ece

THE BRADLEY DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

2013

UNWIRING our hospitals

VirginiaTech
Invent the Future®

ece INDUSTRIAL ADVISORY BOARD

The ECE Advisory Board held its fall 2012 meeting at the new Space@VT building.

BACK ROW (from left to right): Jonathan Whitcomb, Peter Hadinger, Mike O'Neil, Ken Boggs (guest), Rob Virostek, Joyce Woodward, Scott Midkiff (ECE), Christopher Burton, Mark McVey (guest), Eric Starkloff, Harold Carter (guest), Dan Sable, Brandon Witcher

FRONT ROW (from left to right): Gino Manzo, Timothy Winter, Steve Poland, Michael Newkirk, Michael Keeton, Kirsten Brown, Peter Diakun

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Applied Physics Laboratory

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Gino Manzo
Director of Microelectronics
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M.S. '85, Ph.D. '91
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VPT Inc.

Eric Starkloff
Vice President, Product
Marketing for Test
National Instruments
Corporation

Rob Virostek
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Alan Wade
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Wade Associates

Jonathan Whitcomb
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Vice President
Market Development;
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Northrop Grunman Corp.,
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Joyce Woodward
Technical Director
PEO IWS 3.0
Department of the Navy

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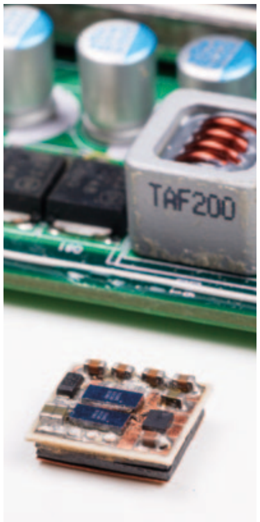
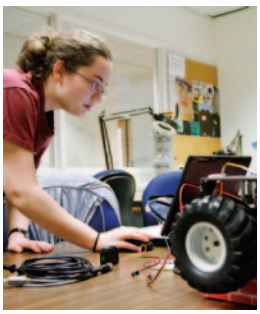
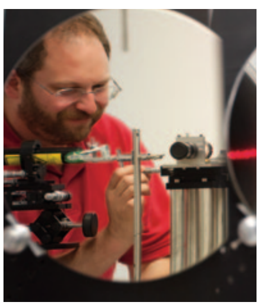






WHAT'S inside

from the ece DEPARTMENT HEAD

For the past half-year it has been a tremendous privilege for me to serve as the interim department head of the Bradley Department of Electrical and Computer Engineering (ECE). As you read the articles in this year's report, I think that you will agree with me that the scope of ECE's research and educational activities is truly remarkable. From work being done at Wireless@VT to "unwire" the hospital of the future, to the rapidly expanding research being done at the Ted and Karyn Hume Center for National Security and Technology (the Hume Center) to address national security challenges, the articles in this report give a window into the cutting edge research being done in ECE. I sincerely believe that one of the department's greatest strengths is our ability to meet new technological challenges head-on with expertise, imagination, and hard work.

On the educational front, this year's report describes initiatives in our cumulative undergraduate design experience, or "capstone" courses, and shows their central place in the ECE undergraduate curriculum. In addition, the report gives examples of undergraduate and graduate research opportunities such as the DARPA spectrum and robotics challenges, the VMEC summer microelectronics program, and Virginia Tech's hybrid electric vehicle team. These opportunities, among many others available in department, offer today's ECE graduates an extremely rich and timely educational experience that uniquely benefits them as they enter today's workforce, or as they continue with their graduate education.

I would like bring to your attention the contributions of a number of individuals in the service of the department. First and foremost, I would like to thank Scott Midkiff for his strong leadership of the department over the past three years. In spite of the limited resources available, under Scott's leadership, ECE made significant strides in a number of educational and research initiatives. In particular, I think the establishment and recent success of the Hume Center and the realization of the Space@VT building are two stellar examples of Scott's leadership. I would also like to extend a special thanks to Scott Bailey and Kathy Atkins, in partnership with Joe Meredith and the Corporate Research Center, for their tireless work to make the new Space@VT building a reality. In addition, I would like to recognize several members of the ECE Advisory Board whose terms have ended this year, including Roger Gambrel, Michael Keeton, Gino Manzo, Dave Marsell, Mike Newkirk, Dan Sable, Eric Starkloff, and Tim Winter. I sincerely thank these individuals for their service to the department. Finally, I would like to acknowledge three distinguished ECE faculty members that are retiring this year: Gary Brown, Bill Davis, and Tim Pratt. Each of these professors has been a fantastic departmental resource and strong contributor to the ECE research and teaching programs. I am sure that you will join with me in wishing them, and their families, the very best in their retirement.

On a personal note, one of the most rewarding aspects of being interim head has been the opportunity to meet alumni when they stop by to visit the department to catch up on news. They often tell of the difference their ECE education has made to their careers. They ask about a particular faculty member who inspired them to pursue a technical area that has ultimately become their career and their passion. Several times I have walked up and down the Whittemore stairwell with alumni looking for a younger version of themselves on the composite for the year they graduated. There are also the alumni who return to campus with their son or daughter who has just been accepted to Virginia Tech. It is a pleasure to witness their genuine excitement at the prospect of pursuing a degree in ECE and, ultimately, adding their photo to a graduation composite four years hence.

When you visit the department office, please stop by to see the photos on the wall of the Dynamo Laboratory in the former Preston Olin Building (1897), the students in the Electrical Engineering Laboratory (1921), or some of the other historical photos of the department. When I see these photos, I remind myself that these are the people who worked to build the department's foundation and establish its legacy. As you read this year's report, learn about our faculty and their research, and are introduced to our Bradley and Webber fellows and scholars, imagine the great places the department and its graduates will go over the next decade—much less the next hundred years. As William Blake wrote, "what is now proved was once only imagined," so I can only wonder what our students and faculty will imagine and then prove in the coming decades. Whatever it is, I am certain that these future contributions will take our breath away.

Paul E. Plassmann
Professor and Interim Department Head

HOSPITALS unwired

A Wireless @VT team is using wireless technology to make the hospitals of the future more efficient. From left: Jeff Reed, Jung-Min (Jerry) Park, and Taeyoung Yang

Wireless communications engineers tackle the next tough environment.

A nurse walks into a room with a bag of medication for a patient. Tearing open the bag breaks an RFID tag, and a computer records that the patient received medicine at 2:46 p.m. The blood pressure and heart rate monitors record minute-by-minute data to see how the patient reacts.

As a cardiologist walks into a patient's room, a wall monitor displays her vital signs and information on how well her pacemaker is working. The computer notes when the doctor came in, and inputs comments from the doctor.

While a patient is sitting up after an MRI, the information is already being transmitted through a wireless network to his medical records and to the two doctors overseeing his case. As the patient is wheeled back to the room, sensors in the rooms and hallway keep track of his location.

Jeff Reed, director of Wireless @Virginia Tech, and associate professor Jung-Min (Jerry) Park envision a hospital where communications between sensors, equipment, and caregivers is pervasive and wireless. The technology, they say, can improve patient care and reduce costs.

In their vision, every sensor and device would be connected in an intelligent system: hospital beds, MRI machines, blood pressure monitors, and environmental sensors would all be tied to a massive wireless communications network. Working with research scientist Taeyoung Yang, they have a plan to make this vision a reality. "I really think this could be the next big area for us as a group," says Reed. "One of the most dramatic changes for our lifestyle in the coming years will be in medical care. Adopting new technology in an appropriate way can improve care and reduce costs," he says.

Each hospital room today can house dozens of devices for monitoring the patient, according to Reed, and simplifying these devices could significantly reduce their cost. Currently, each device has sensors, processors, and a screen. Instead, Reed anticipates having sensors feed into a central computer that will process the data and consolidate the results on one screen. "If you digitize the sensor data at the source, you wouldn't need the case, the power supply, the screen, or the computer inside," he says.

A pervasive wireless communications system can also improve the efficiency of the hospital staff. Reed notes that nurses and doctors can spend a lot of time typing on computers. He believes that "new technologies will help us be more efficient if they're done right. But if these technologies are going to be successful, they need to help the staff focus on the patient instead of the computer."

With wireless technology being used for medical instrumentation, tracking, sensors and data collection, a hospital is 'one of the most cluttered RF environments around.'

Treatment quality can also benefit from next-gen hospital wireless communications networks. Finding equipment, waiting for test results, and gathering data are all made easier with rapid communications between equipment and people. Giving every piece of equipment an RFID tag that monitors a device's location will allow hospital staff to find equipment without searching. Automatic, instant test results allow for more rapid treatment.

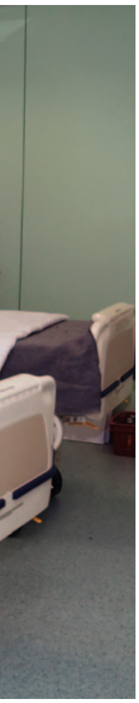
There are also benefits for data collection. With the patient monitoring devices communicating via a central system, patient responses to medication can be monitored continually instead of waiting to be collected and synthesized. With this information fusion, "a doctor can more easily find relationships between things like heart rate and oxygen level if the information from multiple devices is consolidated onto one screen," says Reed.

Wireless Challenges

In a hospital, where people and devices often move between rooms, a communications network will have to be mostly wireless. The potential is tremendous for improved outcomes and lower costs. However, this technology must be implemented with care to avoid additional cost and medical mistakes.

Wireless devices are already being implemented in hospital settings. Today, there can be many wireless devices in each room with a variety of different communications standards operating over many different radio frequency (RF) spectrum bands, Reed says. With wireless technology being used for medical instrumentation, tracking, sensors and data collection, a hospital is "one of the most cluttered RF environments around."

The radio environment promises to become even more crowded. Reed cites the recently adopted rules for medical micro-power networks that will provide functional electric stimulation to activate and monitor nerves and muscles. "How do we glue all this together when there's just not enough band-



A current hospital room with its tangle of wires and multiple monitors. The Wireless @VT team hopes to make the wires and many of the boxes disappear.

width available," he asks. "We need a new approach to using spectrum given the variety of bands, signals, and regulations."

To work with the limited bandwidth, the wireless devices in the hospital will have to operate at low power for devices in a single area so that they don't interfere with other nearby devices. Also, communications will have to be prioritized: certain signals are clearly more important than others. Inventory control, for example, doesn't need a constant communications link to the rest of the hospital. Reed comments that this is "a direct extension of the cognitive radio applications that we've done already."

The plan is to develop the agile hardware, cloud framework and software enabled intelligence, create a safe and secure RF management environment, then demonstrate the technology in real settings. Reed acknowledges that it will take a long time, but the team has already made headway. They hope to demonstrate a drug tracking system this summer.

The technology won't be implemented in a vacuum. There are social ramifications to consider, Reed says. "This is not just a technical problem." Their plan is to build a highly interdisciplinary team to tackle the issues involved. "We want to provide the spectrum infrastructure for study and experimentation," he says.

The team already has a test site at the Center for Advanced Engineering Research (CAER) in Lynchburg, and hopes to add another in Blacksburg. With so many potential stakeholders (including hospitals, pharmaceutical companies, insurance companies, and even the military), this project should also trigger economic development. "One thing we also want to do is help economic development for this state," Reed says. "If you have facilities like this, you can get companies to come."

There are security and privacy issues to accompany this new technology, and Reed doesn't know how to address all of them. "But I'll give them the infrastructure," he says. "I can do that."

PCAST report
triggers greater usable spectrum

In July 2012, ECE faculty member Jeff Reed helped write a report about the wireless spectrum for the President's Council of Advisors on Science and Technology (PCAST). According to Reed, the report focused on "enabling economic growth through better managing our federal spectrum." PCAST members include Eric Schmidt (Google former CEO) and Craig Mundie (Microsoft Senior Advisor to the CEO). Invited experts included Reed, other CTOs, faculty members, and several venture capitalists.

The group recommended the sharing of 1GHz of federal spectrum. This recommendation has started making its way through the Federal Communications Commission (FCC), and Reed says "it looks like it's going to happen." According to Reed, "the FCC is moving fast, and soon 150 MHz of bandwidth in the 3.5 GHz band may be open for new commercial applications." The group also made recommendations for administratively managing the spectrum.

One part of the report cites Virginia Tech's indoor Cognitive Radio Network Testbed (CORNET) when discussing the viability of the technology. This testbed has been sponsored by the Army, Navy, NSF, and ICTAS. It currently consists of 48 fixed radio nodes, and another 10 portable radio nodes are being integrated.

Reed thinks that the new bandwidth will become a big research area. "It reminds me of the time the license-free bands were opened up," he says. "Those are the bands for Wi-Fi and portable wireless devices. The commercial companies didn't know how to make devices that would work in that band—it had to be spread spectrum. Now we're experiencing something similar with spectrum sharing and dynamic spectrum access."

TWO ECE TEAMS FACE the SPECTRUM challenge

A pair of student teams from Virginia Tech's electrical and computer engineering program have qualified among the 15 finalists in an international competition to develop strategies for clear communications in spite of interfering signals on a radio channel.

Teams from the Hume Center and Wireless @VT placed 9th and 11th respectively out of 90 competitors in the DARPA Spectrum Challenge qualification round. Virginia Tech is the only university with two teams as finalists.

In addition to the finalist teams, a team from the VT-MENA (Virginia Tech Middle East and North Africa) program qualified as one of 24 teams eligible to compete for three wildcard slots.

The DARPA Spectrum Challenge was organized in response to the problem of growing interference among wireless devices that function in an increasingly congested radio spectrum. While such disruption is merely a nuisance for most users of wireless technologies—taking the form of poor cell phone reception or a slow Internet connection—radio interference can lead to serious consequences during emergencies and other critical situations that demand reliable wireless communications devices.

"The Spectrum Challenge is focused on developing new techniques for assured communications in dynamic environments—a necessity for military and first responder missions," said Yiftach Eisenberg, DARPA program manager, when announcing the Challenge in December.

The Challenge tasks teams with generating software-defined radio (SDR) protocols that transmit data quickly and accurately in spite of interfering signals. Since all teams must use the same hardware, the focus of the Spectrum Challenge is the strategic development of radio algorithms and protocols.

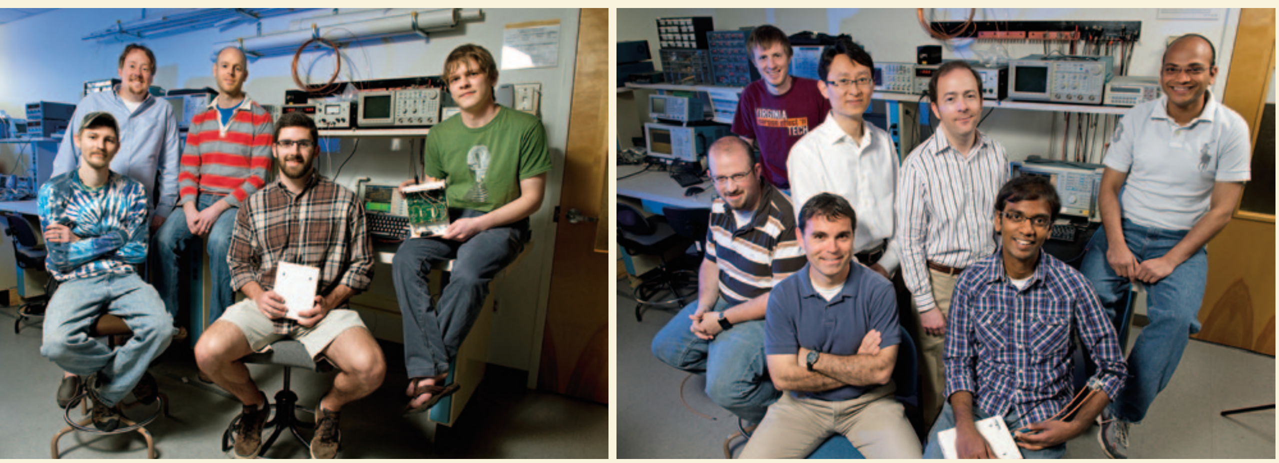
To qualify for the challenge, teams completed three SDR and GNU tasks. They were judged on the number of bytes correctly received in five minutes once packet transfers were initiated.

Both the preliminary and final tournaments will have two challenges: one competitive and one cooperative. The competitive portion will score teams individually based on their ability to transfer data more quickly than other teams, while the cooperative portion requires teams to work together to share the spectrum most efficiently.

The Hume Center team, called VT-HUME, includes Daniel DePoy, Joseph Gaeddert, Mitch Davis, Zach Leffke, Chris Jennette, Marc Lerch, Michael Fowler, Kris Dixon, and Matt Carrick, and is advised by Charles Clancy and Bob McGwier.

The Wireless @VT team, called VT CogRad, is advised by Michael Buehrer and members include Jeff Poston, Jason Snyder, SaiDhiraj Amuru, Daniel Jakubisin, and Vireshwar Kumar.

The VT-MENA team, called VT-MENA Beacon, is advised by Sedki Riad with Mustafa Nainay of VT-MENA and Alexandria University, Khaled Harras of Carnegie Mellon Qatar, and Moustafa Youssef of EJUST and Alexandria University. Students include Mohamed Ibrahim, Mohammed Karmoose, Karim Habak, Karim Banawan, Ahmed Elbagoury, Yahya Ezzeldin, and Ahmed Saeed.



LEFT: The VT-Hume Spectrum Challenge team, from left: Zach Leffke, Marc Lerch, Joseph Gaeddert, Chris Jennette, Daniel DePoy. RIGHT: The Wireless @VT Spectrum Challenge team (VT CogRad), back row from left: Daniel Jakubisin, Jung-Min (Jerry) Park, Jeff Poston, Vireshwar Kumar; front row: Jason Snyder, Michael Buehrer, SaiDhiraj Amuru.

IT'S NO secret

PREPARING STUDENTS FOR CAREERS IN NATIONAL SECURITY

The Ted and Karyn Hume Center for National Security and Technology serves as the umbrella organization for Virginia Tech's student programs related to national security. In this role, the Center now includes the Intelligence Community Center of Academic Excellence (IC-CAE), directed by ECE's Kristie Cooper, who also serves as the Hume Center's assistant director of education. The IC-CAE, a joint venture with Howard University, is one of 20 such programs nationwide.

"We are working to develop a pipeline of leaders for the intelligence community," Cooper says. With IC-CAE, the Hume Center offers a complete range of opportunities, including mentoring, research opportunities, scholarships, courses, special events, clubs, and study-abroad programs. Students also participate in pre-college outreach, currently aimed at local middle schools.

PRE-COLLEGE OUTREACH

In addition to university offerings, the Hume Center organizes pre-college outreach programs. Hume Center students present material and supervise activities at Blacksburg Middle School Science, Technology, Engineering, and Mathematics (STEM) Club meetings. They visit Blacksburg Middle School two to four times per year, and present topics such as communications or forensics. Activities might include making concealment devices out of Pringles cans, fingerprinting, or writing in invisible ink.


Blacksburg Middle School students after a fingerprinting activity led by ECE students.

