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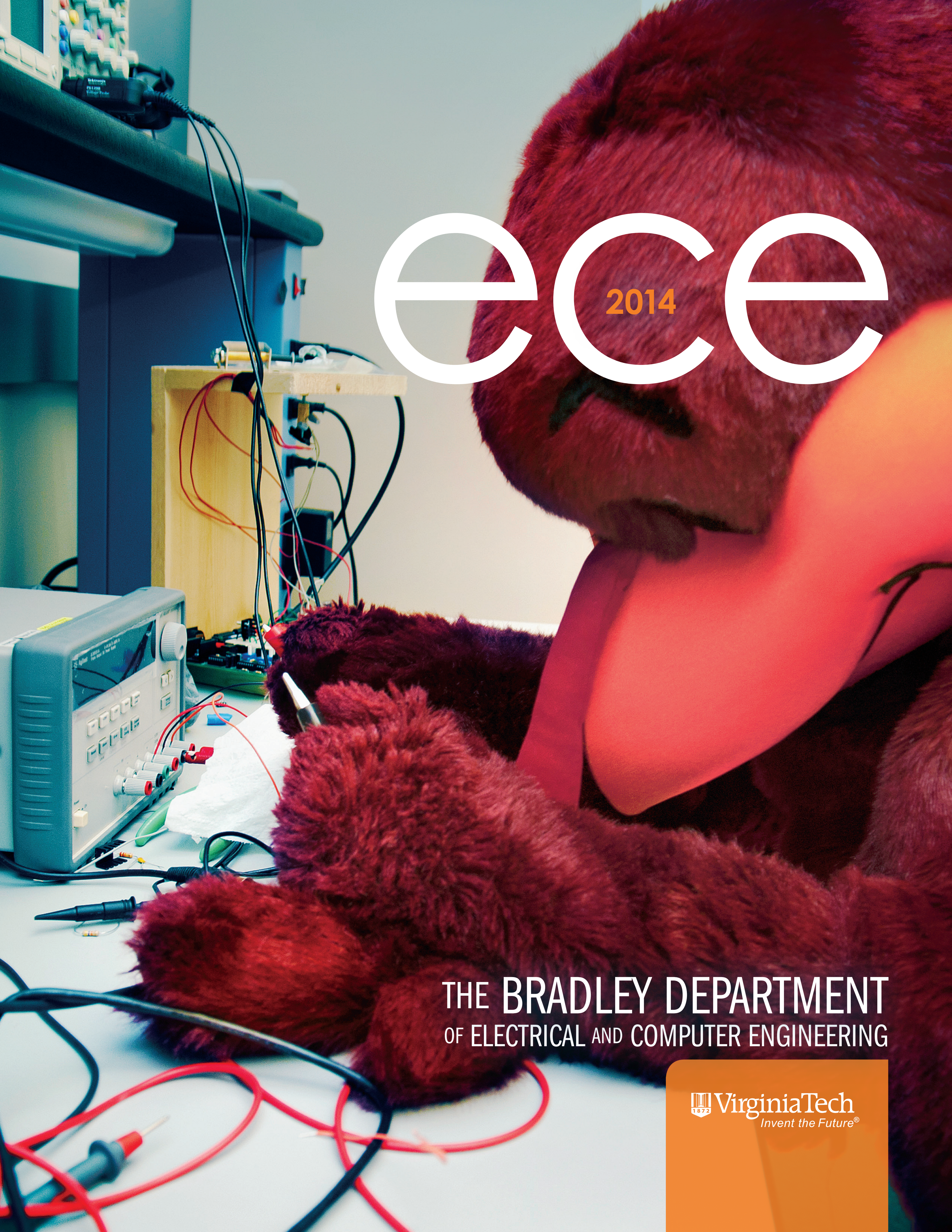
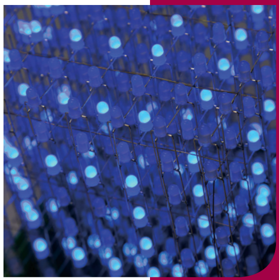
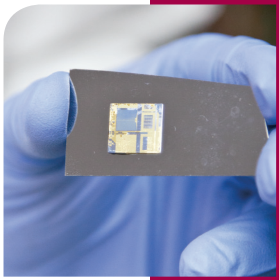
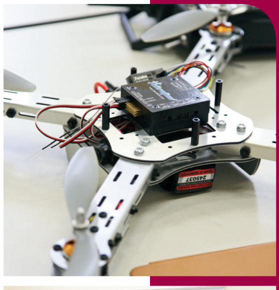
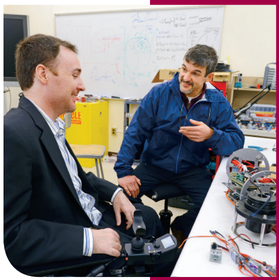


THE BRADLEY DEPARTMENT
OF ELECTRICAL AND COMPUTER ENGINEERING

Virginia Tech
Invent the Future®

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from the ece DEPARTMENT HEAD

IT IS A DISTINCT PLEASURE to greet you as the new department head of the Bradley Department of Electrical and Computer Engineering. In the brief time that I have been at Virginia Tech, I have come to know a dedicated group of faculty, staff, and students that includes some of the best and brightest minds in research and education in the country. This tradition of excellence is reflected in the university's commitment to expand the faculty ranks across the College of Engineering by 12.5 percent in the next several years. Students around the country recognize the prestige of a Virginia Tech engineering degree by applying in record numbers. Undergraduate applications to the college have increased by more than 1,000, which represents a 13.5 percent increase in a single year.

