an unshakable good nature.


Donnie King, BSEE '69

King continued his work while battling increasing handicaps from amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease.

King became one of the world's few experts in magnetometry — magnetic measurement technology to help the Navy track submarines and locate mines.

King spent half his career developing technology to hunt and track Soviet submarines, then after the Cold War was thrilled to collaborate and become friends with some of his former technical competitors from Russia.

When you hear from The College Annual Fund this fall, make your gift to ECE.

HONORS & ACHIEVEMENTS

Honors & Awards

Fred C. Lee has been named one of 68 new members elected to the National Academy of Engineering for his contributions to power electronics. Membership in the academy is one of the highest professional honors accorded to an engineer.

Saifur Rahman received the IEEE-USA Professional Achievement Award for 2010. His appointment as the Joseph Loring Professor of Electrical and Computer Engineering was renewed for another five-year term.

Joseph Baker was named Steven O. Lane Junior Faculty Fellow of Electrical and Computer Engineering.

Joseph Tront was named the W.S. "Pete" White Chair for Innovation in Engineering Education.

Jeff Reed's appointment as the Willis G. Worcester Professor of Electrical and Computer Engineering was renewed for another five-year term.

Krishnan Ramu was honored with the Anthony J. Hornfeck Service Award by the IEEE Industrial Electronics Society.

Dushan Boroyevich has been elected President Elect of the IEEE Power Electronics Society (PELS).

Michael Buehrer and postdoctoral associate Haris Volos won the Fred Ellersick Award for Best Paper in the Unclassified Technical Program at MILCOM 2010, for their paper, "Robust Training of A Link Adaptation Cognitive Engine."

Tom Martin was elected vice chair of the IEEE Technical Committee on Wearable Information Systems (TCWIS).

Anbo Wang was named a Fellow of the International Optics and Photonics Society.

Sandeep Shukla is an ACM Distinguished Speaker and an IEEE Computer Society Distinguished Visitor.

Amir Zaghloul was named a Distinguished Lecturer for the IEEE Sensors Council for 2010-2011. He was also elevated to Life Fellow of the IEEE and Fellow of the Applied Computational Electromagnetics Society.

Virgilio Centeno, with colleagues from architecture, business, and engineering, won the Virginia Tech 2010 XCaliber award for excellence in creating and applying technologies on a large-scale team project. The faculty team mentored the Lumenhaus team that won the 2010 Solar Decathlon Europe.

T.-C. Poon was appointed a Distinguished Chair Professor by Feng Chia University, Taiwan.

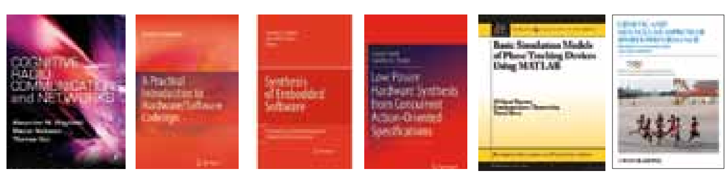
Stephen Ellingson received A College of Engineering Faculty Fellow Award.

William Baumann earned a Dean's Award for Excellence in Teaching and a Certificate of Teaching Excellence.

Jason Lai received a Dean's Award for Excellence in Research.

Hardus Odendaal received a Dean's Award for Excellence in Service.

Books Published



Tom Hou co-edited *Cognitive Radio Communications and Networks: Principles and Practices*; Academic Press/ Elsevier, 2010.

Patrick Schaumont published *A Practical Introduction to Hardware/Software Codesign*; Springer, 2010.

Sandeep Shukla co-edited *Synthesis of Embedded Software: Frameworks and Methodologies for Correctness by Construction*; Springer, 2010. He also co-authored *Low Power Hardware Synthesis from Concurrent Action-Oriented Specifications*; Springer, 2010.

William Tranter and **Tamal Bose** have a new book co-authored with Ratchaneekorn Thamvichai: *Simulation Models of Phase Tracking Devices Using MATLAB*; Morgan-Claypool, 2010.

Yue (Joseph) Wang and **Jinhua (Jason) Xuan** were contributing authors of *Volume XVIII of the Encyclopaedia of Sports Medicine series*, which covers genetic and molecular aspects of sports performance.

Editorships

Tom Hou is editor of *IEEE Transactions on Mobile Computing*, technical editor of *IEEE Wireless Communications*, and area editor of *IEEE Transactions on Wireless Communications*. He also serves as editor of *ACM/Springer Wireless Networks* (WINET) and the editor of *Elsevier Ad Hoc Networks Journal*.