Presentations and activities are organized by undergraduates in the student-run Society of Analytical and Critical Thinkers. The Hume Center provides supplies for the activities.

The outreach is currently aimed at Blacksburg Middle School because of its proximity to Virginia Tech's campus, but the Hume Center hopes to expand the program to other areas. The center also has plans to approach elementary school STEM clubs in the future.

MENTORING & SCHOLARSHIPS

All Hume Center students meet with an advisor at least once per semester. The advisor will help them narrow down their interests and find projects and internships. "We either get them into a Hume Center project or get them an internship at an agency or industry in the intelligence community," says Cooper. The Hume Center has also given more than $323,000 in academic scholarships since 2010, not including study-abroad scholarships.

COURSES

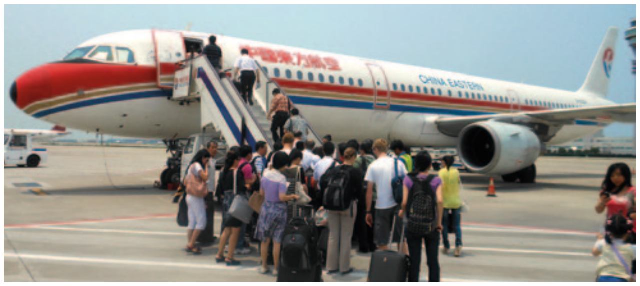
New faculty members are joining the Hume Center, and new courses are being developed. Some of the courses will include intelligence analysis, cyber operations, and intelligence and national security. Additionally, Cooper anticipates that a new cybersecurity minor within the College of Engineering will be available to students soon.

STUDY ABROAD

The Hume Center offers students an opportunity to study abroad in regions of importance to the intelligence community. For the past two years, up to 10 students per year have been spending four weeks in China for an intensive language study program. Students receive four hours of language instruction every day, meet with local politicians and social groups, and have the option of doing a home stay with local families.

All of the students who study in China have an interest in the region, according to Cooper. "Some are either doing a research project on China or have been assigned to the Asian Pacific desk during their internships," she says. Over the past four years, the Hume Center has given approximately $200,000 for study-abroad scholarships.





Hume Center students study abroad in China for a four-week intensive language study program.

CYBERSECURITY SUMMIT

This spring, the Hume Center hosted its third annual cybersecurity summit. The summit is a one-day event with talks in the morning and a hacking competition in the afternoon. "We heard a riveting talk by Rodney Joffey, senior vice president at Neustar on the history of the Conficker worm and how industry worked with each other and government across the world to mobilize and block the spread of the worm across the Internet," reports Charles Clancy, director of the Hume Center.

Graduate students in Virginia Tech's IT Security Laboratory, along with Cybersecurity Club officers, organized the event to include building the servers that the competitors were to hack.

"These events are very important in developing the next generation of cyber warriors because they provide student clubs with something constructive to put their hacking time into—other than their university's internal IT infrastructure," Clancy said.

Virginia Tech is pleased to host the competition each year, according to Clancy. "It's smaller than some of the big national-level events, but this allows us to be a bit more creative. For example, some of the challenges are not just hacking into computers over a network, but include social engineering skills and other outside-the-box ways of gaining access to systems."

This year, more than 50 people attended from Capitol College, George Mason University, Indiana Tech, James Madison University, Marshall Academy, University of Maryland, and Virginia Tech.

2013 Cyber Security Summit at the Arlington Research Center

CYBERSECURITY CLUB

The Cybersecurity Club is an active group of computer engineering and computer science students who meet weekly to discuss cybersecurity news and topics, prepare for competitions and collaborate.

The club hosted the 2012 East Coast Cyber Summer Camp for the U.S. Cyber Challenge, which sported a week of courses on topics such as mobile phone security and forensics, plus a capture-the-flag competition. The 2013 camp will be held in Roanoke.

The club also hosts an annual Cybersecurity Summit for students throughout the mid-Atlantic region at the Arlington Research Center. The summit includes speakers discussing the current state of cybersecurity and research advances in the field, plus a security competition.

The club also operates an ongoing, online wargame competition allowing club participants to hone their cyber attack and defense skills 24/7.

PHOTOS FOR THIS STORY COURTESY OF KRISTIE COOPER. PHOTO P8 BOTTOM COURTESY OF ANDREI MARCU

CAMPUS EVENTS

The Hume Center organizes a variety of events on campus, from a symposium for students to present their research, to various research workshops and speakers.

Every spring, students present their research projects at the IC-CAE National Security Symposium. Hume Center graduate students have graduate research assistantships on funded projects, and all undergraduates on scholarship are required to do an independent undergraduate research project related to national security, Cooper explains, "so there is a wide range of topics." Topics range from wireless exploitation to North Korean dependence on China to cyber conflict.

Hume Center students are encouraged to participate in research workshops. "University Libraries really supports this program," says Cooper. They offer a series of workshops, some of which are just for Hume Center students. Topics include information research, poster presentations, and preparing reports for a digital archive. Spring 2013 workshops from the ICCAE Workshop Series include a discussion of the intelligence cycle, briefing skills, and analytical writing.

There is also a speaker series for interested students. Recent topics have included critical thinking versus intelligence and the importance of understanding geography. One speaker from fall 2012 was Bob Wallace, former director of the CIA's Office of Technical Service noted as a real-life "Q." His talk was based on his book, "Spycraft." "He brought samples of a number of concealed recording devices, such as the infamous bug in the Russian embassy seal," says Cooper. They have also had other speakers from the CIA, Marine Corps Intelligence Activity (MCIA), and others from the intelligence community. Many of these events are standing room only, according to Cooper.

The final topic this spring will discuss the actual event behind the film "Zero Dark Thirty."

TOP: Virginia Tech and Howard University have formed an IC-CAE. **CENTER:** A student presents his research at the IC-CAE National Security Symposium. **BOTTOM:** Kristie Cooper, IC-CAE director and Hume Center assistant director of education.

a security DYNAMO

THE HUME CENTER

Just three years since its founding, the Ted and Karyn Hume Center for National Security and Technology is proving to be a research and education dynamo. It is quickly demonstrating its power to lead the country in providing elite engineers, scientists, and strategists involved in national security.

Led by director Charles Clancy, the Center focuses on a holistic approach—developing educational opportunities plus sustainable and flexible research programs that engage faculty members and students. The mix of education and research is critical to its success, according to Clancy. "Our sponsored research programs all involve student performers," he says. More than 60 graduate students from different departments are involved in Hume research efforts.

Charles Clancy
Director

Robert McGwier
Director of Research

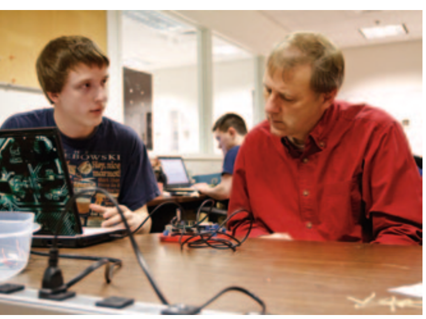
Joseph Tront
Director of Education

While Hume Center educational opportunities have ignited interest among students, its research programs are also having a large impact across the ECE department. The Center involves 10 academic faculty members and 23 research faculty and staff members—all posted in ECE. The Center is also recruiting to fill 12 vacant positions.

Hume's research strengths are in wireless, cybersecurity, space systems, and big data. "We promote interdisciplinary efforts in national security that are beyond the scope of one individual laboratory," Clancy explains.

Hume researchers have been awarded $20 million in grants and contracts, $13 million this past year alone. Industry and defense community sponsorships represent roughly 25 percent each, and the intelligence community comprises the remaining amount.

ROVING the course



TOP: Lindsey Bellian works on her project. **CENTER:** One team's rover navigates a course **BOTTOM:** Sean Thweatt demonstrates his part of the project to Mark Jones.

Students in ECE's embedded systems capstone design course (ECE 4534) work on projects that change every semester to keep pace with current technologies. Starting in Fall 2012, students work with a new platform: a four-wheeled vehicle similar to the remote controlled cars many students raced as children. These ECE 4534 rovers, however, become fully autonomous vehicles that must speed through a course and perform different tasks.

The basic project for Fall 2012 was to add intelligence to a rover that could locate a cube placed somewhere in the room. Student teams would design their cube, and their vehicle had to identify and locate it in a room filled with similar cubes.

This semester, high-speed navigation through a set course is the challenge. "It's not a maze," explains course supervisor Mark Jones, "but they have to go through the course fast and without hitting the walls." The first lap allows the vehicle to map the course, and the second lap is about speed. Students then get to choose extra tasks, such as speed limit signs or finish lines that the rover must obey. "No two teams are doing the same thing," says Jones.

In previous years, students have worked on projects with model trains or smart houses. "The rover is certainly more entertaining," says Cameron Patterson, who is also teaching the course this semester. "You get to see the consequences of incorrect or incomplete code. The rover crashes into walls, doesn't start, or doesn't stop."

The students begin with a 4-wheeled vehicle that has motors and a very basic motor controller. They are also given an ARM processor that runs FreeRTOS, a real time operating system for embedded systems. Students have to select sensors, write software, and integrate the software and hardware components.

According to Patterson, the course includes aspects of control systems, robotics, autonomous vehicles, and artificial intelligence. "I see it as a preview of what many of our students will be doing when they leave here," says Patterson. "It also exposes them to project management and team coordination."

The class is teamwork-oriented: teams of three or four students work together on a single rover. However, each student is responsible for a certain aspect of the project, and must prove that his or her individual portion works independently of the final design. "They have to convince us that their part works even when not connected to parts from other team members," explains Patterson. "It requires them to be creative. They can't demonstrate it with the real rover, so they have to invent a virtual rover of some sort."

According to Jones, communication is one of the best indicators of success in the class. "All students have their part to do, but if they aren't able to communicate what they are doing to everyone on the team, it's hard to put it all together," says Jones. "The teams that do the best are the teams that work well together."

Jones adds that although the final projects are fun, the goal of the class isn't the robot. "It's not about making the robot, it's about students learning how to approach the next design problem they face."

From left: Ryan McNamee, Callie Johnston, Lindsey Bellian, Sean Thweatt.

CREATING HEROES

for the DARPA Robotics Challenge

ECE students have joined on multidisciplinary teams to create humanoid robots that are more versatile than any currently roaming the halls of research.

Two teams qualified to compete in the Defense Advanced Research Projects Agency (DARPA) Robotics Challenge (DRC). This challenge, inspired by Japan's Fukushima nuclear crisis, asks researchers to create robots capable of going into dangerous situations so humans do not have to risk their lives.

According to the challenge announcement, its primary technical goal "is to develop ground robots capable of executing complex tasks in dangerous, degraded, human-engineered environments." The robots should be able to use standard human equipment. The challenge requires a robot to complete all of the following tasks:

1. Get into a standard human vehicle and drive to a specified location.
2. Get out of the vehicle and travel across rubble.
3. Clear obstacles from a doorway.
4. Open the door, and enter the building.
5. Find a leaking pipe and close the associated valve.
6. Reconnect a hose or cable.
7. Climb a ladder.
8. Grab a toolfrom the site, break through a concrete wall and exit.

The robot will be allowed to communicate with a human operator, but the bandwidth will be limited and the signal will be intermittent. There may not be enough bandwidth for a robot to reliably send video or to be in constant contact with its operator.

Contestants will compete in one of four tracks. Seven track A teams were selected and given funding to build and program a robot to do the tasks. Track B funds contestants only to program the robot. The best of the track B teams will be given a robot and will compete with track A teams during the final competition. Tracks C and D are similar to tracks A and B, but without funding.

COURTESY OF DARPA

ECE students are working on two teams that will compete in the DARPA Robotics Challenge—Team THOR and Team ViGIR.

ECE graduate students are working on the mechanical engineering team in Virginia Tech's Robotics and Mechanisms Laboratory (RoMeLa), led by Dennis Hong. RoMeLa is partnering with researchers from the University of Pennsylvania, Harris Corporation, and Robotis Corporation to form Team THOR. They will be competing in track A. The RoMeLa laboratory has won RoboCup, an international soccer robot competition, two years in a row with their humanoid robot, CHARLI.

One of this year's senior design options allows ECE Seniors to work on Team ViGIR, which will be competing in track B. Team ViGIR includes researchers from TORC Robotics and Technische Universität Darmstadt. In 2007, researchers from TORC and Virginia Tech formed one of only three teams to successfully complete the DARPA Urban Challenge, which required them to build an autonomous vehicle capable of traveling over 60 miles of on- and off-road urban terrain in under six hours.

Good luck, Team ViGIR and Team THOR!

ECE *SURGE* alters the FORMULA

Electrical engineering students are introducing new capabilities to VT Motorsports' Formula car

One of Virginia Tech's oldest undergraduate engineering design teams is seeing a surge in membership, due in part to growing participation from ECE students.

Established in 1988, the VT Motorsports Formula SAE team designs and fabricates a high-performance formula-style racecar for an annual competition sponsored by the Society of Automotive Engineers (SAE). The team has historically filled its membership with mechanical engineering students, but its recent efforts to recruit from the ECE department were successful in drawing eleven ECE members to the team this fall.

Brandon Vella (BSEE '13) joined the Formula team in 2011, serves as leader of the electrical team and plays a major role in the team's ECE outreach. "Traditionally, the Formula program has been more ME-based and electrical has been done as an afterthought," he says. "I wanted to build the electrical side of the team to introduce the capabilities that electronics bring to the vehicle."

The Formula team operates on a two-year cycle, with students designing a racecar during their junior year and manufacturing and bringing the car to competition during their senior year. The team is divided into five technical subteams: engine, drivetrain, sus-

PAGE 12 PHOTO OF TEAM BY VINCENT SORRENTO. PAGE 13 PHOTO BY BRANDON VELLA.

The Virginia Tech Formula SAE electrical team, from left: Brandon Vella (BSEE '13), Brian Cassidy (BSEE '13), John Thomas (BSEE '13), Daniel Ridenour (BSEE '13), Shaishav Parekh (BSCPE '13), Tyler Diomedi (BSEE '13), Taylor Yeago (BSEE '13), and Carolyn Doan (BSEE '13) (in car).

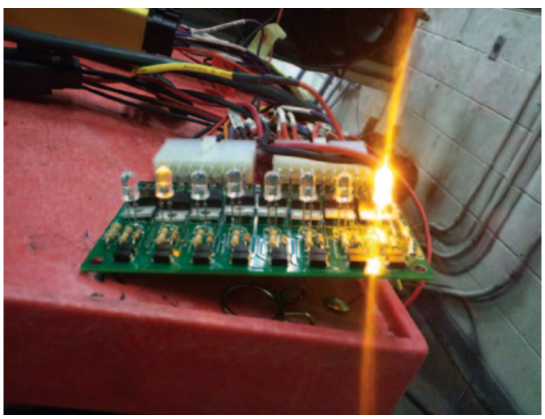
'It shows practical experience, attention to detailed communication, and time commitment. It's almost like a job itself.'

pension, electrical, and aerodynamics.

Last year, the senior electrical subteam had only one ECE student. This year's Formula team has grown to include five ECE students on the senior electrical subteam and six ECE juniors. The team also counts several first-year and second-year ECE students amongst its regular volunteers, plus a number of less regular participants. Some meetings have had as many as two dozen ECEs involved.

"Recruiting is a big time commitment, but also a big payoff in the end," Vella says. "There's a lot of cutting-edge electrical technology to implement."

The addition of new members has made the electrical workload more manageable, giving the team the opportunity to implement additional capabilities beyond what is required for basic operations of their racecar. For example, the team has implemented a wireless telemetry system for the first time this year, allowing students to access vehicle diagnostics in real-time without having to stop their vehicle to download data.



Power Distribution Unit (PDU)

The team's expansion has brought some growing pains, Vella acknowledges. "Delegating what one person did last year to a team of five people is challenging. It takes a lot of communication and organization to be on the same page."

Communicating with subteams brings other difficulties. "Sometimes it takes effort to get teammates from other fields to explain what they think are simple things," says Vella. "We also have to learn to express things in a form that they'll understand."

Overcoming these challenges to work successfully on an interdisciplinary team enables ECE students to develop skills that stand out to prospective employers, says Vella. "ECEs are able to develop an understanding of the system as a whole. It's very impressive because it shows practical experience, attention to detailed communication, and time commitment. It's almost like a job itself."

As the team prepares for this year's SAE competition, Vella is looking forward to seeing all of the pieces come together as a finished vehicle. The electrical team has a bench in ECE's Integrated Design Studio, but the system integration is done in the Ware Laboratory. "I really enjoy seeing everything from the design on the computer to the printed circuit board, from manufacturing pieces to seeing them operate on a bench and then operate on a car. The full-design cycle is very rewarding."

Virginia Tech's Formula team will travel to the Michigan International Speedway this May to compete against 120 international teams in the Formula SAE collegiate competition. The team's racecar will be tested on an autocross course as well as a 22 km endurance course, and evaluated on four major design principles: reliability, drivability, serviceability, and safety.

"Our main goal is to finish the endurance part of the competition," says Vella. "Only a third of the teams finish each year."

Looking ahead, the team has big plans for the 2015 Formula SAE competition. "Our goal in two years is to create an all-electric Formula vehicle," says Vella. "Next year will mark the beginning of the two-year design cycle. The responsibilities for ECEs will be even greater."

students develop INTUITIVE DISPLAY FOR hybrids

Hybrid vehicles are a popular choice for consumers looking to save money and reduce their carbon footprint by decreasing gasoline consumption. Yet many drivers don't know how to optimize their driving habits to take full advantage of the dual mode hybrid system.

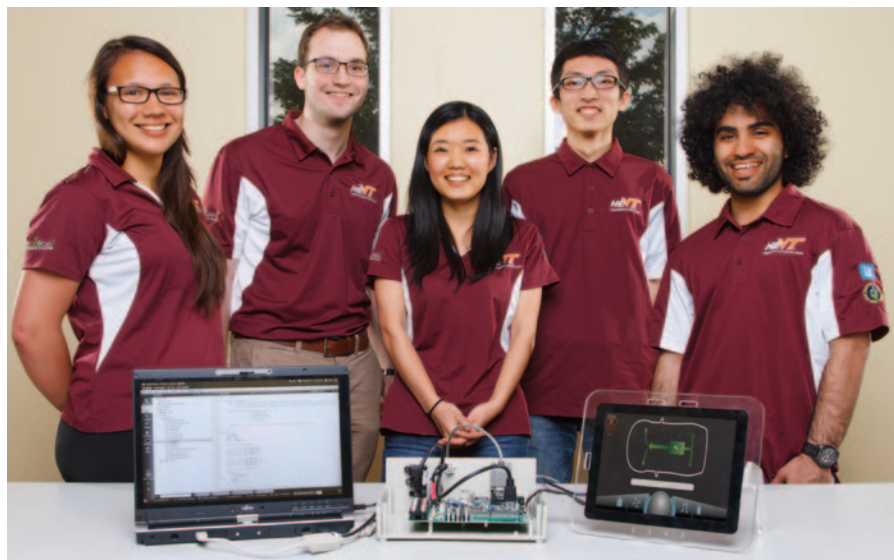
Hoping to solve this problem, ECE students from Virginia Tech's hybrid electrical vehicle team (HEVT) are developing a touchscreen display that makes it easier and more fun for drivers to learn how to maximize their fuel efficiency.