LUKE LESTER, ECE's new department head, made fast friends with the HokieBird when he joined the Virginia Tech faculty. Lester is committed to sharing his passion for ECE with students and faculty alike. "ECE should be fun!" he says.

Within our own department, this past year has been an exciting one for achievements and milestones by our faculty. We have graduated our largest number of Ph.D. students ever at 52 and surpassed the $32 million mark in research expenditures. Four new Fellows of professional societies have been added to our faculty ranks, including Sandeep Shukla (IEEE), Thomas Hou (IEEE), Luke Lester (IEEE, SPIE), and the new president of Virginia Tech, Timothy Sands (IEEE, Materials Research Society). We are particularly proud to count Dr. Sands among the ECE faculty ranks (p. 4) as he brings a wealth of experience in research and academic administration and a deep technical knowledge in nanotechnology and heterogeneous integration.

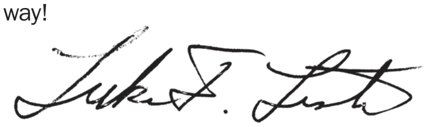
Dushan Boroyevich of the Center for Power Electronics Systems was elected this year to the National Academy of Engineering (NAE) for advancements in control, modeling, and design of electronic power conversion for electric energy and transportation (p. 7). We are very proud that one of our most distinguished faculty members has been recognized with this prestigious honor. Dushan has been and continues to be a role model for faculty and students at Virginia Tech. The impact of his research, graduate student advisement, and professional service in the field of power electronics has been profound. In winning this award, Dushan joins three other members of the ECE family who are members of the NAE: his former Ph.D. advisor, Fred Lee, Professor Emeritus Arun Phadke, and Professor Emeritus and former Department Head Jim Thorp.

There is good news to report on the rankings front. U.S. News & World Report has ranked Virginia Tech's online Master of Information Technology program, which is co-administered by ECE, the department of Computer Science, and the Pamplin College of Business, at second in the country, which is up from third last year. Our undergraduate ECE program continues to be ranked at a very solid 15th in the country. Our graduate programs in electrical engineering and computer engineering are now at the 27th position. Although this level is below our all-time best from last year, we expect to be back on top next year given the substantial successes in recruitment and research recognition.

One of my goals when I came to Virginia Tech was to initiate a two-semester senior design experience that would teach team building and project leadership skills while immersing students in a technical project that is sponsored primarily by industry. It is my belief that the two-semester format not only lets students take on more challenging projects, but also permits them to pursue their passion and have FUN! In the midst of all the required courses, time-consuming homework and rigorous exams, it is important that we allow engineering students ample opportunity to pursue their creative side and stay inspired. After pitching this idea to the ECE Industrial Advisory Board in September 2013, the response has been very positive. Combining the mentoring and equipment resources of the department with the financial and technical expertise of the loyal ECE alumni in various companies, we are ready to launch the two-semester senior design sequence in fall 2014 with about 20 team projects. In fact, this kind of capstone design experience is really not new, but in a department with a graduating class approaching 200 or more, the logistics of organizing this course can appear daunting at first. I am pleased to inform you that ECE has hired a new professor of practice with the express purpose of having him run the new two-semester course. Gino Manzo, who recently retired from BAE Systems with more than 38 years of experience and was on the ECE Industrial Advisory Board for several years, will fill this role. Welcome, Gino!

In the midst of all the required courses, time-consuming homework and rigorous exams, it is important that we allow engineering students ample opportunity to pursue their creative side and stay inspired.

In the following pages you will meet the students, faculty, and alumni who conduct cutting edge research in electronics (p. 12) and nanotechnology (p. 14), solve challenging design problems (p. 19 and 28), and serve as inspiring role models (p. 7 and p. 10) for the next generation of outstanding electrical and computer engineers and devoted Hokies. I think that you will agree with me that our department is serving the Commonwealth of Virginia and the whole nation in an exemplary way!



Luke Lester
Department Head

from the Chair

of the ADVISORY BOARD

ON BEHALF OF THE ADVISORY BOARD of the Bradley Department of Electrical and Computer Engineering at Virginia Tech, I thank you for your interest in and generous support for the department's many activities. As you will see in this year's annual report, it is a fun and exciting time for ECE at Virginia Tech.

This year we are very pleased to welcome Luke Lester as head of the department. Luke brings a wealth of academic and entrepreneurial experience, as well as remarkable energy and enthusiasm for the profession. The advisory board was able to interact with him even before his first day on the job, as he participated remotely in our spring 2013 advisory board meeting from New Mexico. From the beginning, we knew that ECE would be in excellent hands, and that was reinforced when we met him at our fall 2013 meeting in Blacksburg. We want to sincerely thank Dr. Paul Plassmann for his willingness to take on additional duties serving as interim head during the search and wish him continued success in his endeavors.