Michael Hsiao is associate editor of *ACM Transactions on Design Automation of Electronic Systems* and serves on the editorial boards of *IEEE Design & Test of Computers* and the *Journal of Electronic Testing: Theory and Applications*.

Allen MacKenzie is associate editor of *IEEE Transactions on Communications* and *IEEE Transactions on Mobile Computing.*

Paolo Mattavelli was the 2010 associate editor for *IEEE Transactions on Power Electronics* and IPCC Transactions Review Chair for the *IEEE Transactions on Industry Applications*.

T.-C. Poon is division editor of *Applied Optics*.

Saifur Rahman is editor-in-chief of *IEEE Transactions on Sustainable Energy*.

Sandeep Shukla is associate editor for *IEEE Transactions on Computers, IEEE Embedded Systems Letters, IEEE Design & Test*, and *Elsevier Journal on Nano-Networks*. He is also guest editor for a special issue of *IEEE Design & Test* on Transaction Level Modeling for Multi-Core Systems.

Anbo Wang is senior editor of *Sensors - Insciences Journal*.

Jason Xuan is associate editor of *BMC Bioinformatics*.

Conference Chairs & Speakers

Peter Athanas gave the keynote speech at DCIS 2010: The 25th Conference on Design of Circuits and Integrated Systems, Nov. 2010 in Lanzarote, Spain. He also served as program chair for FPT 2010: International Conference on Field-Programmable Technology, Dec. 2010, Beijing; and for RSP 2010: 21st IEEE International Symposium on Rapid System Prototyping, June 2010, Washington, D.C.

Dushan Boroyevich gave an invited plenary talk at the Applied Power Electronics Conference (APEC), March 2011, Fort Worth, Texas.

Dong Ha served as technical program chair for US-Korea Conference (UKC) 2010, August 2010, Seattle, Wa.

Tom Hou is vice chair of the IEEE INFOCOM Standing Committee. He served as technical program co-chair for the International Conference on Computer Communication Networks (IC3N), Aug. 2010, Zurich, Switzerland; and as lead technical program co-chair of IEEE ICC 2010 – Wireless Networking Symposium, May 2010, Cape Town, South Africa.

Scott Midkiff was technical program co-chair for the 5th ACM International Workshop on UnderWater Networks (WUWNet), Sept. 2010, Woods Hole, Mass, and workshops co-chair for the IEEE International Conference on Pervasive Computing and Communication (PerCom), March 2011, Seattle, Washington.

Saifur Rahman served as the general chair of the Asia Pacific Power & Energy Engineering Conference, March 2011, Wuhan, China.

Patrick Schaumont was program co-chair for the ACM Workshop on Embedded Systems Security, Oct. 2010, Scottsdale, Ariz.

Sandeep Shukla presented a keynote talk at the International NOTERE 2010: Novel Technologies for Distributed Systems Conference; June 2010, Toezur, Tunisia.

Anbo Wang served as chair of Advanced Sensor Systems and Applications IV, Photonics Asia, Oct. 2010, Beijing, China; and chair of Optical Fiber Sensors and Applications IV, April 2010, Orlando, Fla.; and Photonic Microdevices/Microstructures for Sensing II, April 2010, Orlando, Fla.

Tenure & Promotion

Masoud Agah was tenured and promoted to associate professor.

Robert Clauer was tenured at his currently held rank of professor.

Allen MacKenzie was tenured and promoted to associate professor.

Exceptional National Service

Sanjay Raman is program manager in the Microsystems Technology Office of the Defense Advanced Research Projects Agency (DARPA/MTO).

William Tranter is a program director in the Division of Computing and Communication Foundations (CCF) at the National Science Foundation.

Saifur Rahman is chair of the NSF Advisory Committee for International Science and Engineering.

ECE FACULTY

A. Lynn Abbott
Associate Professor
Illinois '89

Masoud Agah
Associate Professor
Michigan '05

Peter Athanas
Professor
Brown '92

Scott Bailey
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Colorado '95

Joseph Baker
Assistant Professor
Michigan '01

William T. Baumann
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Tamal Bose
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Robert P. Broadwater
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Illinois '67

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Associate Professor
Virginia Tech '96

Virgilio Centeno
Associate Professor
Virginia Tech '95

C. Robert Clauer
Professor
UCLA '80

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