"We needed to display a very complicated system in a way that was simple enough so the user understands on a high level what's going on and can make adjustments," says Alexander Keller (BSEE '13). "We're implementing an eco-screen that tracks driver history to record how eco-friendly they're driving."

Keller serves as the leader of HEVT's software team, which also includes Fangfang Oremland (BSEE '13) and Xingjian Ma (BSCPE '14).

The group is experimenting with different visual themes to display information such as system mode, battery charge, and energy efficiency in a way that is user friendly. One idea involves a blossoming or wilting flower. Another would use a series of Hokie footprints to reward good drivers. "We're trying to change people's attitudes and make driving eco-friendly a game," says Keller.

The HEVT team is participating in year two of EcoCAR 2: Plugging in to the Future, a three-year competition sponsored by General Motors and the U.S. Department of Energy. The compe-



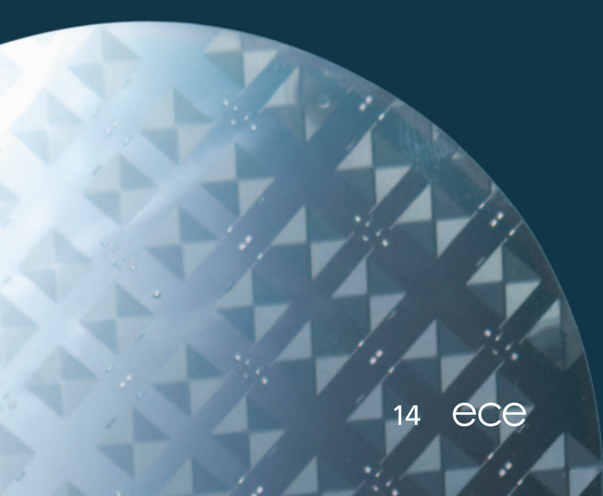
The HEVT software team, from left: Emylee Esteban (BFAVCD '15), Alexander Keller (BSEE '13), Fangfang Oremland (BSEE '13), Xingjian Ma (BSCPE '14), and Sultan Alobaishi (BSEEE '14, BSCPE '14).

SUMMER MICROELECTRONICS

Four ECE undergraduates engaged in hands-on research in microelectronics last summer through the Virginia Microelectronics Consortium (VMEC) program.

Launched in 2009, the VMEC Summer Scholars Program connects college juniors and seniors to internships at each of VMEC's member universities and microelectronics companies. The program provides students insight into the practical applications of their studies by allowing them to work side by side with experienced engineers in industry and academia.

"My mentor's motivation for the internship was to give me an understanding of how science works in the real world," said Igor Janjic (ECE '14). Janjic completed his internship at Old Dominion University's Jefferson Laboratories, where he worked to develop a new material with a high coefficient of thermal conductivity by alternating layers of antimony telluride and bismuth telluride into a super lattice form. "I was very pleased by the amount of exposure I got to everything—designing ex-



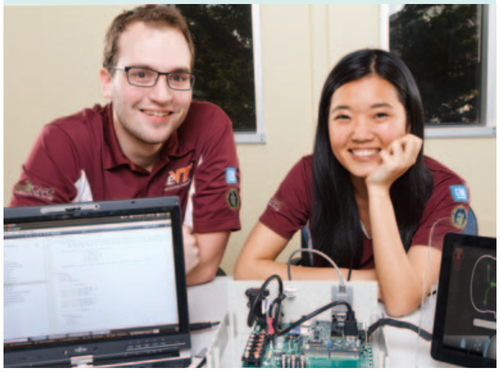
tition challenges teams to re-engineer a stock Chevrolet Malibu into a hybrid car and reduce fuel consumption and emissions without compromising performance, utility, or safety.

Last year, HEVT worked on designing and building hybrid components for their car. The software team's focus was setting up its hardware and learning how to transmit data from a vehicle to a touchscreen using the CAN (Control Area Network) protocol. The team received first place for software design at the year one competition.

HEVT received its vehicle this fall and is removing the stock parts and implementing hybrid components. The software team's touchscreen will take the place of the car's stock driver controls.

"Our goal by the end of the semester is to have a minimalistic driver display," says Keller. "Last year we developed our own driver display, but it was very complicated and no one knew what was being displayed. This year we worked with Emylee Esteban ('15), a graphic design student, to make it more pleasing to the eye and simple to use." This gave the team experience working with non-engineers on the team.

The new touchscreen does more than display CAN messages about energy efficiency—it also controls the vehicle's radio and AC unit. "We used icons so the user can get to the buttons very quickly so they don't have to take attention away from driving," says Oremland.



The HEVT team uses a Freescale i.MX 6 board to transmit CAN messages to the touchscreen display.

In addition to gaining programming and embedded systems experience, working on a multidisciplinary team has allowed HEVT's ECE students to dip their toes in other fields.

"Typically, electrical engineers work on a more abstract level, because you can't really see electrons. It's not very hands-on in a sense that you actually see what's going on in the electrical world," says Keller. "We actually got to see how a car is built. From building the engine, to installing the battery—it's very hands-on. What I found most rewarding is seeing this thing come together."

Keller and Oremland are graduating seniors and have planned ahead to ensure a smooth transition of leadership to Xinjiang Ma, the software team's returning member. "He can teach others what we were trying to do. He can learn from our mistakes," says Oremland.

Two new students have also been recruited to serve on the software team next year and Oremland hopes that ECE involvement on the HEVT team will continue to grow. "We're hoping even more people will join next year so they can divide up work and do more things, such as integrate an iPod or GPS."

periments, using equipment, learning from people with a greater experience level," said Janjic.

Kevin McDermott (ECE '13) was also impressed with his hands-on experience. Working along the wafer processing line at BAE Systems, "I was in a clean room suit carrying wafers from tool to tool and inspecting them. I implemented chemical- or water-based cleans to reduce defects at specific points along the processing line. I was learning something new every day," he said.

As a CPE student, Sean Moore (ECE '12) applied to the program forn a deeper understanding of microelectronics. Moore was placed at the University of Virginia, where he worked to develop a tool to help students test their circuit designs. "My favorite part of the experience was working with a team of researchers," he said. His computer engineering background made him an especially valuable team member.

Arash Majdi (ECE '14) interned at Micron, where he worked as a production quality assurance (PQA) intern for the DRAM components group. His coursework in Fundamentals of Semiconductor Devices provided a good background for his work at Micron, he noted. "Before going to Micron, I had no idea how things were fabricated and what the processes behind the scenes are," said Majdi.

"The VMEC Summer Scholars program is a great experience for undergraduates," said Majdi. "It exposes you to the real world by teaching you what's coming in 5-10 years—research done now for the future."

THROUGH human eyes

It takes a crowd to teach a computer to see

If you Google for "a peaceful picture of downtown Chicago," it will probably return pictures of peaceful protests in downtown Chicago, according to Devi Parikh, who joined the department as an assistant professor in January. "I'm interested in designing algorithms and systems that can take an image and answer questions the same way a human would," she says. She wants to bring computer image processing closer to how the human brain works. "People are the best vision systems we have."

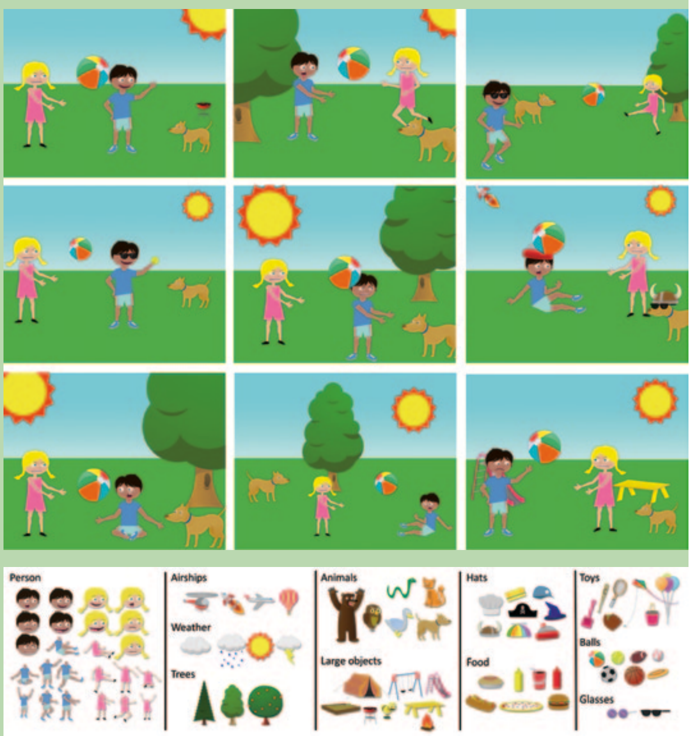
Parikh uses crowdsourcing and human debugging to prioritize issues for computer vision research and to understand how humans process images. She then creates algorithms that use both contextual and descriptive reasoning to identify objects as a human would.

> 'If you know that an object is in a corn field...you know that the object probably isn't a microwave. It reduces the possibilities without even looking at the object.'

Parikh is developing a system to discover the order in which computer vision issues should be tackled. Several components must converge for an answer. "We don't have a good way of figuring out which components we should be working on in the first place," she explains. "And because some components are inherently solving ambiguous problems, we don't know how perfect we can expect them to be." Parikh wants to determine which components result in the highest payoff for even slight improvements.

Parikh applies what she calls "human debugging" to the process. Using a complete computer vision system, she systematically substitutes a human for one component at a time. This person sees a specific input, and answers a question about that input. That's it. To get enough people for her experiments, Parikh uses crowdsourcing services. "We put images up online and get hundreds of people to look at them and answer questions about those images."

A related research area, for which Parikh also uses crowdsourcing to gather human responses, involves how computers and hu-



Top: An example set of semantically similar scenes created by human subjects for the same given sentence, "Jenny just threw the beach ball angrily at Mike while the dog watches them both." **Bottom:** An illustration of the clip art used to create the children and the other available objects.

SPOTLIGHT

on new faculty members

Devi Parikh comes to ECE after serving as a research assistant professor at Toyota Technological Institute in Chicago. She has published 41 papers and she is the co-author of a book. Parikh earned a B.S. in ECE from Rowan University in 2005, and a M.S. and Ph.D. from Carnegie Mellon University in 2007 and 2009, respectively.

mans describe images. For example, given a picture of two children playing in a playground, a human will know that the context of the picture is the two children playing and not focus on trees in the background. Parikh explains that before computers can come to the same conclusion, we have to quantify how humans perceive and interpret different images.

Again, using Internet crowdsourcing, Parikh asked one set of people to look at and describe an image. A second set of people read these descriptions and created clipart scenes based on the descriptions. "We collected a huge dataset with two children on a playground, and can start building models to learn what in a scene can be ignored and what can't be," says Parikh.

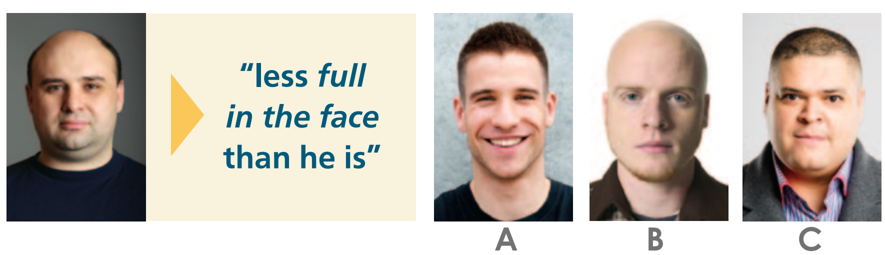
For her computer vision algorithms, Parikh uses both contextual reasoning and descriptions to help computers process visual input more like people. According to Parikh, contextual reasoning requires a computer to look at the area around the object of interest, and decide what the object is likely to be before looking at the object itself. "If you know that an object is in a corn field," she says, "even without looking you know that the object probably isn't a microwave. It reduces the possibilities without even looking at the object." Parikh is trying to effectively combine these kinds of contextual clues.

Computers with descriptive capabilities are useful any time humans need to interact with a computer, and help with machine learning, semi-autonomous vehicles, and image searching. "We're trying to establish an effective means of communication between humans and machines," Parikh explains. "If we can figure out a way to teach machines, they will be more effective than just computers." If a semiautonomous vehicle comes across an object that it can't identify, but knows to describe it as a "shiny sharp object," a human operator can more easily classify and interact with that object. For image search algorithms, such as facial recognition, this kind of descriptive ability is vital. When searching for a specific person, the computer may first respond with every brown-haired person in an image. If the user says, "now give me just the old ones with facial hair," the results can be limited.

For all her research, Parikh enjoys formulating new ways of solving the problems. She explains that methods like human debugging are unexpected for machine learning. Now, computer, please find me a pair of snazzy high-heeled black shoes for the party next week…

TEACHING A NEW COURSE

This spring, Devi Parikh is teaching Advanced Topics in Computer Vision. According to Parikh, "the goal is to get students up to date on state-of-the-art research." With a list of current hot topics in the field, students read a few different papers for each topic. During class, a student presents the findings of each paper and Parikh gives a high-level lecture about where computer vision is headed. "There's a lot of discussion," Parikh says. "Students read two or three papers each time."



Parikh's image search algorithms make human-computer communication more natural. Facial recognition is an important application of her work.

The students are learning how to critique computer vision research, what has already been done in the field, for which important challenges remain. Even after just six weeks of class, Parikh noted that students have changed how they describe papers. "I can tell they're getting a feel for it." Students in the course have already taken the first computer vision course, and are using computer vision in their research.

stocking

the visual TOOLBOX

computers and humans team up to make sense of image data

From scribblings on the main portion of an image and on the background, a computer can separate out the important parts.

Big data is one of today's buzzwords. We hear about big data in the fields of biology, marketing, finance, and robotics. Big data is too big for our traditional tools, and we look to experts in both software and hardware for the new tools we need to make sense of this data.

ECE assistant professor Dhruv Batra is using machine learning for computers to help humans parse these huge datasets. "My particular focus is building algorithms that don't necessarily replace humans, but assist them in extracting meaning from data," he explains. "They might not perform perfectly, but will give reasonable choices to a human operator."

His specific research area is at the intersection of machine learning and computer vision. "I'm interested in helping machines understand the visual world around them," he says. "This is particularly important for autonomous systems and image or video analysis."

One application that Batra's research addresses is tracking people, their stance, and their activities in videos—which may be useful in the context of surveillance. With 72 hours of video being uploaded every minute to YouTube alone, it's impossible for a human operator to watch everything. According to Batra, "we just don't have the algorithms today that can perform this task with a sufficiently high accuracy." Batra is focusing on developing algorithms that will provide four or five potential detections of suspicious activity for a human operator to check. "The computer will come up with plausible hypotheses, and the human can make intelligent decisions. We can think of it as interactive intelligence, as opposed to autonomous intelligence."

Some of Batra's previous algorithms help users sort through images to find what they seek. Selecting one image from a collection, the user scribbles two markings: a blue one on what he or she is looking for, a red one on the background. The scribbling is

‘The computer will come up with plausible hypotheses, and the human can make intelligent decisions. We can think of it as interactive intelligence, as opposed to autonomous intelligence.’

not precise, but if the computer can’t come up with something reasonable based on the user’s markings, it intelligently asks for more. The computer can then pick out the relevant parts from other images and show the results to the user.

Another of Batra’s programs can assemble a 3D model based on pictures from different angles. Again, the user scribbles red on the important parts, and the computer cuts them out and creates a 3D model.

These problems are difficult because a computer has trouble inferring and processing information that isn’t explicitly present in an image. As an example, Batra notes that although he can’t see the chair that a person behind a desk is sitting on, he doesn’t expect that person is hovering. A computer, however, only sees a series of pixel values. What our brains understand naturally, computers do not.

A New Machine Learning Course

Batra is teaching Introduction to Machine Learning and Perception this spring, in which students to learn how algorithms are used to identify patterns and make predictions from large quantities of data. The course is of wide interest and the roster includes students from ECE, computer science, computational biology, biomedical engineering, mechanical engineering, and industrial and systems engineering.

The course draws inspiration from real-world applications of machine learning including IBM’s Jeopardy-playing computer (Watson), Google’s self-driving car, and Microsoft’s game controller (Kinect).

Playing Jeopardy is a difficult task, according to Batra. “It’s not a clear question/answer system. Clues lead to some entity and the computer has to parse it, understand what the words mean, put it together, and do all this faster than a human.” IBM’s Watson, however, did all this and beat the human contestants.

The Google smart car has logged more than 300,000 miles of travel without driver intervention. “They do have a person sitting in the driver’s seat,” says Batra, “but my understanding is that he takes over only in the case of an emergency.” According to Batra, “this is the rise of machine learning. I want to convey this excitement to the students and teach them how to build these algorithms that deal with large quantities of data and improve performance.”

Batra also brings in a Microsoft Kinect sensor to help motivate students. “You start talking about video game controllers and you get their interest,” he says. The Kinect demonstrates how computers can understand human motion from visual data. Batra notes that although it’s not open source, “the team of researchers at Microsoft Research Cambridge, some of whom I collaborate with, have written a computer vision paper describing their approach. I teach my class the same techniques, and show them how the material they’re learning is implemented in the products they are using today.” Batra also mentions that the Kinect is such a sturdy and accurate sensor that researchers buy it as a research tool. Many undergraduates in Batra’s class are building demos based on Kinect.

The course is designed for senior undergraduate and for graduate students, but Batra is interested in offering it earlier in the curriculum, offering a similar class at the sophomore level, for example. The course is limited only by the need for students to understand linear algebra, probability, and programming.

SPOTLIGHT
on new faculty members

Dhruv Batra joined ECE this semester, coming from Toyota Technological Institute in Chicago, where he served as a research assistant professor. He co-authored one book and has published 29 journal and conference papers. He earned his B. Tech from Benaras Hindu University in 2005 and his M.S. and Ph.D. from Carnegie Mellon University in 2006 and 2010 respectively.

HIGH ENTHUSIASM for low power

Qiang Li likes building devices that boost performance or shrink size by remarkable amounts. As a graduate student, he was featured in a 2010 article showing a miniature DC-DC converter that was 51 percent of the size of then-current technology. This spring, Cheryl Martin, chief of ARPA-E highlighted a device he and Fred Lee developed that is 10 times smaller than current technology.

Now an assistant professor in his first year of teaching, Li not only appreciates being part of "one of the best power electronics research groups in the country," but also likes teaching. "I very much enjoy interacting with undergraduate students," he says.

"I'm a Hokie," he adds. "I enjoy working here. All the researchers at CPES are passionate about what they are doing. That's why they do such a great job."

CPES has very close relationships with industry, which helps to fuel the group's passion, according to Li. "CPES has a unique and wonderful industry partnership program," he says. He appreciates how, by working with its partners, CPES is able to conduct fundamental research that helps the entire industry take the next steps. "Instead of waiting 10-20 years to see our efforts make a difference, some of our technologies get commercialized in three to five years. We can see the immediate benefits for society from the work we do."