We are also thrilled to learn that the incoming president of Virginia Tech, Timothy Sands, is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and that his tenure will be transferred into the ECE department. We welcome Dr. Sands and his wife, Laura, to the university and look forward to working with him and Richard Benson, the dean of the College of Engineering, to continue strengthening the programs and reputation of the department.

After a year of reduced activity during the department head search, the advisory board is excited to support the newly approved two-semester Senior Design Capstone Course that will be led by a man who is very familiar to the advisory board. Gino Manzo is a former advisory board chair that has joined the ECE Department to run this promising new program for ECE seniors that is described in this report. At this point, nearly all companies represented by the advisory board have pledged some level of support by providing one or more project ideas, subject matter expertise, and/or financial resources. This new program was conceived by Luke and quickly embraced by the board. We all look forward to the interactions with the students as they work in small teams on our real-world problems, building on their strong knowledge base to prepare them for a quick start in their future careers—hopefully with one of our companies!

As I close my second and final year as chair, I want to thank my colleagues on the advisory board for their active participation over the years. They are a truly exceptional group that I know will continue to support the department in the exciting times that lay ahead. I also want to thank the faculty and staff in the department for their continued excellence in teaching and research, which prepares Virginia Tech ECE students to quickly become outstanding and productive members of our profession.

I hope you enjoy reading about the wide array of projects featured in this year's report, and that it will trigger some new level of interest in the department. Whether you are a prospective student, proud alum, corporate partner, or simply interested in this world-class teaching and research organization, I believe you will find many amazing things in the pages that follow.

Warm Regards,

Michael Newkirk

Michael Newkirk, Ph.D. ('94)
Chair, ECE Advisory board

Michael Newkirk
Chair, ECE Advisory Board

Sands to join ece

TIM SANDS meets with graduate students at his office at Purdue University, as he prepares to join Virginia Tech as its 16th president.

WHEN VIRGINIA TECH'S NEXT PRESIDENT is installed in June, he will join the Bradley Department of Electrical and Computer Engineering as a tenured professor. Timothy Sands, a leader in higher education and interdisciplinary research, is also an expert in microelectronics, optoelectronics, and nanotechnology.

While Sands has served as executive vice president for academic affairs and provost of Purdue University since 2010—with a six-month stint as interim president—he spent most of his career as an engineer, first in industry, then as a professor at the University of California, Berkeley and at Purdue. His research in nanomaterials and devices has advanced the fields of solid-state lighting, thermoelectric energy conversion, and semiconductor processing. Among other advances, Sands co-invented a process used throughout the world today in the manufacture of high-performance green and blue LEDs.

He has been the lead on research grants totaling more than $4 million from sponsors including the National Science Foundation (NSF), Office of Naval Research (ONR), IBM, and NASA. He has published more than 260 refereed journal and conference papers and holds 16 U.S. patents

Sands is a Fellow of the IEEE and the Materials Research Society (MRS) and in 2012 was elected to the National Academy of Inventors as a Charter Fellow. According to his nanoHUB profile, his most significant scientific and technical contributions include i) the understanding of the interface reactions leading to low-resistance, shallow, and thermally stable ohmic contacts to compound semiconductors; ii) demonstration of the first stable and epitaxial metal/III-V heterostructures; iii) transfer of the laser lift-off process for GaN LED packaging to industry; and iv) leadership of the team that fabricated the first monolithic fluorescence detection microsystems.

Sands grew up in the San Francisco Bay area and went to what he considered his local public university, UC Berkeley. "It was 30 miles away, and it was $212 a quarter, and that made it feasible for me," he said. He started in civil engineering because he had always enjoyed building things, but was so engaged by his physics and mathematics courses that he earned a B.S. with highest honors in engineering physics in 1980.

Tim Sands' **ROAD** to **VIRGINIA TECH**

1980

B.S. Engineering Physics, University of California, Berkeley. Highest honors.

"I had a gut feeling that working with students would be the difference and that they would change my outlook on the value of what I was doing."

He credited an undergraduate research experience with starting him on a career in research. "I was just running punch cards through a computer to optimize an RC circuit in a particle detector," Sands recalled. "I didn't really understand what I was doing. But I got to interact with scientists from Berkeley, and scientists from CERN in Switzerland. I met all sorts of really exciting people who were both good with their hands—they could build anything—but they were working on the most fundamental questions in science. That really made me reflect on the idea that maybe I would like to do scientific research, and that stuck with me."

The oil embargo of the mid 1970s triggered an interest in photovoltaics and solar cells and using technology to solve some of society's biggest problems. Immediately after earning his bachelor's degree, Sands spent a summer at the Solar Energy Research Institute (SERI), now called the National Renewable Energy Laboratory (NREL) at Golden, Colo. He then returned to Berkeley and earned his M.S. and Ph.D. in materials science in 1981 and 1984, respectively.

He completed a postdoctoral fellowship in the Materials and Molecular Research Division of Lawrence Berkeley Laboratory, then took an industrial research position with Bell Communications Research (Bellcore, now Telcordia Technologies) in Red Bank, N.J. This was during the divestiture of AT&T, when Bellcore was split off from Bell Laboratories to provide the research and development services for the local exchange carriers. "I had planned to be an academic," Sands said. But, when he met the team at Bellcore, "I was overwhelmed by their collaborative spirit and high aspirations for their work." So, he joined them.

Sands worked at Bellcore for nine years, as a member of the technical staff, then director of the Thin Films and Interface Science Research Group, and later, director of the Nonvolatile Memory Research Group. In 1993, Sands returned to Berkeley as a professor in the Department of Materials Science and Engineering. "I loved industrial research, but felt that something was missing," he said. "I had a gut feeling that working with students would be the difference and that they would change my outlook on the value of what I was doing."

His experience at Berkeley proved his instinct correct, he said. "With students, it's an investment for a lifetime." Ph.D. students "become part of your academic family."

While at Berkeley, he taught classes in bonding, crystallography and crystal defects, semiconductor processing, and crystal structure and bonding. He also developed a new freshman seminar called "The Disk Drive: Microcosm of Engineering," and senior-level and graduate-level courses in thin-film materials science. He conducted research in thin films and nanotechnology. It was at Berkeley that he co-invented the laser lift-off process for fabricating InGaN LED membranes.

In 2001, Sands served as a visiting professor at the Interuniversity Microelectronics Center and

PURDUE NEWS SERVICE PHOTO/DAVID UMBERGER

TIM SANDS served as director of the Birck Nanotechnology Center at Purdue, working with researchers from a dozen different disciplines.

1980
Intern at the Solar Energy Research Institute (SERI), now the National Renewable Energy Laboratory (NREL).

1981
M.S. Materials Science, University of California, Berkeley.

1984
Ph.D. Materials Science, University of California, Berkeley.

1984
Member of the Technical Staff, Bellcore, Red Bank, N.J.

1993
Professor, Department of Materials Science and Engineering, University of California, Berkeley.

TIM SANDS is an expert in microelectronics, optoelectronics, and nanotechnology. He co-invented a process used worldwide to manufacture high-performance green and blue LEDs.

Faculty of Engineering at Katholieke Universiteit in Leuven, Belgium. On his return to Berkeley, he became the director of the Integrated Materials Laboratory.

In 2002, he accepted a named university professorship at Purdue University. He was the Basil S. Turner Professor of Engineering with a joint appointment in the School of Materials Engineering and the School of Electrical & Computer Engineering. He told a local reporter at the time that part of the attraction was Purdue's Discovery Park, which had been founded the previous year. Discovery Park is Purdue's hub for interdisciplinary and translational research, conceived as a place where scholars from all disciplines could work together to define whole new areas of research and solve grand challenges. In 2006 Sands was named the Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center, one of Discovery Park's six core centers that brings together researchers from a dozen different disciplines.

Materials engineering is inherently interdisciplinary. In a July 2006 presentation for the Nanotechnology Center for Learning and Teaching, Sands described the explosion of advances in nanotechnology as a result of "chemists, physicists, and engineers working elbow-to-elbow." Nanotechnology had a steep slope of change, he said.

While at Purdue, Sands taught courses in materials in electronic devices and thin films and coatings. He also developed courses in nanofabrication and materials and devices, for solid-state energy conversion. Remembering the impact of his own undergraduate research experience, he mentored 30 undergraduates in research projects at Purdue.

His interest in working on big issues, such as energy use, has not waned. His most recent research has focused on developing novel nanocomposite materials for environmentally friendly and cost-effective solid-state lights, direct conversion of heat to electrical power, and thermoelectric refrigeration. In October 2012, he called it, "the next solid state revolution," in a research focus piece on Purdue's materials engineering website. "Several nascent solid-state technologies, born in the 1950s, are now poised to uproot such stalwarts as the light bulb and the compressor-based refrigerator," he wrote. Even more intriguing, he said, were the new applications such as energy scavenging for distributed sensor networks, electrical power generation from waste heat in automobile exhaust, and permanently embedded architectural lighting.

The obstacles to implementing these solid-state technologies are efficiency and manufacturing cost. "Efficiency improvement by a factor of two or three must start from breakthroughs in materials," Sands said, with nanocomposites offering the greatest opportunity.

At a Virginia Tech press conference last December, Sands described how researchers often divide into those following their curiosity and those seeking to improve society. The faculty, staff, and students at Virginia Tech, he said, present the ideal mix that resonates with his values and experience. Virginia Tech has faculty members and students who follow their curiosity, but recognize when it has value to society and don't just "throw it over the wall," but nurture it to bring it to its potential, he explained. ■