Power electronics advances make many technologies more affordable and sometimes economically feasible for the first time. "We have been very successful with developing technologies (voltage regulators, advanced control scheme, high frequency magnetic components and high density integration) for telecommunications and computing applications," Li says. "Now we are moving into photovoltaic and battery management." The target, he says, is to increase efficiency and save energy.

The CPES laboratories also house a DC nano-grid, which has a battery system, a photovoltaic array, a wind turbine and LED lighting. "We can combine everything together and build the system for the future. Imagine what power electronics can do with PV and batteries."

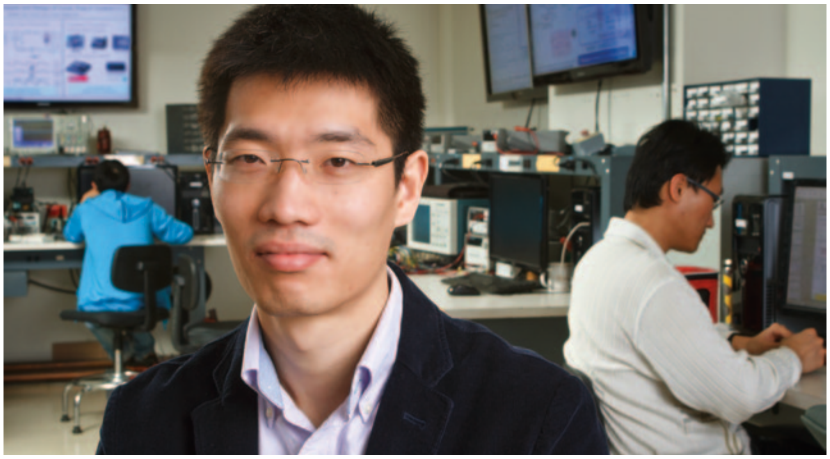
Li's personal research focuses on low-power, high-frequency applications. "We are trying to push high power density through high frequency," he explains. He points to a 2006 prototype that is 500 kHz converter, then to the latest voltage regulator designed for a $1.56 million ARPA-E project. "This prototype is

BOOSTING ELECTRICAL EFFICIENCY

The Center for Power Electronics Systems (CPES) runs a $4 to $5 million-a-year research effort dedicated to changing the way electricity is used through dramatic improvement in power electronics systems.

From 1998 to 2008, CPES was a National Science Foundation Engineering Research Center (ERC). A collaboration of five universities and many industrial firms, the CPES ERC was the largest-ever collaboration of power electronics researchers. During the ERC period, CPES developed the IPEM, a standardized off-the-shelf module that is today enabling more applications to achieve performance and reliability increases with lower cost and greater energy efficiency.

Today, the CPES Industry Consortium, with 81 industry members and three mini-consortiums for focused research in Power Management, High Density Integration, and Renewable Energy and Nanogrids, along with various sponsored research projects, is one of the largest university-based power electronics centers in the country. Fred Lee serves as founding director and Dushan Boroyevich is co-director.



SPOTLIGHT

on new faculty members

Qiang Li joined ECE in August 2012 as an assistant professor. His research interests involve high-density electronics packaging and integration, high-frequency magnetic components, high-frequency power conversion, distributed power systems, and renewable energy. Li earned his BSEE and MSEE from Zhejiang University in China in 2003 and 2006 respectively. He earned his Ph.D. from Virginia Tech in 2011.

5MHz—10 times higher.”

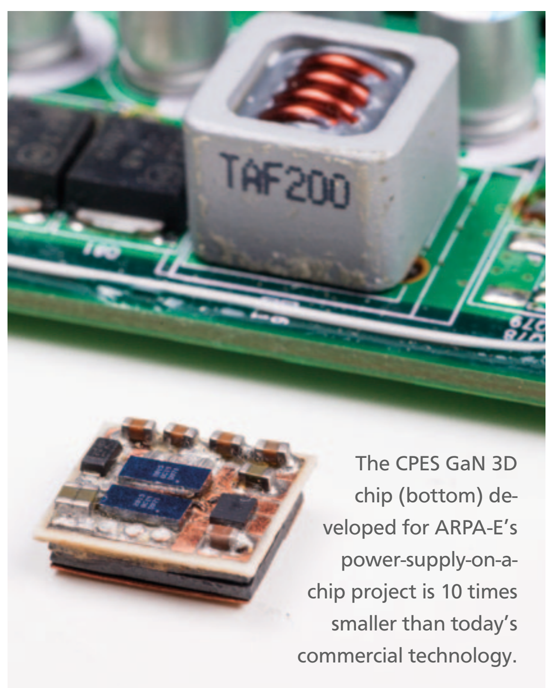
Li works on the ARPA-E: power-supply-on-a-chip project with Lee, who is principal investigator. Their 3D chip uses semiconductors of gallium nitride on silicon and a high-frequency soft magnetic material. In addition to increased efficiency, the chip is 10 times smaller than commercial voltage regulators. Today voltage regulators occupy 30 percent of a motherboard's footprint. The new chip is expected to free up to 90 percent of voltage regulator space.

The ARPA-E project was initially a two-year project, he explains. Because of the success of the CPES design, however, an additional year of funding was extended to move the technology toward commercialization. CPES is working with Enpirion, International Rectifier and the University of Delaware on the project.

> 'Instead of waiting 10 to 20 years to see our efforts make a difference, some of our technologies get commercialized in three to five years. We can see the immediate benefits for society from the work we do.'

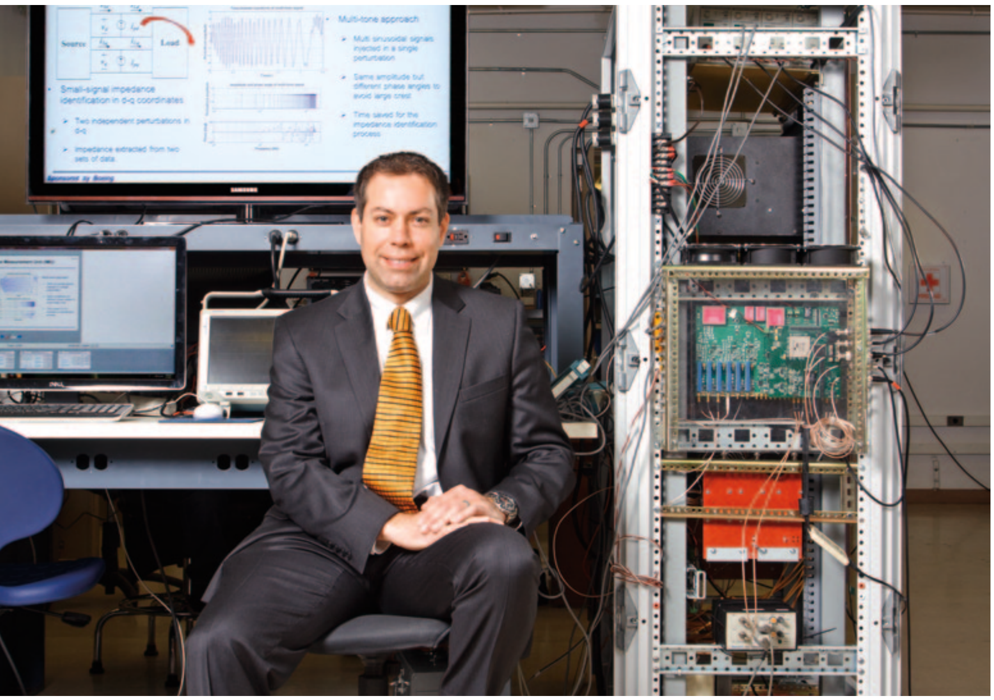
Li works with CPES industry partners in its Power Management mini-consortium on improved power management technology for telecommunications, computing, PV, battery and LED power management. “Our objective is to increase the efficiency, reduce the size and boost the intelligence of power electronics devices.” Achieving these goals involves packaging and circuit design, magnetics design, and modeling. He enjoys each aspect of the problem.

When Li first started studying power electronics, he had no idea whether or not he would enjoy the field. “I like to think that power electronics chose me,” he says. “In high school when I was choosing my major for college, I knew nothing about power electronics. But, I knew I liked to build hardware. I knew I wanted to be in a field where I could build something.” He also liked the idea of electronics and decided that power sounded like it could be interesting. “I had no idea what I was getting into, but it turns out I like it very much.”



The CPES GaN 3D chip (bottom) developed for ARPA-E's power-supply-on-a-chip project is 10 times smaller than today's commercial technology.

POWER electronics
and the world's largest machine



Rolando Burgos in the CPES High-Power Laboratory. The research center is adding more high-power capability and will soon inaugurate its new medium voltage network for research testing.

Power electronics technology has successfully enabled energy and cost savings in many low- and medium-power applications. Recent advances in materials and modularization have poised the technology to achieve similar savings for high-power applications—including the power grid, which is sometimes called the world's largest machine.

Rolando Burgos joined ECE as an associate professor last fall to help lead the high-power efforts in the Center for Power Electronics (CPES). Power electronics is expected to interface two-thirds of all electrical loads connected to the grid leading to tremendous energy savings potential, he says.

Working closely with industry members in the Renewable Energy and Nano-grid (REN) mini-consortium at CPES, Burgos helped map out a new high-power research direction, involving three major topics: developing new modular, multi-level power converters for both AC and DC power distribution systems; investigating new dynamic interaction aspects triggered by the control system of grid-connected power converters—which could lead to unstable operating conditions; and the exploration of DC distributed systems for both low and medium voltage.

In AC power systems, the group is investigating distribution systems that have a high penetration of renewable energy sources. "The big question is, how can power electronics help integrate these renewable resources into the grid in an efficient, reliable, safe, and sustainable way?" he says.

Part of the answer will involve the development of advanced Flexible AC Transmission System (FACTS) devices, according to Burgos. "We believe enhanced FACTS devices can enable the integration of larger amounts of renewable energy," he says. "They can increase the power transmission capability, help direct the power flow and optimize the control of the whole power system, especially under strong power fluctuations and intermittency which are inherent to renewables." Integrating the next generation of FACTS devices will involve more than developing appropriate power converters, but also the use of new synchronization and control methods maximizing their true potential.

"It's a difficult problem," he says. Renewable energy sources like solar and wind are subject to power fluctuations and intermittency. "They come and go. Their integration carries the risk of driving the grid into unstable conditions and eventually a full voltage collapse."

The challenge for renewable energy is how to tap the abundant resources that are often located in remote areas far from consumption centers. Burgos cites another power electronics solution that is taking care of this—high voltage direct current (HVDC) transmission, which represents the most efficient way to transport large amounts of energy over long distances.

"How much renewable energy you can integrate into the grid is ultimately the main issue that needs to be addressed," he says.

Burgos and the CPES team are also involved with developing DC distribution systems for residential and higher-power distribution systems. DC distribution is gaining much support in recent years, with supporters saying that the energy-saving potential of DC distribution is significant given the elimination of redundant AC/DC and DC/AC conversion stages typical of present-day AC distribution systems.

Developing power electronics technology for both AC and DC distribution means that power electronics will be useful in patching and updating the current AC grid, or in establishing new DC grids. "We don't know what will happen with power grids," Burgos says. "Will the newer technology replace the old grid or operate alongside?" He points out that cellular telephone networks operate alongside the landlines, even as they replace existing wired networks. The future power grid, or super grid, is rapidly evolving, although in an unknown direction. "Only time will show which structure will prevail, but either way, it will be a power electronics-based network," he believes.

While power electronics holds great promise for future generations of power grids, research in high-power electronics presents a new set of challenges due to the hazardous testing conditions and the lack of test equipment capable of operating in such environments. "This makes the research more difficult in terms of laboratory facilities," according to Burgos. As a result, CPES is slowly transitioning towards high power testing, and it will soon conduct its inaugural measurements using a 4160 VAC medium voltage network. "There are very few universities with a medium voltage lab at present, and we are proud to be one of them," he adds.

SPOTLIGHT

on new faculty members

Rolando Burgos joined ECE after serving three and a half years at ABB Corporate Research as principal scientist. He also held an adjunct position as an associate professor of ECE at N.C. State University. Burgos received a B.S. in electronics engineering in 1995, an electronics engineer professional degree in 1997, an MSEE in 1999, and a Ph.D. in 2002, all from the University of Concepcion, Chile.

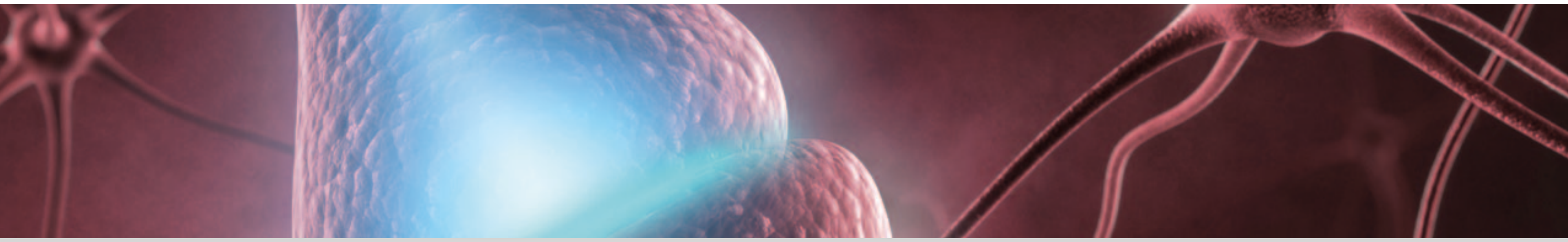
Power Engineers 2.0

In applying power electronics to power transmission and distribution systems, power electronics engineers are venturing into a body of knowledge that has traditionally been the domain of power systems engineers. Today it is becoming more common to hear both groups asking the same questions and working on the same problems. This is a natural progression from integrating an enabling technology in an established complex system.

The Department of Energy (DoE) is encouraging universities to promote the integrations and expose engineers to both sets of knowledge. "The power engineers of tomorrow will face exponential growth in demand for electricity, plus the management of renewable energy, and of smart-grid technology," says Rolando Burgos. "DoE is concerned that the requirements of power engineers are increasing at the same time that many power engineers and power engineering professors are retiring. Tomorrow's power systems engineers need both sets of skills."

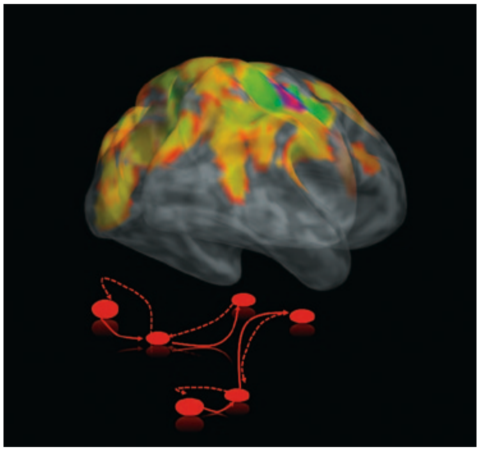
Under a Virginia Tech College of Engineering effort, Burgos is co-advising a graduate student with Yaman Evrenosoglu, a power systems faculty member. The student, Chi Li, is working on FACTS devices and their synchronization and controls methods. "At Virginia Tech, we have very strong programs in both areas and educating students across these bodies of knowledge will ensure that our graduates can take leadership positions in the field," he says.

mapping your



Rosalyn Moran is applying ECE imaging and modeling expertise to map the electrical activity in the brain. She tackles issues from understanding how we learn to how our brains age, and how parts of the brain interact when facing degenerative diseases like Parkinson's or Alzheimer's.

"The brain is the most fascinating electrical device," says Moran, who joined ECE this past fall as an assistant professor posted at the Virginia Tech Carilion Research Institute (VTCRI).



Moran was part of the team that developed the modeling methodology for interpreting neuroimaging results.

Nerve cells in the brain are not continuous, but pass signals through their network via synapses, which use electrical signals to boost chemicals that jump the gap between nerve endings. The electrical and chemical activity represents the brain's function, whether it is conscious thought or the basic process of keeping the heart pumping.

Moran has been in on the ground floor of brain imaging and mapping for understanding this electro-chemical activity. She came to Virginia Tech after spending six years as a member of the group in London, U.K. that is the "standard bearer for how to understand brain imaging," she says. She worked with Karl Friston and Ray Dolan at the Wellcome Trust Centre for Neuroimaging, Institute of Neurology, at the University College London. The group produced the seminal work on dynamic causal modeling (DCM), which is the most commonly used methodology for developing models of the functioning brain.

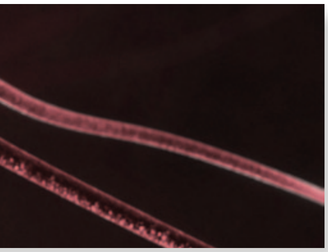
Moran first went to the London group as a visiting graduate student from University College, Dublin. "We had a molecular measure of glutamate in schizophrenic-type rodents," she says. "The schizophrenic rats had lower glutamate levels and different electrical signatures in the brain than normal rodents. We wanted to understand this, so I went to Friston's group at the human neuroimaging institute to see if we could unravel this electrical and chemical overlap." Glutamate is the cortex's most prominent neurotransmitter.

After earning her Ph.D., Moran joined the group at University College London as a postdoctoral fellow then a senior research associate. "My last two years of post-doc work involved the human brain and the chemicals involved in high-level functioning, including dopamine and acetylcholine."

She continues to work on neuroimaging methodologies at Virginia Tech, developing what she calls a mathematical microscope to tease the chemical and synapse-level data from macro-level imaging, such as fMRI, EEG, and magnetoencephalography. "Our approach holds promise for better understanding the active neurochemistry of brain networks that support cognition and behavior," she says.

She is also working with different teams at Virginia Tech to understand the brain changes caused by Parkinson's and Alzheimer's Diseases. "Here at VTCRI, researchers are interested in a range of different behavioural phenotypes as well as disease, so there's a wealth of information to borrow from when building hypotheses on aging brains and developing interesting paradigms to test them" she explains. "DCM will help show us any directionality changes in aging brain connectivity, which is crucial for pinning our empirical

BRAIN'S circuitry



'If the brain is an inference machine, how does life experience alter your biology? We have the tools at our disposal to figure this out.'

observations to more formal ideas on how the brain may operate as an inference machine" She is also looking forward to collaborating with teams conducting a large scale lifespan study of the people of Roanoke, known as the Roanoke Brain Study.

On another project, she is working with ECE's Yue (Joseph) Wang from the Virginia Tech Research Center–Arlington. They plan to investigate the many circuit mechanisms thought to be disrupted by Alzheimer's. Via brain imaging studies using DCM they want to identify which of the disruptions are most critical in supporting cognitive function. "Abnormal signal propagation may depend on whether these processes affect cells that inhibit or excite neurons," Moran says.

Moran hopes that studying Alzheimer's and Parkinson's can lead to a better quality of life for those afflicted. But she's also interested in answering some broader questions about our brains, such as where do experience or wisdom reside in the brain? Is the aging brain really moving toward an optimal state?

"We use Bayesian inference in our analysis and in understanding how the brain itself actually computes data and perceives its environment," she says. "I'd like to apply this Bayesian inference to look at how the brain ages. If the brain is an inference machine, how does life experience alter your biology? We have the tools at our disposal to figure this out."

Neuroscientists have learned that as the brain ages, it loses synapses in certain areas and is less likely to maintain new ones. The pruning model of the brain suggests that the brain has the capacity to become efficient and process what's at the core of our everyday experience, according to Moran. "This concept suggests that as you age, you can generalize well and you are a better contextualizer. You are better adept at coping with abnormalities," she explains. This has yet to be shown using neuroimaging and is just a theory, she acknowledges. "We don't know the extent to which it's adaptive or if there's evidence for the idea yet"

Moran would also like to understand—or even refute—the idea that after a certain age, the brain is in decline. "The mantra of theories on aging neurobiology give the sense that stuff declines; that there is a cliff at 30," She says. "Maybe something gets better, not worse. Maybe we are aging toward our optimum brain."

There are challenges to being in ECE and working in neurobiology, according to Moran. "You learn to appreciate the diversity of knowledge and that there are things that really require appreciation and serious study like the psychology of human cognition," she says. "You have to train your mind to think of cognitive problems instead of wiring problems…It's a commitment."

If you want to "get into a messy system and help develop the science around it," why not go into neuroscience? she asks.

SPOTLIGHT

on new faculty members

Rosalyn Moran earned a BE (electronics) in 2004 and a Ph.D. in 2007 from University College Dublin in Dublin, Ireland. She served as a postdoctoral research fellow, then a senior research fellow at the Wellcome Trust Centre for Neuroimaging, Institute of Neurology, University College London, London, UK.

TAPPING FIBER OPTICS for biomedical imaging

Some things are too small for conventional technology to see. Others are just hidden. From the nanoscale to the nearly-visible, Yizheng Zhu is creating fiber optic devices to image concealed areas of all sizes.

Zhu joined the ECE faculty in August as an assitant professor. He comes to Virginia Tech from Duke University, where he was a research scientist in the Department of Biomedical Engineering.

> 'By measuring the unmeasurable, we can visualize the invisible.'

Zhu's smallest-scale research is smaller than microscopy: he's trying to see things at the nano level. At this size, photons are too "large" for light to be usable in a conventional fashion. Zhu explains that the diffraction limit of light, or the smallest resolution light can depict, is approximately a quarter of a micron. "If you want to go even smaller," he says, "you have to think of other ways to do it. I'm trying to develop new techniques that can break into the nano scale."

Existing technologies using fluorescence can have a resolution on the scale of tens of nanometers, but Zhu has a different technique in mind. He is using the intrinsic properties of the specimens, such as thickness, to detect light in a non-fluorescence way. According to Zhu, his technique and fluorescence are complementary. Fluorescence has more specificity to determine what kinds of molecules are present, while his method focuses on topography.

"At this level, I'm trying to very sensitively detect tiny changes between an object and its surroundings, so it will stand out from the background," he says. Zhu expects the techniques he is developing to eventually image a nanoscale object in three dimensions. He can already see changes in the axial direction that are only tens of picometers.

On a larger scale, Zhu is designing tools that can study the progression of a disease in vivo. With Biological Sciences professor Liwu Li, Zhu is studying atherosclerosis, or the buildup of plaque in blood vessels. "If cells go through a transformation like this, their morphology will change. We plan to use my microscopy techniques to study these changes," Zhu explains. One of his goals is to build imaging probes that can be inserted into a blood vessel in vivo to monitor how plaque forms.

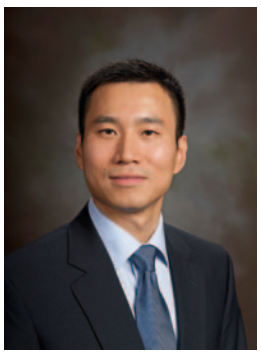
Previously, Zhu developed another in vivo monitoring device—an endoscope that can easily enter a human esophagus or colon for early cancer detection. Zhu explains that fiber optic devices are perfect for this kind of work because of their small size and flexibility.

"By measuring the unmeasurable, we can visualize the invisible," says Zhu.

He has had much success in that effort. While at Duke, he developed biomedical devices using fiber-optic technology. He has designed quantitative optical microscopy techniques with high sensitivity, novel fiber-optic interferometers for studying depth-resolved one- and two-dimensional light scattering, and a clinical endoscopic system based on angle-resolved low coherence interferometry.

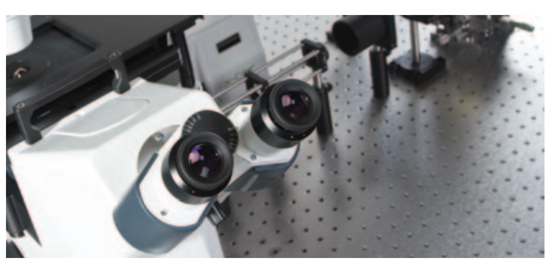
He participated in two clinical studies relating to his biomedical research. One trial tested his clinical endoscopic system design for detection of dysplasia in Barrett's Esophagus and included helping an industrial partner with commercialization of the system. In another study, he studied light scattering signatures of resected colon tissue for the identification of intestinal dysplasia.

Zhu has written more than 40 journal and conference papers and three book chapters. He holds two granted and three pending patents, of which two have been exclusively licensed.



SPOTLIGHT
on new faculty members

Zhu earned a B.Eng. and M.Eng. in electrical engineering from Tsinghua University in 1998 and 2000, respectively, and a Ph.D. from Virginia Tech in 2007. Zhu has written more than 40 journal and conference papers and three book chapters. He holds two patents and has applied for three more.



Zhu is establishing his laboratory in Durham Hall. Commercial equipment, such as the microscope shown here will connect to his custom optics system.

when it comes to cancer, TOO MUCH DATA is not enough

When it comes to modern biomedical research, new experimental methods yield vast amounts of data. For example, a standard experiment might simultaneously determine millions of DNA markers across the entire genome. While this sounds like a lot of data, for Guoqiang Yu, it isn't nearly enough.

Yu joined the ECE faculty as an assistant professor in August 2012. A member of the Computational Bioinformatics and Bio-imaging Laboratory (CBIL), he seeks the genetic causes of diseases from breast cancer to drug abuse. By itself, each gene has a very minor effect, but for many diseases, becomes significant when it interacts with certain combinations of other genes. Finding these critical interactions will help guide researchers to new diagnostic tests and treatments.

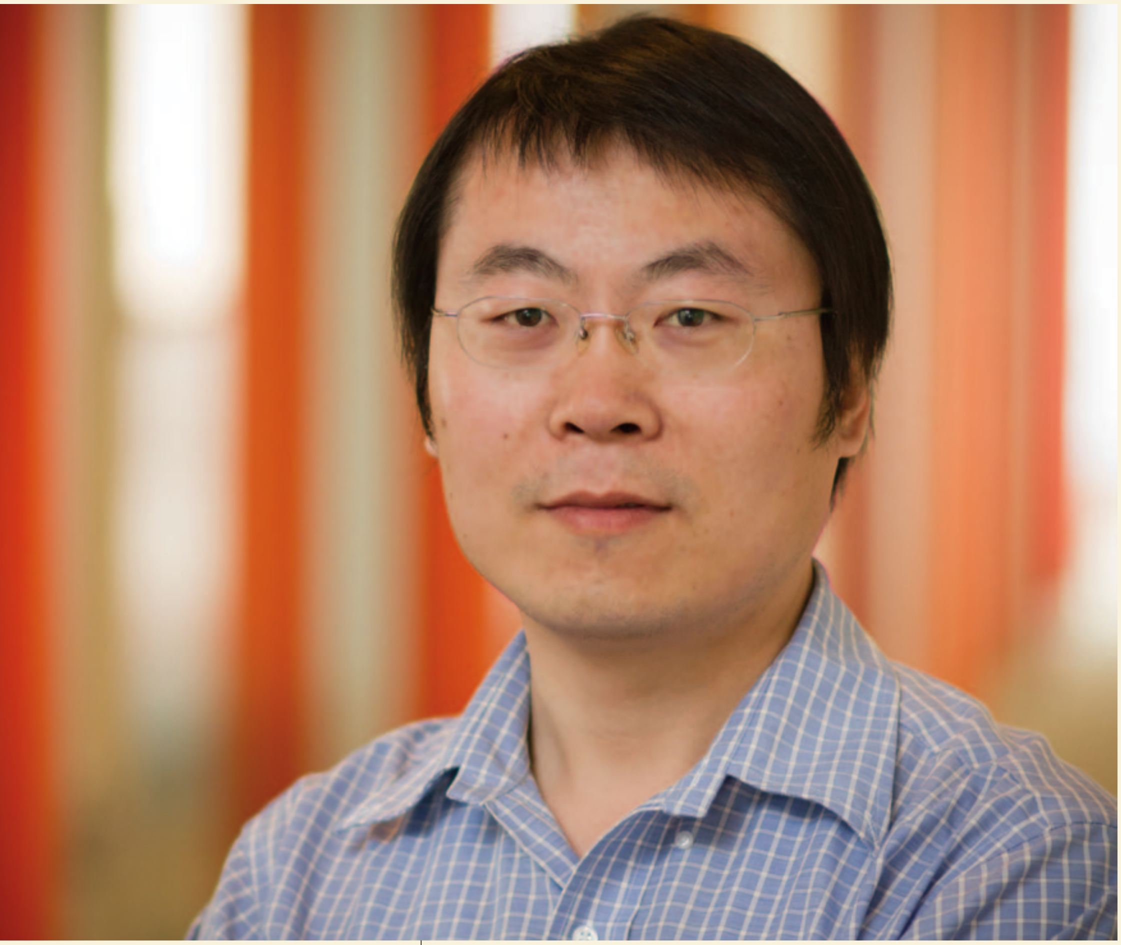


PHOTO BY DAN SNOOK

Because of the number of ways genes can act on each other, the amount of data required to find these effects expands rapidly. When you add external environmental factors, the data load expands even more. Also, there are too many potential interactions and dependencies to look at just a small portion of the problem at once.

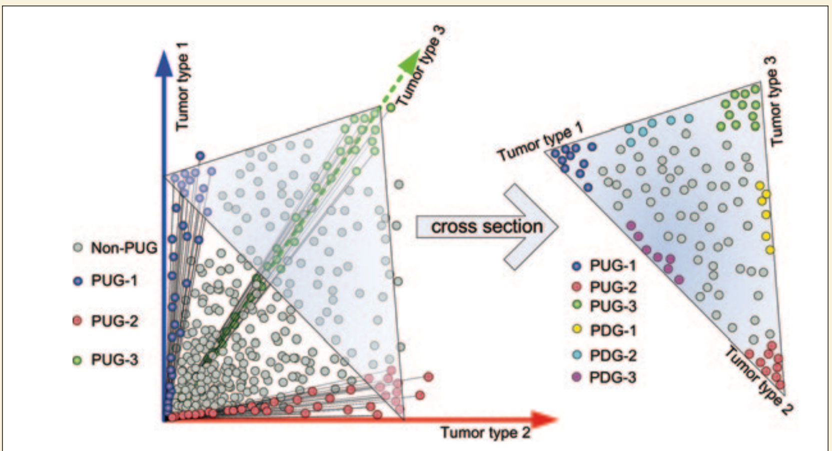
Yu is using this expanded data set—and more—in his research. He combines information from The Cancer Genome Atlas (TCGA), SNP genotyping, behavioral assessments, and neuroimaging, among other sources.

"I have been working on the complex interactions between genes and environmental factors," Yu explains. "Now I want to extend the work to complex interactions between different phenotypes," or observable characteristics. Yu is taking a systems approach to explore the big picture formed by all this data, and he is combining machine learning, signal processing, mathematics, and computational bioinformatics.

One of Yu's projects is developing a method to sort through interactions and determine which ones

SPOTLIGHT
on new faculty members

Guoqiang Yu came to Virginia Tech after a post-doctoral fellowship at Stanford University School of Medicine and Bio-X. He earned his B.S. in Electrical Engineering from Shandong University in 2001, his M.S. from Tsinghua University in 2004, and his Ph.D. from Virginia Tech in 2011. Yu has published 25 journal and conference papers and contributed to a chapter of a recent book titled Statistical Diagnostics of Cancer. Yu is posted in the Capital Region, Virginia Tech Research Center–Arlington.



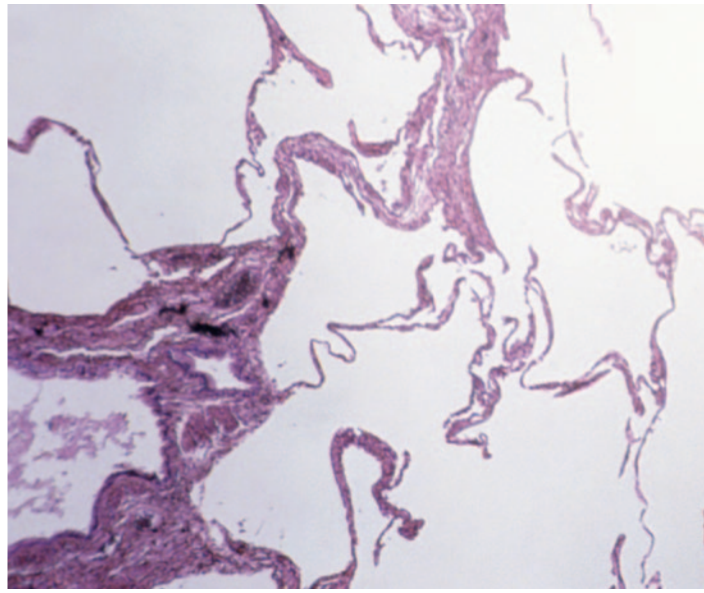
A visual representation of one of Yu's algorithms.

are important. He hunts for interactions that might be important as well as for places that might be missing important interactions. "It is very challenging to distill from complicated and noisy data definitive underlying rules," Yu says, but he believes a comprehensive view of the interactions will help.

Another project has sent Yu searching for genetic modifiers associated with Duchenne muscular dystrophy. He hopes that looking into the complex interplay between multiple phenotypic manifestations will better reveal the modifiers.

"My research is very rewarding," says Yu. "We feel we are contributing to society. It's also exciting to be the first person to understand a problem." He admits that this feeling doesn't come often, but when an idea works after a hundred failures, "I get in this mood and just feel excited…I cherish that feeling."

RESEARCH briefs



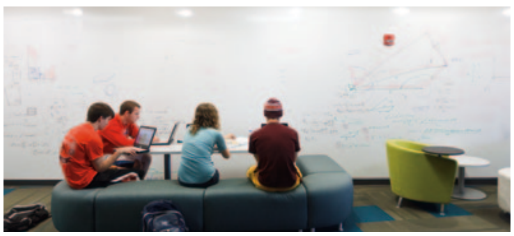
NEW STUDY to examine high fat risks

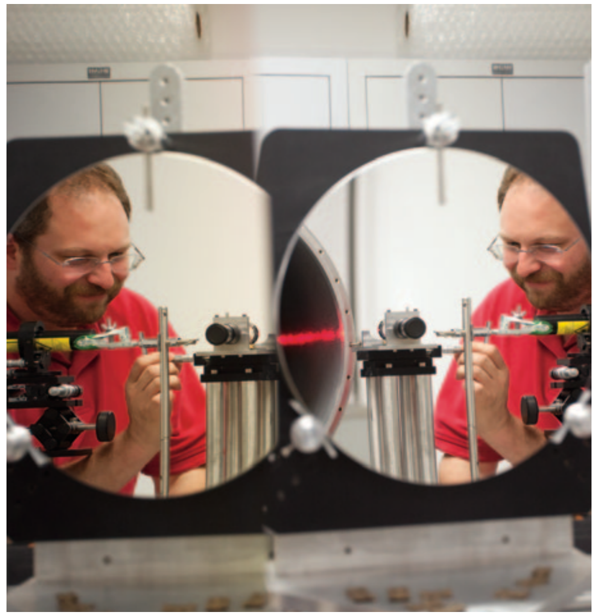
It's possible that one woman's high fat diet during pregnancy can increase the risk of breast cancer for several generations. ECE associate professor Jason Xuan and ECE professor Yue (Joseph) Wang will be researching this possibility as part of a collaboration led by Georgetown University. The project is funded by the National Institute of Health (NIH). Virginia Tech's share is $400,000 over four years.

A high-fat diet during pregnancy increases ethinyl estradiol (EE2) levels, which has been linked to increased risk of breast cancer in daughters, granddaughters and great-granddaughters. This study investigates the risk of breast cancer in mice for four generations following the exposure of the original female to a high-fat diet.

The team will also test their hypothesis that this increased risk of breast cancer is caused by changes in DNA methylation. This is a normal part of DNA development, but changes in this process could have an impact that persists for generations.

Space@VT moves into new quarters





Clockwise from top left: Nathaniel Frissell, AJ Ribeiro, and Neeraj Pramodkumar look at real-time data from a North American radar array in the VT SuperDARN lab. In his new lab space, Scott Bailey works on a collimator with a laser source, which is used to focus a large telescope that flies on a rocket. A group of students work in one of the common areas of the new building.

Space@VT moved into a new building in July 2012, enabling space science researchers from multiple departments to work in close proximity. The new building has offices, laboratories, meeting/seminar rooms, and design, test, and fabrication facilities. Collaboration was the driving force behind the new building, according to ECE's Scott Bailey. "Working together is a lot easier, and our time is spent more efficiently and productively."

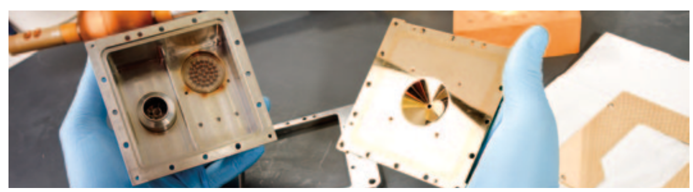
Virginia Tech team to launch nanosatellite

Virginia Tech researchers will be launching a new satellite that will be the first to specifically study gravity waves traveling between the lower atmosphere and ionosphere. ECE professor Greg Earle and his team will be working with researchers from the University of Illinois to build a nanosatellite that NASA will launch in late 2015 or early 2016.

The project has been selected for funding by the NSF, and has received support from VPT and ICTAS, and the Virginia Space Grant Consortium. NASA has agreed to fund the launch.

This will be a low Earth orbit (LEO) satellite that will help us understand "how waves generated by weather systems in the lower atmosphere propagate and deliver energy and momentum into the mesosphere, lower thermosphere, and ionosphere (MLTI)," Earle explains. "Our experiment will be the first global satellite investigation to focus entirely on these waves, which may be responsible for plasma instabilities that disrupt radio propagation."

Most energy moves downward through the atmosphere along magnetic field lines, but at middle and low latitudes energy is sometimes transferred upward. Studies of the ionosphere "cite gravity waves as the mechanism by which energy is transferred from low to



high altitudes," says Earle, "yet we have little understanding of this process in a global, systemic sense."