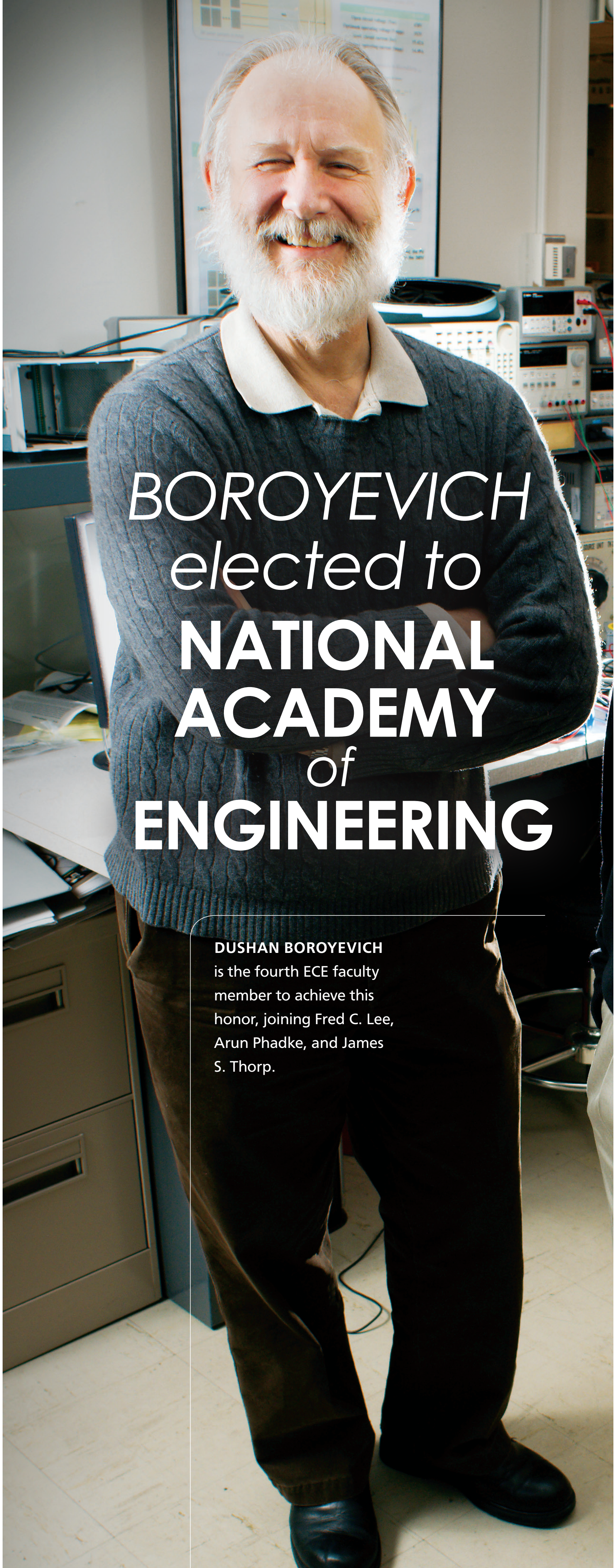
2001
Visiting Professor, Interuniversity Microelectronics Center and Faculty of Engineering, Katholieke Universiteit Leuven, Belgium.

2002
Basil S. Turner Professor of Engineering, School of Materials Engineering and School of ECE, Purdue University.

2010
Executive Vice President for Academic Affairs and Provost, Purdue University.

2012
Interim President, Purdue University.
Elected to National Academy of Inventors.

2014
Appointed president of Virginia Tech and tenured faculty member of ECE.



DUSHAN BOROYEVICH is the fourth ECE faculty member to achieve this honor, joining Fred C. Lee, Arun Phadke, and James S. Thorp.

DUSHAN Boroyevich, the American Electric Power Professor of Electrical and Computer Engineering, has been elected to the National Academy of Engineering.

Election to the National Academy of Engineering is among the highest professional distinctions awarded to engineers. Inductees are honored for contributions to research, practice, or education, and for developing new fields of technology and other major advancements in the field of engineering. There are a total 2,250 U.S. members of the academy.

"I am honored and humbled," Boroyevich says of his election to the academy. He believes that the distinction is a tribute to Virginia Tech, the College of Engineering, the Department of Electrical and Computer Engineering, and his mentors. This country and the Virginia Tech community, he says, were welcoming and supportive, "when I came from some 'god forsaken' country (Yugoslavia) to study for a Ph.D. under Fred Lee's supervision and again, when I came back from the 'war-riven' country to become a professor."

POWER CONDITIONING
FOR SYSTEMS ON THE MOVE

ENGINEERS USE POWER electronics technology to convert electricity between ac and dc, and to change the voltage and frequency as needed for applications ranging from milliwatt consumer electronic devices to gigawatt systems. Dushan Boroyevich has spent most of his career at the larger end of the spectrum, predominantly working with autonomous electric power systems in airplanes, automobiles, ships, and trains.

Transportation systems must carry their power sources and fuel wherever they go, so manufacturers are constantly seeking ways to improve efficiency and reliability. This leads to reduced need for redundancy, lighter loads, less fuel consumption and ulti-

A RESEARCH POWER

Electronic power conversion expert

Boroyevich, co-director of the Center for Power Electronics Systems (CPES), is being honored for his contributions in control, modeling, and design of electronic power conversion for electric energy and transportation. His research has focused on multi-phase power conversion, electronic power distribution systems, modeling and control, and design optimization. His comprehensive geometric approach to modeling and control of high-frequency switching power converters is now widely used for power conversion systems.

Research productivity

He has advised more than 84 doctoral and master's students at Virginia Tech, and co-authored with them over 650 technical publications. He has participated in 100+ sponsored research projects at Virginia Tech with his share of funding exceeding $16 million.

Honors and awards

Boroyevich is an IEEE Fellow, a recipient of the William E. Newell Power Electronics Technical Field Award, and a past President of the Power Electronics Society. He received the Award for Outstanding Achievements and Service to Profession from the European Power Electronics and Motion Control Council, six prize paper awards, and several research and teaching awards.

Academic background

Boroyevich received his bachelor's degree from the University of Belgrade in 1976 and an MSEE from the University of Novi Sad in 1982, both in the former country of Yugoslavia, now Serbia. From 1976 to 1982, he was an instructor at Novi Sad, working to establish its electronics program. He came to Virginia Tech for his Ph.D. in EE, studying with Fred Lee, under a General Electric fellowship. In 1986, he returned to Novi Sad as an assistant professor and founded the university's power and industrial electronics program.

A Virginia Tech professor

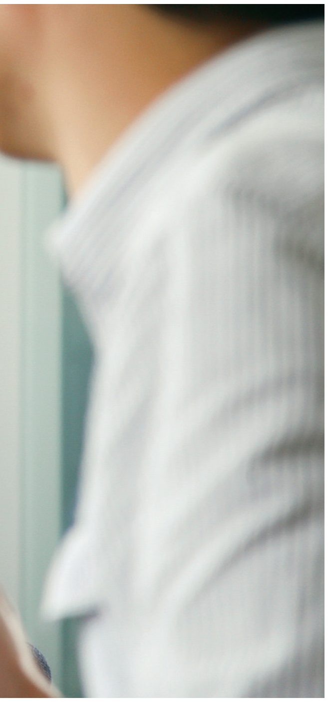
In 1990, he returned to Virginia Tech as an associate professor, working with Lee in the Virginia Power Electronics Center (VPEC). In 1998, Lee, Boroyevich, and faculty from Virginia Tech, the University of Wisconsin-Madison, Rensselaer Polytechnic Institute, University of Puerto Rico-Mayaguez, and North Carolina A&T State University formed the Center for Power Electronics Systems (CPES), the first NSF engineering research center in the area of power electronics.

DUSHAN Boroyevich does his best thinking when consulting with students. "When we sit down and brainstorm and discuss things over and over, new things happen," he says. "I'm most creative and productive when interacting with others." Learning and creativity are fundamentally an emotional human sharing experience, he says, and that philosophy permeates his teaching and research at every level.

mately, lower costs and lower environmental impact. At the same time, passenger demands have increased, particularly regarding power for multiple devices and much higher comfort expectations.

As a result, the past few decades have seen an explosion in the complexity of the autonomous power systems. "In the past, ships and planes had electro-mechanical switches to direct the electricity from the sources, down the cables, to the energy-consuming devices (loads). But today's distributed systems have many sources and many different load requirements—each one requiring a power electronic converter to optimize its own performance and efficiency," says Boroyevich. "Recently, there has been a growing focus on also optimizing the power distribution system between the sources and loads by reducing the size and weight of the wiring and eliminating the electro-mechanical switchgear. That's where much of my work has been," he adds. By optimizing the whole power system, less wiring is required, reducing still more bulk and weight while increasing the system energy efficiency.

Boroyevich has concentrated most of his research on power electronics system control and power density. The control problems relate to the interactions between the power converters that control the flow of electricity. "How do all these converters work



"When we sit down and brainstorm and discuss things over and over, new things happen."

with each other?" he asks. "You have the converters optimizing the sources and loads and the converters optimizing the use of the wires. These are all 'electronic boxes' and they all think they are smart." Problems can arise when a "smart" converter shuts down the whole power system because of a local variance. Another big issue is that these electronic boxes operate internally at high frequencies, which inadvertently generate signals that may propagate through the power system, and can cause each other to malfunction due to (electromagnetic interference—EMI).

Power density is also a big factor in mobile power electronics systems. Any change made to a system must weigh less than what it's replacing, according to Boroyevich, who first got involved in power converter packaging in the mid 1990s. "With power electronics, the whole system can be smaller if we design it properly, in an integrated way," he says. "The challenge is how do we make the converters as small as possible without sacrificing reliability, efficiency, and manufacturability?"

The answers rely on continuous collaboration with mechanical engineers and materials scientists. It's an ongoing challenge, he says.

Boroyevich enjoys working on the tough interdisciplinary problems and working in a research group that tackles such broad applications as does CPES. Other research teams in the center work on lower power applications like cell phones, computers, data centers and consumer electronics, while still others work on the underlying basic technologies such as circuits, components, and their integration. The different perspectives are beneficial, he says. "Our ideas and approaches are similar, but our constraints differ."

Another difference is that high-power applications traditionally evolved from ac power sources, whereas many low-power applications are dc-based. The growing integration of power electronics technology has enabled ac and dc to be used for best efficiency instead of being determined by the source. "This whole question of Tesla *vs.* Edison and who won is of no practical significance today," Boroyevich says. "They were both correct." And now the technology exists to use both forms to their best advantage, he says, by using high-frequency ac within converters and dc for interconnecting them.

Generating and using electricity as sustainably as possible is critical, according to Boroyevich. "I believe that energy is the next big challenge for humanity." He says that electricity is the cleanest, most environmentally friendly, and least-prone-to-disaster form of energy for distribution and consumption, but that today's 100-year-old power grid technology is not up to the task. Today's autonomous power systems, especially planes, cars, ships, and trains, can serve as a guide for national energy grids and larger systems, he says.