Gathering precise data about these waves requires in-situ measurements, which have been hard to get because satellites that operate at the necessary low altitudes have lifespans too short to be cost-effective. With the smaller, cheaper CubeSats this is no longer a problem. According to Earle, the Virginia Tech CubeSat is about the size of a shoebox.

The new satellite will measure perturbations caused by these waves in both neutral and ion densities in the ionosphere, while on-board photometers will measure the wavelengths and amplitudes of the wave fields in the upper mesosphere. Using meteorological data along with the satellite's data, the team hopes to discover the connections between terrestrial storms and the MLTI system.

Wang awarded YIP

For tools to detect vulnerabilities in concurrent software

ECE's Chao Wang has received a three-year Office of Naval Research (ONR) Young Investigator Program (YIP) to develop methods and software tools that can detect security vulnerabilities in multicore software.

The Young Investigator grant is the most prestigious of ONR grants for faculty members early in their careers. Awardees are noted for their exceptional promise for conducting creative research. ONR made only sixteen awards in 2013.

According to Wang, "seemingly simple software defects, such as buffer overruns, have led to numerous security exploits in the past." With the use of multicore processors, he continues, "concurrency related software defects may become the new buffer overruns."

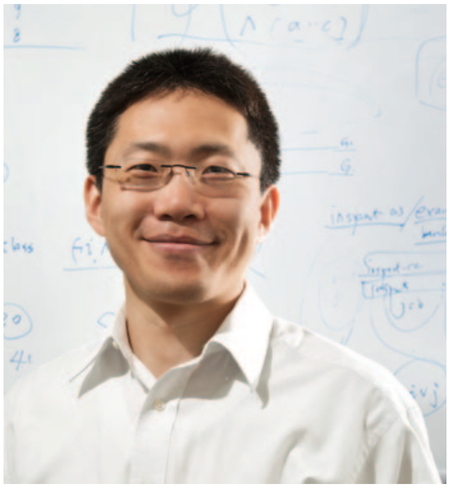
As software takes advantage of multicore processors, it becomes increasingly difficult to detect vulnerabilities. Concurrency vulnerabilities can sometimes be discovered as program bugs, but some remain hidden until maliciously attacked.

Wang stresses that it is inherently difficult to reason about concurrent programming. Because there are so many interleavings where different program threads interact, "multiple runs of the same program may exhibit different behaviors even for the same input," he says. "Furthermore, the number of interleavings is often astronomically large."

Wang explains that current methods for detecting vulnerabilities either detect only specific sets of interleavings, or "over-approximate the impact of threading and report too many false positives."

Wang proposes to use a model driven program analysis framework that automatically generates models from existing software code. These models will reduce the complexity of the program analysis problem. Wang explains that with this approach, "we won't have to enumerate all the interleavings. Instead, we concentrate on only the discrepancy (if any) between the intended program behavior and the actual program behavior." This will work for a wide range of security vulnerabilities, known and unknown.

"Although automated model generation has been used or at least envisioned in other settings...it has never been fully explored for mitigating concurrency vulnerabilities," Wang notes. "This research will fill the gap."



Wang joined ECE in August 2011, after serving seven years as a Research Staff member at NEC Laboratories in Princeton, New Jersey. He earned his B.S. and M. S. from Peking University, China in 1996 and 1999, respectively, and a Ph.D. in 2004 from the University of Colorado at Boulder.

Reducing low-power power consumption with NEMS

Leyla Nazhandali and Masoud Agah, are creating nanoelectromechanical systems (NEMS) that can reduce power consumption by more than 95 percent in devices with long idle periods. They have received a $425,000 NSF grant to create NEMS switches to reduce power leakage for low power applications.

According to Nazhandali, "power consumption is one of the primary roadblocks to greatly expanding the role of computing in everyday life." She explains that this is important for many applications, including server farms and sensor deployment into areas with little power available—such as bridges, war zones, and inside the human body.

The tiny switches Nazhandali and Agah are developing have low resistance when on and infinite resistance when off, making the power gating more efficient. They will design both the NEMS switch and on-chip control circuitry, "which includes a high voltage generation system and a self-healing controller that can gracefully handle switch failure," says Nazhandali. They are also aware of the difficulty of integrating these switches into current technologies, and are investigating how to best incorporate NEMS switches into industry-standard CMOS process flows.

Wireless researchers form new broadband I/UCRC

Jung-Min (Jerry) Park, along with co-principal investigator Jeff Reed, has received a $300,000 grant from the National Science Foundation to establish a site at Virginia Tech for the Broadband Wireless Access & Applications Center (BWAC), which is an Industry/University Cooperative Research Center (I/UCRC). Park will serve as the site director.

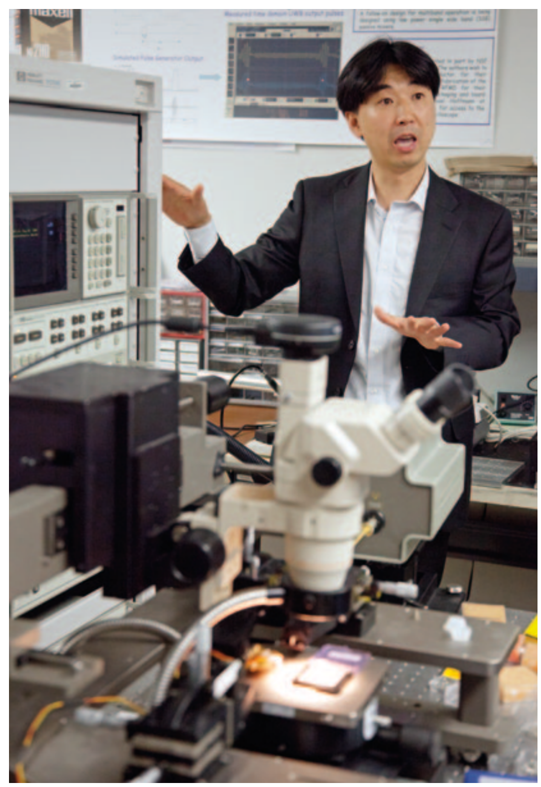
The University of Arizona serves as the main BWAC site. Additional BWAC sites are at Auburn University, University of Notre Dame, and the University of Virginia. Another I/UCRC, the Wireless Internet Center for Advanced Technology (WICAT) currently headed by the Polytechnic Institute of New York University, will disband in favor of the new center.

According to Park, "the rationale for WICAT was the recognition of the importance of wireless technology for communication, and especially as a medium for accessing the Internet." WICAT researchers focused on cooperative communications, ad-hoc networks, video over wireless, cognitive radios and testbeds, and rapidly reconfigurable networks.

BWAC will have a new focus, and some questions they are tackling include how to use a larger portion of the radio spectrum (outside the standard 1 to 5 GHz), how to most efficiently share the existing spectrum, how to provide wireless communication to medical devices, and how to address national security issues.

The evolution of wireless technology "requires a new vision and research direction, so that emerging research fields may be positioned to both enable and bring new solutions for these unprecedented bandwidths that will be a part of future wireless technologies," says Park.

New Multifunctional IC Systems group formed



Four ECE faculty members (Dong Ha, Kwang-Jin Koh, Majid Manteghi, and Sanjay Raman) have formed the Multifunctional Integrated Circuits and Systems (MICS) research group, which focuses on analog, mixed-signal, and radio frequency (RF) integrated circuit designs; antenna systems; and RF interfaces. LEFT: ECE professors Sanjay Raman (on screen) and Dong Ha (MICS Director) at the first MICS day, when faculty, students, and corporate representatives gathered to discuss their research. RIGHT: ECE's Kwang-Jin Koh shows his lab on MICS day.

ECEs design MEMS to detect hazardous air pollutants

ECE associate professors Masoud Agah and Leyla Nazhandali have been awarded a $417,550 grant from the National Institute for Occupational Safety and Health (NIOSH) to design microelectromechanical systems (MEMS) that can detect hazardous air pollutants.

Standard methods of measuring these toxins require a sample to be collected, transported to a lab, then analyzed with gas chromatography. According to Agah, "this limitation makes it very difficult to prioritize exposures that should be targeted for mitigation strategies." Agah and Nazhandali's new system will monitor for pollutants continuously and in real-time.

Working with Linsey Marr, associate professor of Civil and Environmental Engineering, they will develop a miniaturized gas chromatography device to analyze hazardous air pollutants. "The system integrates sampling and laboratory analytical functions on a portable printed circuit board platform," Agah explains. When complete, these devices will be able to alert workers to dangerous conditions.

Outdoor cognitive radio testbed planned

A Wireless@VT team has received a $260,000 Department of Defense (DoD) Defense University Research Instrumentation Program (DURIP) grant to develop an outdoor cognitive radio network testbed. Jeff Reed serves as principal investigator (PI), with Jung-Min (Jerry) Park as Co-PI.

Virginia Tech has previously developed an indoor heterogeneous wireless communication network testbed, called the VT Cognitive Radio Network Testbed (VT-CORNET). This testbed currently consists of 48 fixed radio nodes, and another 10 portable radio nodes are currently being integrated.

VT-CORNET covers a wide range of indoor scenarios, and allows for relatively short range experimentation, however it has minimal outdoor ability. This is a limitation because many military operations occur outside.

The Virginia Tech team will be developing an Outdoor Cognitive Radio Network Testbed (O-CORNET) to supplement their existing testbed. O-CORNET will consist of 15 stationary and two mobile outdoor radio nodes.

Team strives to thwart cyber physical attacks

Not all cyber attacks are focused on stealing sensitive information—some seek to destroy physical infrastructure. These kinds of attacks, such as the Stuxnet worm that targets control systems, can damage anything from automated manufacturing to power plants.

ECE's Cameron Patterson and William Baumann have been awarded a $500,000 National Science Foundation Secure and Trustworthy Cyberspace (SaTC) grant to predict such attacks. "We're assuming that the systems are already infected," says Patterson, "so we're focused on seeing the imminent launch of a latent attack."

According to Patterson, infrastructure attacks are difficult even to detect. "Knowing that an attack on a process control system has occurred or is occurring usually means noticing that the physical process is becoming unstable," he says. Also, "there is a point of no return after which damage or loss of life can occur. If the attack can be predicted, however, emergency procedures might be applied—such as shutting down a turbine."

Automated process control systems are designed and tested using accurate models for the process being controlled, and Patterson plans to use these models for detection. Instead of discarding the model after testing, he plans to leave it in place in the deployed controller. The controller will then store two identical and periodically synchronized copies of the control algorithm: one connected to the physical process and the other connected to the model. Patterson explains that the model can be fast-forwarded a short time to detect dangers. "We'd see anomalous behavior in the modeled system up to a minute before it happens in the real system, giving extra time to intervene and put the system into a safe state." The prediction unit, backup controller, and switchover mechanism are fixed, synthesized into programmable hardware, and formally verified. They cannot be modified remotely.

Patterson and Baumann plan to test this approach by controlling an inverted pendulum system. "We don't want to solve this just in MATLAB," Baumann explains. "We can't use real process control systems such as those in chemical or nuclear plants. They don't let people play with them." The inverted pendulum has many of the same issues that would arise in real systems, including instability, nonlinearity, actuation limits, and disturbances.

Once they have developed their tools and prototype, they plan to allow open access to the system and see if anyone can hack it.

2012 | 2013 BRADLEY & WEBBER HONORS

BRADLEY SCHOLAR

Callie Johnston
BSCPE '14
Mentor, Ohio

Career goals: Working in neural-controlled prosthetics.
Honors & Activities: Association of Women in Computing, Tau Beta Pi, Eta Kappa Nu, Salsa, Tech Polynesian Dance, and Fire Club.
Why Virginia Tech: Virginia Tech has a great ECE program. I have a number of opportunities, including research, that I can take advantage of while here.

BRADLEY ALUMNI

(S): Scholar **(F):** Fellow

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

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

J. Shawn Addington (F)
(BSEE '90, MSEE '92, Ph.D. '96)
Department Head, ECE
Virginia Military Institute
Lexington, Va.
Developing the microelectronics and semiconductor devices programs at VMI.

Sarah S. Airey (S)
(BSCPE '01)

Christopher Anderson (S/F)
(BSEE '99, MSEE '02, Ph.D. '06)
Associate Professor
United States Naval Academy
Annapolis, Md.

Matthew E. Anderson (S)
(BSCPE '08)

Stephen P. Bachhuber (F)
Staff Design Engineer
Triquint Semiconductor
High Point, N.C.

Mark Baldwin (F)
(BSEE '93, MSEE '05, Ph.D. '08)
Consulting Engineer
Dominion
Glen Allen, Va.
Works in modeling, control, and protection of electric power generation equipment.

William D. Barnhart (S/F)
(BSEE '00, MSEE '02)

Benjamin Beasley (S)
(BSEE '09)

Ray Bittner (F)
(BSCPE '91, MSEE '93, Ph.D. '97)

Aric Blumer (F)
(Ph.D. '07)

Bryan Browe (F)
(BSEE '97, MSEE '99)

Kirsten Rasmussen Brown (S)
(BSEE '94)

Steven Edward Bucca (F)
(BSEE '87, MSEE '89)

Mark Benjamin Bucciero (F)
(BSCPE '01, MSCPE '04)

R. Michael Buehrer (F)
(Ph.D. '96)
Professor
Virginia Tech
Blackburg, Va.

Charles Bunting (F)
(MSEE '92, Ph.D. '94)
Halliburton Professor of Engineering
Oklahoma State University
Stillwater, Ok.

Carey Buxton (F)
(Ph.D. '01)

Scott Cappiello (S) (BSCPE '94)
Vice President,
Program Management
MicroStrategy, Inc.
San Marcos, Calif.
He has a product definition role in the research and development department.

Matthew Carson (S)
(BSEE '98, MSME '01)
He is moving to South Asia to work with an NGO called Colcord Social Enterprises.

Ricky Castles (S)
(BSCPE '03, MSCPE '06, Ph.D. '10)
Assistant Professor
East Carolina University
Greenville, N.C.

Eric D. Caswell (F) (Ph.D. '01)

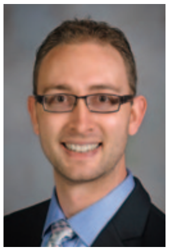
Dae Hee Cho (S) (BSEE '06)
Intellectual Property Attorney
Winston & Strawn LLP
Los Angeles, Calif.

BRADLEY & WEBBER FELLOWS

Matthew Bailey

Bradley Fellow
BSEE/BSCPE/Math '09
Virginia Tech

Advisor: Dan Stilwell
Research: Corrosion detection of tanks and voids on Navy ships using a ducted fan UAV. He is developing the sensor array and navigation, localization, and mapping of a ducted fan UAV for use in unknown environments aboard Navy ships. The goal is to eliminate the need for humans to examine the coatings of the tanks for signs of corrosion.



Matthew Carter

Bradley Fellow
BSCPE '09
University of California – San Diego

Advisor: Christopher Wyatt
Research: Brain network connectivity. He is investigating methods to improve the identification of the network parameters of task-related brain activation patterns, focusing on data obtained through the use of MEG (magnetoencephalography).

Thaddeus Czauski

Bradley Fellow
BSCPE '09 with nuclear engineering certificate
University of Pittsburgh

Advisor: Jules White
Research: Using locations to present relevant data and automatically protect data. He is working on methods to reliably determine the room location of mobile devices, enable quick and reliable data downloads relevant to that room (such as patient records when a doctor enters a hospital room), then automatically protect sensitive information.

Jeffrey R. Clark (F)
(MSEE '03, Ph.D. '06)
Proprietor, Black Dog Writing & Editing Services
Blacksburg, Va.
He published his first novel, *Her Strength Unbounded*, in 2012.

Ross Clay (S) (BSCPE '09)
Ph.D. student
North Carolina State University
Raleigh, N.C.

Brittany Clore (S)
(BSCPE '10, MSCPE '12)
Information Assurance Staff
The MITRE Corporation
McLean, Va.
Supporting the U.S. Department of Defense CIO cybersecurity strategy and policy efforts.

Kevin Cooley (S) (BSEE '02)
Electrical Engineer
Industrial Automation Specialists
Hampton, Va.
The company's www.buildmyproduct.com, offers product design assistance.

Carrie Ellen Cox (F) (MSEE '00)

David Casteel Craven (S)
(BSCPE '08)

Stephen Craven (F) (Ph.D. '08)
Networks Specialist
TVA

Cass Dalton (S) (BSCPE '03)

Phillip Danner (S) (BSCPE '91)

Bradley A. Davis (F)
(BSEE '86, MSEE '88, Ph.D. '00)

Daniel A. Davis (S) (BSCPE '99)

Scott Davis (S) (BSCPE '00)

Joel A. Donahue, P.E. (F)
(MSEE '94)
President
Janlee Services, Inc.
Blacksburg, Va.
Offers diagnostic and referral services for residential building systems, plus legal consulting services.

Brian Donlan (F)
(MSEE '05)

W. Ashley Eanes (S)
(BSEE '95)

Richard Ertel (F)
(Ph.D. '99)

Brian Flanagan (S/F)
(BSEE '97, MSEE '98)

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

Todd B. Fleming (F)
(BSCPE '94, MSEE '96)

Ryan Fong (S/F)
(BSCPE '01, MSCPE '04)
Senior Engineer
Fourth Dimension Engineering

Jayda Freibert (S)
(BSEE '98)

Daniel Friend (F)
(BSEE '98, MSEE '98, Ph.D. '09)
Associate
Zeta Associates
Aurora, Colo.

Bradley Gale (S)
(BSEE '97)

Daniel Gillespie (S)
(BSCPE '95)

Brian Gold (S)
(BSEE/Math '01, MSEE '03)

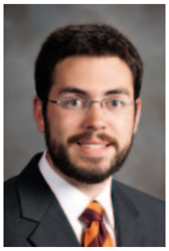
Jonathan Graf (S)
(BSCPE '02, MSCPE '04)

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

Adam P. Hahn (S)
(BSCPE '03)

Alexander Hanisch (S)
(BSCPE/Math '03)

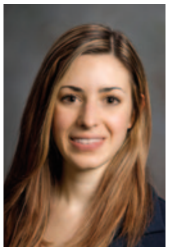
BRADLEY & WEBBER FELLOWS *continued*



Shaver Deyerle

Bradley Fellow
BSEE '10
Virginia Tech

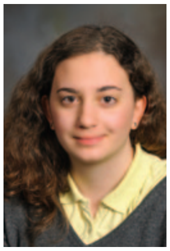
Advisor: Peter Athanas
Research: He is developing an FPGA-based receiver synthesis system capable of blindly classifying modulation types and automatically creating the hardware necessary to demodulate the signals. The project leverages custom-designed rapid-assembly tools to allow for a hardware-in-the-loop approach to modulation classification.



Christina Dimarino

Webber Fellow
BSE '12
James Madison University

Advisor:
Dushan Boroyevich
Research: Characterization of SiC power semiconductor devices. She is characterizing the static and dynamic performance of various SiC power semiconductor devices at high temperatures (200° C). High-temperature capability is a major advantage of SiC over conventional Si devices. Devices include 1.2 kV SiC MOSFETs, BJTs, and JFETs.