"Why would we think our power grid will be the same in 50 years as it is today? We have shown in transportation that we can throw out 150 years of railroad technology in favor of the individualistic automobile." Perhaps we will be just as bold with energy production and transmission.

For the **LOVE** *of* **ROBOTS**

Ryan Williams
CPE '05

RYAN WILLIAMS (CPE '05) always knew that he wanted to study engineering. "From a young age, I was always creating things, building things," he recalls. "I think it's embedded in my personality. I just like solving problems."

The Roanoke native will earn his Ph.D. in EE this summer from the University of Southern California (USC), where he is focusing on autonomous robotics.

Williams' interest in robotics developed during his senior year in ECE, when he was offered the opportunity to work with Professor Daniel Stilwell as an undergraduate researcher in the Autonomous Systems and Controls Laboratory (ASCL).

Williams worked on a prototype for an autonomous underwater vehicle (AUV), helping to design the craft's inertial measurement unit (IMU), which collects the data for steering. He gained experience testing the prototype in the lab and in the field, and completed an undergraduate thesis on AUV navigation.

Shortly before his graduation, ASCL was awarded a grant from the Navy to build the world's first high-speed AUV. Williams decided to stay on for a year as a research engineer to lead circuit-board design and software-development efforts.

THIS SPRING, Williams gave an ECE graduate seminar on his research in robotic control.

In 2006, Williams received a fellowship to continue his studies as a doctoral student at USC's Robotic Embedded Systems Laboratory. In his free time, he enjoyed exploring his new West Coast home. The former high school athlete was smitten with the California mentality and quickly took up golfing, swimming, and surfing.

But on Jan. 27, 2008, his active lifestyle ended with a life-changing accident. While surfing, Williams was launched headfirst by a wave into a hidden sandbar. He sustained a broken neck that rendered him paralyzed in all four limbs.

Williams returned home to Roanoke and embarked on two grueling years of rehab, while continuing his education through USC's distance education program. He suspended his research and took one class per semester during his recovery.

"It was obviously a catastrophic injury," says Williams, "but you don't really realize the impact it has on your body. It impacts all of your body's systems. It makes you sick and tired. I was physically ill for a long time."

Adjusting to his new normal was physically and mentally trying. "I have no hand function at all," explains Williams. "I have a cuff that I wear on my right hand with a pencil. I can type at 20-30 words per minute. It's very difficult, still to this day."

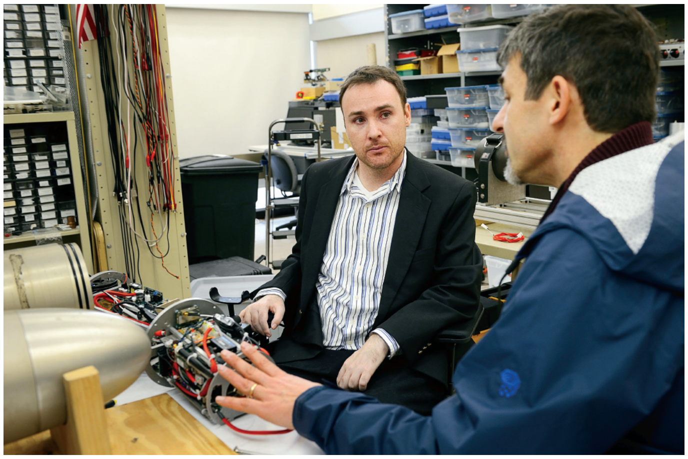
Coordinating **leaderless** teams

IMAGINE A TEAM with no leader and how critical communication becomes. Every team member must communicate with every other member or the team risks failure. Ryan Williams works with leaderless teams like this, except that his teams are robots. He works on controlling teams of fully-autonomous mobile robots that have no central controller. "Decentralization makes it significantly more difficult," according to Williams. "You have to really diffuse information in the network."

Williams has created control algorithms that can guarantee useful behaviors from teams of robots by ensuring that all robots can communicate with each other, even when their physical locations impede communication. It's simpler if every robot can communicate directly with every other robot, he explains, but his research focuses on the cases when some robots might be cut off from communicating with some robotic teammates. Using his algorithms, some communications may need multiple hops, but ultimately "every robot can communicate with every other robot," he says. Adding complexity, Williams is also working with heterogeneous interaction: when two kinds of robots (mobile robot and static nodes) need to communicate. "We've also recently started to consider cases when the robots are different in how they move or communicate," he says.

One primary task for the robot teams is moving in a rigid formation. "If they are rigid, they can hold a load," he explains. "If they can fly in formation, they can do everything." It's not as simple as just moving robots together, however. Williams' robots must change formations as they work. "Formation and shape control is a means of cohesive and persistent motion for a team." he explains.

Williams' work can apply to any multi-robot system, whether underwater, in the air, or on the ground. "Most roboticists concentrate on really cool stuff for single robots," he says. "I concentrate on what happens when you take robots that do cool things by themselves and put them together."



WILLIAMS SAYS his time working with Daniel Stilwell was "one of the most rewarding and influential periods of my life."