Lucy Fanelli

Webber Fellow
BSECE '12
Brown University

Advisor: Gregory Earle
Research: Space@VT electronics design. She designs the electronic systems for the Center for Space Science & Engineering Research. She is currently working on an instrument that measures ion concentration on a satellite in low-Earth orbit. The data will be used to study gravity waves in plasma.

BRADLEY ALUMNI *continued*

Nathan Harter (F)
(MSEE '07)

Dwayne Allen Hawbaker (F)
(BSEE '89, MSEE '91)

William C. Headley (F)
(BSEE '06, MSEE '09)
Ph.D. Student
Virginia Tech

Matt Helton (S)
(BSEE '01)

Jason Hess (F)
(BSEE '97, MSEE '99)

Erik Hia (F)
(BSCPE '99, MSCPE '01)
Manager, Engineering- Software
Overture Networks
Morrisville, N.C.
Recently took over management of the Core Platform Software group and its flagship Overture 6500 platform.

Daniel Hibbard (F)
(BSEE '02, MSEE '04)

James E. Hicks (F)
(MSEE '00, Ph.D. '03)

Hugh Hockett (S)
(BSCPE '03)

Spencer Hoke (S)
(BSCPE '03)
Staff Software Engineer
Qualcomm
Raleigh, N.C.
Working on the Snapdragon cell phone and tablet software for Windows.

Russell T. Holbrook (S)
(BSCPE '03, BA COMM '04)

Andrew S. Hollingsworth (S)
(BSCPE '03)

Michael Hopkins (F)
(Ph.D. '12)

Ellery Horton (S)
(BSCPE '04)

Keith Christopher Huie (F)
(MSEE '02)
Program Engineer
Raytheon
Dallas/Fort Worth, Texas
Responsible for overall engineering cost, schedule, and technical performance of the Driver's Vision Enhancer (DVE), Thermal Weapon Systems (TWS), Digital Processor redesign, and Enhanced Night Vision Goggle (ENVG) programs.

Ryan Hurrell (S) (BSEE '03)
Senior Engineer
Siemens–Healthcare:
Molecular Imaging
Knoxville, Tenn.
Serves as team lead for the patient handling system used in Siemens PET/CT imaging systems.

John Todd Hutson (S) (BSEE '93)

Ryan Irwin (F)

Edward Jones (S) (BSEE '07)

Basil Thomas Kalb (S) (BSEE '98)

Adam Kania (S) (BSEE '01)

David Kapp (F)
(MSEE '93, Ph.D. '95)

Dimosthenis Katsis (F)
(BSEE '95, MSEE '97, Ph.D. '03)
President
Athena Energy Corp.
Bowie, Md.
The firm is developing alternative energy products, recently achieving ETL/UL certification for its first solar power product.

David L. Kleppinger, Jr. (S)
(BSCPE '04, MSCPE '08, Ph.D. '10)

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

William Kuhn (F)
(BSEE '79, Ph.D. '96)
Professor, ECE
Kansas State University
Manhattan, Kan.

Evan Lally (F)
(BSEE '03, MSEE '06, Ph.D. '10)

Michael Fraser

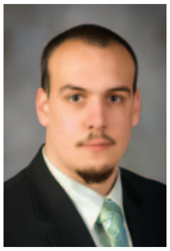
Bradley Fellow
BSEE '09, MSEE '12
Virginia Tech

Advisor: Anbo Wang
Research: Applying interdisciplinary research knowledge to design photonic systems for various physical, chemical, and biological applications. He is using dielectric microcavity resonators structured inside telecom optical fiber to excite whispering gallery modes. The purpose is to make an encapsulated, ultra-low threshold laser.

Kelson Gent

Bradley Fellow
BSECE '10
University of Texas at Austin

Advisor: Michael Hsiao
Research: Integrating formal tools and stochastic search algorithms to generate functional test patterns. He is also investigating the use of register transfer level circuit descriptions in order to gain high-level design information for pattern generation. Improvements in test algorithms are vital to the semiconductor industry because of high debugging costs.



Nicholas Kaminski

Bradley Fellow
BSEE/BSCPE '10
Virginia Tech

Advisor: Charles Bostian
Research: The fundamentals of wide-use Cognitive Radios (CR). He developed a performance evaluation scheme to examine the use of CR for his master's thesis and is now extending the work to provide the underpinning for the design of socially interactive CRs.

Jeff D. Laster (F)
(BSEE '91, MSEE '94, Ph.D. '97)
Principal Technical Manager,
Raytheon
Mentor Graphics
Dallas, Texas
Serves as a mentor for Mil-Aero SAE-of-the-Year World Trade Best Competitive Replacement.

Mark Alan Lehne (F)
(Ph.D. '08)

Charles Lepple (F)
(BSEE '00, MSEE '04)
Senior Research Engineer
Johns Hopkins University
Applied Physics Lab
Laurel, Md.

Jason E. Lewis (S/F)
(BSEE '99, MSEE '00)

Joseph C. Liberti (F)
(BSEE '89, MSEE '91, Ph.D. '95)

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

Janie Hodges Longfellow (S)
(BSCPE '01)

Daniel L. Lough (F)
(BSCPE '94, MSCPE '97, Ph.D. '01)

Amy Malady (F)
(BSEE '09, MSEE '11)

Cheryl Duty Martin (S)
(BSEE '95)
Research Scientist
Applied Research Laboratories
The University of Texas at Austin
Austin, Tex.

Stephanie Martin (S)
(BSEE '04)
JAmmer Techniques Optimization (JATO) Communications Electronic Attack Team Lead
Johns Hopkins University Applied Physics Lab
Laurel, Md.

Michael F. Mattern (S)
(BSEE '02)

Christopher Maxey (S)
(BSCPE '02, MSCPE '04)

Eric J. Mayfield (S)
(BSEE '97, MSEE '98)

David C. Mazur (S/F)
(BSEE '11, MSEE '12)

James W. McClamara (F)
(BSEE '02)

Brian McGiverin (S)
(BSCPE '96)

John McHenry (F)
(BSEE '88, MSEE '90, Ph.D. '93)
Senior Electrical Engineer
Department of Defense
Fort Meade, Md.

Keith McKenzie (F)

David McKinstry (F)
(MSEE '03)

Vinodh Menon (BSCPE/ISE '02)

Carl Minton (F)
(BSEE '97, MSEE '02)
Systems Engineer
Arion Systems, Inc.
Chantilly, Va.

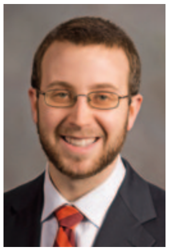
Stephen Nash (S)
(BSCPE '03)
Senior Software Engineer
Verite Group
Dulles, Va.

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

Michael Newkirk (F)
(BSEE '88, MSEE '90, Ph.D. '94)
Principal Professional Staff
The Johns Hopkins University
Applied Physics Laboratory
Chair, ECE Advisory Board

Paul Nguyen (S/F) (BSEE '98)

BRADLEY & WEBBER FELLOWS *continued*



Robert Lyerly

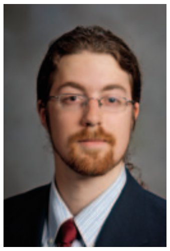
Bradley Fellow
BSCPE/BSCS '12
Virginia Tech

Advisor:
Binoy Ravindran
Research: Heterogeneous compilation. He is employing compilation techniques for automatically refactoring an application to take advantage of heterogeneous hardware — CPUs with different instruction-set architectures, GPGUs, FPGAs, etc. The techniques can be used for applications from embedded systems to large server farms.

Anne Martin

Webber Fellow
BSECE '10
F.W. Olin College of Engineering

Advisor:
Michael Buehrer
Research: Physical layer security of wireless systems. This includes the secrecy rate of information transfer, secrecy capacity approaching systems, and physical layer encryption, among other approaches. Future research includes expanding physical layer security to cooperative approaches among networks.



Elliott Mitchell-Colgan

Bradley Fellow
BSECE '12
Lafayette College

Advisor:
Yaman Evrenosoglu
Research: He is modifying the Under Frequency Load Shedding power protection scheme to work with both electrical networks with a heavy wind power generation and those with none. He is applying a decision tree to identify predictor variables for classifying under generation separately from a drop in frequency due to less wind.

BRADLEY ALUMNI *continued*

J. Eric Nuckols (F)
(BSEE '97, MSEE '99)

Abigail Osborne (S) (BSCPE '04)

Neal Patwari (S)
(BSEE '97, MSEE '99)
Associate Professor, ECE
University of Utah
Salt Lake City, Ut.

Joseph Allen Payne, Jr.
(BSEE '00)

My Linh Pham (S)
(BSCPE/ Physics '07)

William B. Puckett (F) (MSEE '00)

Yaron Rachlin (S) (BSEE '00)

Parrish Ralston (F)
(BSEE '06, MSEE '08, Ph.D. '13)
Northrop Grumman Electronics Systems
Linthicum, Md.
Microwave design and process integration for GaAs and GaN technologies.

David Reusch (F)
(BSEE '04, MSEE '06, Ph.D. '12)
Director of Applications Engineering
Efficient Power Conversion Corp.
Involved with high-frequency power conversion techniques for power electronics, including high-density packaging and integration, transformer design, and wide bandgap semiconductors.

Richard Steven Richmond (F)
(MSEE '01)

Amy M. Johnson Ridenour (F)

C. J. Rieser (F)
(MSEE '01, Ph.D. '04)
Lead Communications Engineer/ Laboratory Coordinator
The MITRE Corporation
Charlottesville, Va.

Jamie Riggins (S/F)
(BSCPE/BSEE '04, MSEE '06)
Logistics & Readiness Flight Commander
United States Air Force

D. Gray Roberson (F) (Ph.D. '07)

Pablo Max Robert (F)
(MSEE '98, Ph.D. '03)

Thomas Rondeau (S/F)
(BS '03, MS '06, Ph.D. '07)

Jon Scalera (F) (MSCPE '01)
Resident in Radiology
Boston Medical Center
Boston, Mass.

Amy L. Schneider (S)
(BSCPE '03/ BA German '04)

David Craig Schroder (S)
(BSEE '05)

Steven Schulz (F) (MSEE '91)

Ian Schworer (F)
(BSCPE '03, MSEE '05)

Jeffrey T. Scruggs (F)
(BSEE '97, MSEE '99)

Kashan Ali Shaikh (S)
(BSCPE '02)

Adam K. Shank (S) (BSCPE '07)

Raymond A. Sharp (S) (BSEE '02)

Rebecca K. Shelton (F) (MSEE '08)

Jacob Simmons (S)
(BSCPE '08, MSEE '10)
Software Engineer
Harris Corporation
Lynchburg, Va.
Automated test engineer for Harris' next-generation 911 dispatch console.

Roger Skidmore (F)
(BSCPE '95, MSEE '97, Ph.D. '03)

Jeff Smidler (S) (BSEE '99)

Graham David Stead (S) (BSCPE '93)

Jennifer Hastings Steele (S)
(BSEE '96)

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

Javier Schloemann

Bradley Fellow
BSCPE '04, MSEE '07
Clemson University

Advisor: Michael Buehrer
Research: Collaborative position location. He is working on methods to improve localization, primarily in the challenging, GPS-denied indoor environment. He is looking at the value of collaborating mobile nodes, techniques for tapping map knowledge to improve the positioning solution, and issues of fusing data from many disparate sensors.

Richard Tillman

Bradley Fellow
BSEE '12
Virginia Tech

Advisor: Steven Ellingson
Research: Precision measurement of astrophysical source flux densities below 100 MHz for use in array calibration. He is developing an interferometer using high-linearity front ends with internal noise calibration and investigating using astronomical measurements for in situ characterization of HF/VHF antenna patterns and self-impedances.

David Uliana

Bradley Fellow
BSCPE '11
Virginia Tech

Advisor: Peter Athanas
Research: Applications of reconfigurable computing to big-data, life sciences problems. He is constructing and introducing high-level hardware assembly environments to non-engineer scientists. The goal is to mitigate computational bottlenecks by boosting their ability to use high-performance computing platforms with little engineering aid.

Douglas Sterk (F)
(BSEE '00, MSEE '03)
Senior Design Engineer
VPT, Inc.
Blacksburg, Va.

Samuel S. Stone (S)
(BSCPE '04)

Anne Palmore Stublen (S)
(BSEE '91)

Seema Sud (F) (Ph.D. '02)

Juan Suris (F) (Ph.D. '07)
Assistant Professor
University of Puerto Rica
Mayaguez, P.R.

Ethan Swint (F) (Ph.D. '12)

David L. Tarnoff (F)
(BSEE '87, MSEE '91)
Associate Professor
Applied Science & Technology
East Tennessee State University
Johnson City, Tenn.
He teaches courses in computer hardware, embedded system design, iOS application development, and web technologies. His research focuses on embedded system design, and applications using ARM-based processors.

Alexander Taylor (F)
(BSEE '02, MSEE '04)

Daniel J. Tebben (F) (Ph.D. '06)

Jerry Towler (S)
(BSEE '08, MSEE '11)

Rose Trepkowski (F)
(MSEE '04)

Christian Twaddle (S)
(BSCPE '01)

Matthew C. Valenti (F)
(BSEE '92, Ph.D. '99)
Professor
West Virginia University
Morgantown, W. Va.
Received the 2013 WVU Foundation Outstanding Teaching Award.

Michael G. Vondrak (S)
(BSCPE '05)

Wesley T. Wade (S)
(BSEE '93)

Kristin Weary (S)
(BSEE '03)

Capt. Michael L. Webber (F)
(BSEE '02, MSEE '04)

Paul C. Weinwurm, P.E.
(BSEE '03)

Matt Welch (S)
(BSEE '09)

Jason S. K. Wienke (S)
(BSEE '02)

William Worek (S)
(BSCPE '99, MSCPE '02)

Kai Xu (S)
(BSEE '95)

Matthew A. Yaconis (F)
(BSEE '97)
Senior Software Engineer
Rockwell Collins
Sterling, Va.
Designs products, tools, and simulation models for training pilots and maintenance personnel. The toolsets are also used in certification of avionics components.

Jason Yoho (F)
(MSEE '98, Ph.D. '01)

Phillip A. Zellner (F)
(BSEE '07)

Richard Zimmermann (S)
(BSCPE '07)

Gregory A. Zvonar (S)
(BSEE '90, MSEE '91)
Principal Member of Technical Staff
The Charles Stark Draper Laboratory
Cambridge, Mass.

2011 2012 PH.D. DEGREES AWARDED

Aguayo Gonzalez, Carlos R.
Power Fingerprinting for Integrity Assessment of Embedded Systems
Committee Chair: Reed, J. H.

Amanna, Ashwin E.
Statistical Experimental Design Framework for Cognitive Radio
Committee Chair: Reed, J. H.

Baidas, Mohammed W.
Node Selection, Synchronization and Power Allocation in Cooperative Wireless Networks
Committee Chair: MacKenzie, A.

Cao, Xiao
Optimization of Bonding Geometry for A Planar Power Module to Minimize Thermal Impedance and Thermo-Mechanical Stress
Committee Chair: Ngo, K. D. T.

Channakeshava, Karthik
Utility Accrual Real-Time Channel Establishment in Multi-hop Networks
Committee Chair: Hsiao, M.

Chen, Li
Statistical Machine Learning for Multi-Platform Biomedical Data Analysis
Committee Chair: Wang, Y.

Chen, Xuetao
Resource Allocation in Wireless Distributed Computing Networks
Committee Chair: Bose, T.

Chen, Zhimin
SCA-Resistant and High-Performance Implementations of Cryptography Using Instruction Set Extensions and Multi-Core Processors.
Committee Chair: Schaumont, P.

Choi, Bumsuk
Acoustic Source Localization in a 3D Complex Urban Environment
Committee Chair: Burgos, R.

Deaton, Juan D.
Enabling Dynamic Spectrum Access in Next Generation Wireless Networks
Committee Chair: DaSilva, L. A.

Dunlop, Matthew W.
Achieving Security and Privacy in the Internet Protocol Version 6 Through the Use of Dynamically Obscured Address
Committee Chair: Tront, J. G.

Guo, Xu
Secure and Efficient Implementations of Cryptographic Primitives
Committee Chair: Schaumont, P.

Harun, Mahmud
Modification of Large Reflector Antennas for Low Frequency Operation
Committee Chair: Ellingson, S.

Hassan Eltarras, Ramy M.
BioSENSE: Biologically-inspired Secure Elastic Networked Sensor Environment
Committee Chair: Eltoweissy, M.

Henry, Michael B.
Emerging Power-Gating Techniques for Low Power Digital Circuits
Committee Chair: Nazhandali, L.

Hofmann, Matthias C.
Localized Excitation Fluorescence Imaging (LEFI)
Committee Chair: Xu, Y.

Irwin, Ryan E.
Traffic-Aware Channel Assignment for Multi-Transceiver Wireless Networks
Committee Chair: MacKenzie, A.

Jose, Bijoy A.
Formal Model Driven Software Synthesis for Embedded Systems
Committee Chair: Shukla, S.

Kim, Jeong Ki
Low-Power RF Front-End Design for Wireless Body Area Networks
Committee Chair: Ha, D.

Li, Qiang
Low-Profile Magnetic Integration for High-Frequency Point-of-Load Converter
Committee Chair: Lee, F. C.

Liu, Qian
Wideband Digital Filter-and-Sum Beamforming with Simultaneous Correction of Dispersive Cable and Antenna Effects
Committee Chair: Ellingson, S.

Maiti, Abhranil
A Systemic Approach to Design an Efficient Physical Unclonable Function
Committee Chair: Schaumont, P.

Na, Chewoo
IEEE 802.15.4 Wireless Sensor Networks: GTS Scheduling and Service Differentiation
Committee Chair: Yang, Y.

Oliver, John M.
3D Micromachined Passive Components and Active Circuit Integration for Millimeter-Wave Radar Applications
Committee Chair: Raman, S.

Otoom, Mwaffaq N.
Capacity Metric for Chip Heterogeneous Multiprocessors
Committee Chair: Paul, J. M.

Qian, Hao
A High-Efficiency Grid-Tie Battery Energy Storage System
Committee Chair: Lai, J. S.

Ramkumar, Barathram
Automatic Modulation Classification and Blind Equalization for Cognitive Radios
Committee Chair: Bose, T.

Reusch, David C.
High Frequency, High Power Density Integrated Point of Load and Bus Converters
Committee Chair: Lee, F. C.

Schlake, Farimehr
Optimal Consumer-Centric Delay-Efficient Security Protocols in Multi-Agent Networks — A Game and Mechanism Design Theoretic Approach
Committee Chair: Mili, L. M.

Shao, Shengnan
An Approach to Demand Response for Alleviating Power System Stress Conditions Due to Electric Vehicle Penetration
Committee Chair: Rahman, S.

Shatila, Hazem S.
Adaptive Radio Resource Management in Cognitive Radio Communications using Fuzzy Reasoning
Committee Chair: Reed, J. H.

Sun, Pengwe
Cascade Dual-Buck Inverters for Renewable Energy and Distributed Generation
Committee Chair: Lai, J. S.

Swint, Ethan B.
DC Reluctance Machine — A Doubly-Salient Reluctance Machine with Controlled Electrical and Mechanical Power Ripple
Committee Chair: Lai, J. S.

Wang, Chen
From Network to Pathway: Integrative Network Analysis of Genomic Data
Committee Chair: Xuan, J.

Xie, Bei
Partial Update Adaptive Filtering
Committee Chair: Bose, T.

Xue, Bin
Formal Approaches to Globally Asynchronous and Locally Synchronous Design
Committee Chair: Shukla, S.

Yu, Guoqiang
Machine Learning to Interrogate High-throughput Genomic Data: Theory and Applications
Committee Chair: Wang, Y.

Zhang, Bai
Modeling and Characterization of Dynamic Changes in Biological Systems from Multi-platform Genomic Data
Committee Chair: Wang, Y.

Zhang, Bo
Supporting Software Transactional Memory in Distributed Systems: Protocols for Cache-Coherence, Conflict Resolution and Replication
Committee Chair: Ravindran, B.

Zhao, Zheng
High Efficiency Single-stage Grid-tied PV Inverter for Renewable Energy System
Committee Chair: Lai, J. S.

PATENTS AWARDED

"Efficient Outphasing Transmitter," T. Bose, X. Chen, and J. Reed.

"Optical Fiber Pressure and Acceleration Sensor Fabricated on a Fiber Endface," Y. Zhu, X. Wang, J. Xu, and A. Wang. (Canada)

"Intrinsic Fabry-Perot Optical Fiber Sensors and Their Multiplexing," A. Wang. (Canada)

"High Frequency Loss Measurement Apparatus and Methods for Inductors and Transformers," M. Mu and F. Lee.

"Switching Capacitor–PWM Power Converter," M. Xu, K. Jin, and F. Lee.

"Techniques for Forming Contacts to Quantum Well Transistors," R. Pillarisetty, B. Chu-Kung, M. Hudait, M. Radosavljevic, J. Kavalieros, W. Rachmady, N. Mukherjee, and R. Chau.

"Modulation-Doped Multi-Gate Devices," M. Hudait, R. Pillarisetty, M. Radosavljevic, G. Dewey, and J. Kavalieros.

"Semiconductor Heterostructures to Reduce Short Channel Effects," R. Pillarisetty, M. Hudait, M. Radosavljevic, G. Dewey, T. Rakshit, and R. Chau.

"Quantum Well MOSFET Channels Having Uni-Axial Strain Caused by Metal Source/Drains, and Conformal Regrowth Source/Drains," P. Majhi, M. Hudait, J. Kavalieros, R. Pillarisetty, M. Radosavljevic, G. Dewey, T. Rakshit, and W. Tsai.

"Apparatus and Methods for Improving Parallel Conduction in Quantum Well Device," R. Pillarisetty, M. Hudait, B.–Y. Jin, B. Chu-Kung, and R. Chau.

"High Hole Mobility P-Channel Ge Transistor Structure on Si Substrate," M. Hudait, S. Datta, J. Kavalieros, and P. Tolchinsky.

"Extreme High Mobility CMOS Logic," S. Datta, M. Hudait, M. Doczy, J. Kavalieros, M. Amlan, J. Brask, B.-Y. Jin, M. Metz, and R. Chau.

"Stacking Fault and Twin Blocking Barrier for Integrating III-V on Si," M. Hudait, M. Shaheen, L. Chow, P. Tolchinsky, J. Fastenau, D. Loubychev, and A. Liu.

"Double Quantum Well Structures for Transistors," R. Pillarisetty, M. Hudait, M. Radosavljevic, G. Dewey, T. Rakshit, and J. Kavalieros.

"High Hole Mobility Semiconductor Device," M. Hudait, S. Datta, R. Chau, and M. Radosavljevic.

"Tensile Strained NMOS Transistor Using Group III-N Source/Drain Regions," S. Datta, J. Brask, B.–Y. Jin, J. Kavalieros, and M. Hudait.

"Modulation-Doped Multi-Gate Devices," M. Hudait, R. Pillarisetty, M. Radosavljevic, G. Dewey, and J. Kavalieros.

"Modulation-Doped Halo in Quantum Well Field-Effect Transistors, Apparatus Made therewith, and Methods of Using Same," R. Pillarisetty, T. Rakshit, M. Hudait, M. Radosavljevic, G. Dewey, and B. Chu-Kung.

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

"Self-Aligned Replacement Metal Gate Process for QWFET Devices," M. Radosavljevic, B. Chu-Kung, M. Hudait, and R. Pillarisetty.

"Method, Controller, and Power Converter for Controlling a Single-Switch Based Switched Reluctance Machine," K. Ramu.

"Doppler Sensor for the Derivation of Torsional Slip, Friction and Related Parameters," C. Holton and M. Ahmadian.

"Motor Power Factor Correction Apparatus and Method," K. Ramu.

"System and Method for Controlling Four-Quadrant Operation of a Switched Reluctance Motor Drive Through a Single Controllable Switch," K. Ramu, K. Ha, and S.-Y. Park.

"Dual-Band Dual-Orthogonal-Polarization Antenna Element," A. Zaghloul and W. Dorsey.

"Perturbed Square Ring Slot Antenna with Reconfigurable Polarization," W. Dorsey and A. Zaghloul.

HONORS & ACHIEVEMENTS

FACULTY HONORS & AWARDS

Fred Lee was elected as an Academician of Academia Sinica, the highest academic honor in Taiwan. He received an award at the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON 2012) to recognize his position as a top-three engineering author, based on his research output and citation. Lee was also inducted into the Virginia Tech Faculty Entrepreneur Hall of Fame.

Jeffrey Reed received the 2012 Forum International Achievement Award from the Wireless Innovation Forum. He is a distinguished lecturer for the IEEE Vehicular Technology Society (LTS) and serves on the Idaho National Laboratory National and Homeland Security Strategic Advisory Committee.

Sandeep Shukla was named a distinguished scientist by the Association for Computing Machinery (ACM). He received a Junior Faculty Collaborative award from ICTAS to fund cooperative research with AOE's Mazen Farhood.

Tom Martin was a member of the team that won the 2012 Virginia Tech XCaliber Award for integrating technology in teaching and learning. He was also a member of a team that tied for first place in the Charles W. Steger Design Competition for ideas to aesthetically enhance the public spaces in the Virginia Tech Research Center–Arlington.

Saifur Rahman was honored with the Meritorious Service Award from the IEEE Power & Energy Society (PES), for which he serves as vice president. He also received the Divisional Professional Leadership Award from IEEE-USA for outstanding leadership efforts in the field of power and energy.

Michael Hsiao was named an IEEE Fellow for his contributions to the automatic test pattern generation of integrated circuits.

Sanjay Raman was named an IEEE Fellow for his leadership in adaptive microwave and millimeter-wave integrated circuits.

Leslie Pendleton was on a team that received the Best PIC V and Best Overall Paper awards at the 2012 American Society for Engineering Education (ASEE) Annual Conference & Exhibition. Her team was also awarded the Cooperative Education and Internship Association (CEIA) Ralph W. Tyler Award for Distinguished Research in the Field of Cooperative Education.

Scott Bailey's team received the NASA Group Achievement Award for the SDO/EVE Experiment in 2012.

Jules White received the Outstanding New Assistant Professor award from the College of Engineering.

Kwan-Jin Koh received a Junior Faculty Collaborative award from ICTAS to fund cooperative research with Dong Ha.

Chao Wang received a Junior Faculty Collaborative award from ICTAS to fund cooperative research with Michael Hsiao.

Patrick Schaumont was honored with the Dean's Award for Excellence in Teaching from the College of Engineering.

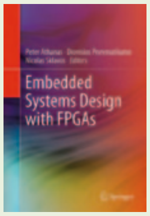
Kathleen Meehan was appointed as a strategic advocate for Analog Devices' ADI University Program.

Mary Taylor received the 2012 Virginia Tech Award for Excellence in Career Advising.

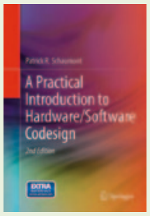
Richard Claus, professor emeritus, was inducted into the Virginia Tech Faculty Entrepreneur Hall of Fame.

Jaime De La Ree received a Certificate of Teaching Excellence from the College of Engineering.

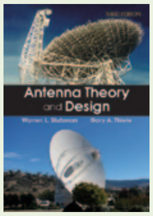
BOOKS PUBLISHED



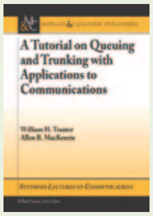
Peter Athanas was the co-editor of "Embedded Systems Design with FPGAs" (Springer, 2013).



Patrick Schaumont authored "A Practical Introduction to Hardware/Software Codesign," second edition (Springer, 2013).



Warren Stuztman authored "Antenna Theory and Design," third edition (Wiley 2013).



William Tranter and **Allen MacKenzie** wrote "A Tutorial on Queuing and Trunking with Applications to Communications" (Morgan & Claypool, 2012).

NATIONAL SERVICE

Jeffrey Reed served on the President's Council of Advisors on Science and Technology (PCAST) working group that issued recommendations for leveraging government-held spectrum to spur economic growth. He also serves on the Army Research Office Board of Visitors.

Charles Clancy is a member of the Virginia General Assembly's JCOST Cyber Security Panel.

Scott Bailey served as chair of the NASA Office of Space Science proposal review committee.

Sanjay Raman has been serving as a program manager for DARPA's Microsystems Technology Office.

Scott Midkiff is the chair of the advisory boards for the departments of electrical and computer engineering at Duke University and George Washington University.

Wayne Scales served as chairman of the Active Experiments and Dusty Space Plasma Sub-Commission Committee on Space Research Scientific Assembly.

Yue (Joseph) Wang is a member of the NIH Biodata Management and Analysis study section.

INTERNATIONAL SERVICE

Saifur Rahman is the chair of the NSF Advisory Committee for International Science and Engineering. He also serves on the program oversight committee for the National Academy of Sciences Partnerships for Enhanced Engagement in Research (PEER) program.

Fred Lee was an invited panelist for the Engineering and Physical Sciences Research Council's Underpinning Power Electronics Panel, United Kingdom, February 2013.

T.–C. Poon was named distinguished chair professor at Feng Chia University in Taiwan. He is an external academic advisor for the Department of Electronic Engineering at City University of Hong Kong. He was awarded the Visiting Professorship for Senior International Scientist of the Chinese Academy of Sciences (CAS), and for the High-End Foreign Experts Recruitment Program, both at Shanghai Institute of Optics and Fine Mechanics.

CONFERENCE CHAIRS

Peter Athanas served as co-chair of the International Conference on Reconfigurable Computing and FPGAs (ReConFig), Cancun, Mexico, December 2012.

Dushan Boroyevich served as co-chair of the International Power Electronics and Motion Control Conference and Exposition (EPE-PEMC 2012 ECCE Europe), Novi Sad, Serbia, September 2012.

Michael Buehrer was co-technical program chair for the 2013 Wireless Positioning and Networking Conference, Dresden, Germany, March 2013.

Rolando Burgos was technical program chair of IEEE ECCE 2012, Raleigh, North Carolina, September 2012.

Charles Clancy served as co-chair for the Securing the Mobile Frontier executive discussion hosted by the CGI Initiative for Collaborative Government and Virginia Tech. He was a local chair for the 2012 U.S. Cyber Challenge Summer Cyber Workshop.

Fred Lee was general chair of the International Power Electronics and Motion Control Conference- ECCE Asia (IPEMC 2012-ECCE Asia), Harbin, China, June 2012. **Dushan Boroyevich** was honorary chair at the conference.

Saifur Rahman was the general chair of the IEEE Innovative Smart Grid Technologies (ISGT) Conference, Washington, D.C., February 2013. He chaired the NSF U.S.-China Workshop: Identification of Challenges and Opportunities for Large Scale Deployment of the Smart Grid, Arlington, Virginia, February 2013.

Patrick Schaumont served as program co-chair for the International Association for Cryptographic Research Workshop on Cryptographic Hardware and Embedded Systems (CHES), Leuven, Belgium, September 2012.

Sandeep Shukla served as general chair for the ACM-IEEE International Conference on Formal Methods and Models for Codesign (MEMOCODE), Arlington, Virginia, July 2012. He was co-general chair for the Electronic System Level Synthesis Conference (ESL-syn), San Francisco, California, June 2012.

Joseph Tront was co-chair of the Workshop on the Impact of Pen & Touch Technology on Education, Los Angeles, California, March 2012.

Yue (Joseph) Wang served as the general chair of the IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS), Washington, D.C., December 2012.

EDITORSHIPS

Peter Athanas is a guest editor of a special issue of "Microprocessors and Microsystems: Embedded Hardware Design."

Scott Bailey was guest editor of the "Journal of Atmospheric and Solar-Terrestrial Physics" special issue on Layered Phenomenon in the Mesopause Region, 2012-2013

Michael Buehrer is an associate editor of "IEEE Transactions on Communications and IEEE Wireless Communications Letters."

Rolando Burgos is associate editor of "IEEE Transactions on Power Electronics and of IEEE Power Electronics Letters."

Michael Hsiao is an associate editor of "IEEE Transactions on Computers" and he serves on the editorial board for the "Journal of Electronic Testing." He served as an associate editor for "ACM Transactions on Design Automation of Electronic Systems" and on the editorial board for "IEEE Design & Test of Computers."

Mantu Hudait serves on the editorial advisory board of "Nanotechnology Reviews."

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

Jung-Min Park serves on the editorial board of the "Journal of Communications and Networks (JCN)."

T.–C. Poon is a division editor of "Applied Optics."

Saifur Rahman is editor-in-chief of "IEEE Electrification Magazine."

Charles Clancy is an associate editor for "IEEE Transactions on Information Forensics and Security."

Jeffrey Reed served on the "Proceedings of the IEEE" editorial board.

Patrick Schaumont is an associate editor of "IEEE Transactions on Computers," "ACM Transactions on Design Automation of Electronic Systems," and the "Journal of Cryptographic Engineering."

Sandeep Shukla served as an associate editor for "IEEE Transactions on Computers" and "IEEE Embedded Systems Letters." He is a member of the editorial boards for the "Computer Society of India Journal of Computing," the "ISRN Journal of Software Engineering," and "Nano Communication Networks." He was a guest editor for special issues of "IEEE Transactions on Computers."

Yue (Joseph) Wang is an associate editor for the "EURASIP Journal on Bioinformatics and Systems Biology." He is a member of the editorial boards for the "International Journal of Biomedical Imaging" and "Systems Biomedicine."

KEYNOTE ADDRESSES

Charles Bostian was a keynote speaker at the 2013 USNC-URSI National Radio Science Meeting.

Dushan Boroyevich gave a plenary speech at Future of Electronic Power Processing and Conversion 2012 (FEPPCON VII) and a keynote address at European Center for Power Electronics (ECPE) Workshop: Future Trends for Power Semiconductors.

Fred Lee gave plenary speeches at the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON 2012) and at the 2012 Applied Power Electronics Conference and Exposition (APEC).

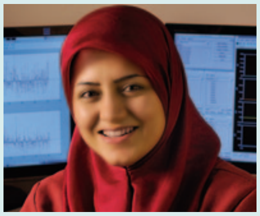
Fred Lee and **Qiang Li** gave a plenary speech at the Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME 2012).

Saifur Rahman gave keynote addresses at the 2012 IEEE International Conference on Emerging Technologies, the 2012 IEEE International Conference on Power and Energy (PECON), the 2012 Saudi Technical Exchange Meeting (STEM), and the 2013 IEEE Power & Energy Society Conference on Innovative Smart Grid Technologies, Latin America (ISGT-LA).

Jeffrey Reed gave a keynote speech at the 2013 Wireless Innovation Forum Conference on Wireless Communications Technologies and Software Defined Radio (SDR-WInnComm).

TENURE & PROMOTION

Michael Buehrer was promoted to professor.



Leyla Nazhandali was tenured and promoted to associate professor.

Dan Stilwell was promoted to professor.

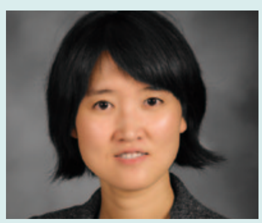
William Davis was named professor emeritus.

Binoy Ravindran was promoted to professor.

Jason Xuan was tenured as an associate professor.

Thomas Hou was promoted to professor.

Sandeep Shukla was promoted to professor.



Yaling Yang was tenured and promoted to associate professor.

BUILDING RENAMED

Virginia Tech renamed the headquarters building of its Institute for Critical Technology and Applied Science (ICTAS) to honor Hugh Kelly (BSEE '37, MSEE '38) and his wife Ethel.

STUDENT AWARDS

Reza Arghandeh (Ph.D. student) won the best student paper award at the 20th International Conference on Nuclear Engineering (ICONE), Anaheim, California, August 2012.

Lisa Durbeck (Ph.D. student) was awarded a National Defense Science and Engineering Graduate (NDSEG) Fellowship, which supports doctoral candidates pursuing degrees in science and engineering disciplines of military importance. She also received a P.E.O Scholar Award (Philanthropic Educational Organization), a merit-based scholarship for women pursuing doctoral degrees.

Darius Emrani (CPE '13) competed as one of 25 finalists (out of 600) at the Go Green in the City competition, Paris, France, June 2012.

Jason Forsyth (Ph.D. student) received the best paper award for 2012 from IEEE Transactions on Automation Science and Engineering.

Adelaja Arojuraye (Ph.D. Student) and **Patrick Goley** (BSEE '13) were awarded National Science Foundation Graduate Research Fellowship Program Fellowships. Goley also received the Aspire! Award for curiosity from Virginia Tech's Division of Student Affairs.

An ECE team received the best presentation award at the International Conference on Future Computing and Communication, Hong Kong, August 2012. **Daniel Guymon** (BSEE '10, MSEE '12) was the first author and **Alan Baines** (BSEE '10, Ph.D. student) presented.

Alireza Mahmoudian received ECE's 2012 Blackwell Award for the best research paper by a graduate student. He developed a radar technique for measuring aerosol density in space. He also received the NSF Coupling, Energetics, Dynamics of Atmospheric Regions (CEDAR) Conference Presentation Award.

Alexandru Turcu (Ph.D. student) won the best student paper award at the International Systems and Storage Conference (SYSTOR), Haifa, Israel, June 2012.

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Franklin County High School Class of 1965
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When you hear from The College Annual Fund this fall, designate your gift to ECE.

Although every effort has been made to ensure the accuracy of this report, we acknowledge that errors may have occurred. If your name was omitted or listed incorrectly, please accept our sincere apologies and send corrections to the Office of University Development at (540) 231-2801, or contact: www.givingto.vt.edu/Contact/contact-form.

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Colorado State '79

Dushan Boroyevich
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Gary S. Brown
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R. Michael Buehrer
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Concepcion '02

Virgilio Centeno
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