"I used to love to write, especially mathematical work. I would think via paper. When you can't move ideas from your brain to a form of reality easily, it makes things exponentially harder. I had to learn to solve many problems in my head. When I'm at my desk, I'm just sitting there. I just think and think and think."

But even during his most challenging days, Williams never considered discontinuing his education. "Dropping out was not an option," he says. "Giving up does not compute."

Williams persevered, one class at a time, for three years until the completion of his coursework. He resumed research in 2011, switching his concentration from underwater robots to multi-agent coordination and control.

He has published 11 conference and journal articles and he has attended the IEEE International Conference on Robotics and Automation and the IEEE/RSJ International Conference on Intelligent Robots and Systems multiple times.

This spring, Williams returned to ECE to deliver a graduate seminar on interaction and topology in multi-agent coordination. It was a happy homecoming for Williams, who still keeps in touch with Stilwell and regards his time at Virginia Tech as "one of the most rewarding and influential periods of my life."

Postgraduation, Williams hopes to secure a professorship and continue his line of research. "There are a lot of problems that remain unsolved," he says. "What's going to turn the tide is when robots can reliably aid society—without human intervention." ■

OUTGROWING SILICON

STEP BY STEP AT THE ATOMIC LEVEL

YAN ZHU WORKS inside the hood (below and opposite), where he prepares the substrates for chips like the one shown above.

MANTU HUDAIT, an associate professor of ECE, and his research team at the Advanced Devices & Sustainable Energy Laboratory (ADSEL) are growing the next advances in transistor and solar technology. They are working at the atomic level to heterogeneously integrate different materials on low-cost silicon substrate.

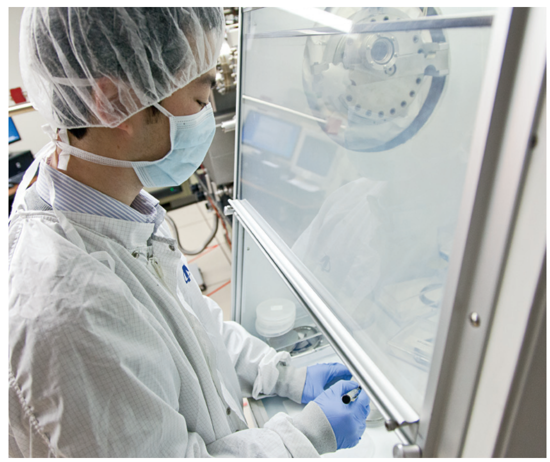
Their goal is to take advantage of the low cost and manufacturability of silicon, while extending its speed, power, and efficiency. Ultimately, they want to make computing devices faster and reduce power needs as well as improve the efficiency and affordability of solar cells.

The researchers include Ph.D. students Nikhil Jain and Yan Zhu, master's students Patrick Goley and Michael Clavel, undergraduate researcher Peter Nguyen. Souvik Kundu, a post-doctoral researcher, recently joined the group.

Faster Computers

A project that interests most computer users is creating faster microprocessors. Hudait explains that today's technology has nearly reached the full potential of silicon, and that other options must be explored. The most cost-effective options should still be able to make use of the extensive knowledge base in place for silicon. "If we want to continue to increase performance at the same rate, there's no clear way to continue to do it with silicon," he says. "We will need to switch to new channel materials."

Two of the materials the group is working with are germanium (Ge) and indium gallium arsenide (InGaAs). These materials have higher carrier mobilities, which give them the potential for faster speeds. However, there are challenges and disadvantages that go along with this: higher cost and a problematic chemical reaction with the oxide layer.



First, the cost of Ge and GaAs is significantly higher than that of silicon. To take advantage of silicon's research base and lower cost, the group is using thin layers of germanium layered on top of a "virtual" silicon base. The problem with this, explains Zhu, is that the crystalline structure has a different spacing between the atoms of the two materials. When germanium is grown on top of the silicon, it tries to adapt to silicon's spacing, causing flaws in the chip.

Second, germanium doesn't play as well as silicon with the necessary oxide layer. The oxide layer forms a dielectric that separates the gate from the channel in a transistor. According to Goley, "silicon dioxide gives you a nearly perfect interface between the oxide and the silicon channel. Doing that with

"If we want to continue to increase performance at the same rate, we need to switch to a new material."

germanium is much more complicated. Germanium likes to interdiffuse with oxide layers, which creates more charge imbalance, leading to more scattering," Goley says, thus decreasing carrier mobility. "We're going through all this trouble to change to germanium, and by the time you put the oxide layer on, the channel mobility has been degraded to the level of silicon," asserts Goley.

The team is currently working on solutions to the Ge interface problem. "Starting with a very thin layer of thermally grown germanium oxide," Clavel explains, "we preserve the quality of the interface and then protect it using a layer of diffusion-resistant aluminum oxide."

Clavel is also exploring other oxides, such as tantalum pentoxide (Ta2O5) and tantalum silicate (TaSiOx), mentioning that tantalum-based oxides have been well-researched for memory applications. To deposit these oxides, the ADSEL researchers use atomic layer deposition (ALD), explains Clavel, whose labmates call him 'marathon man' because of his long hours in the cleanroom working with these materials. "ALD is literally growing oxides one layer at a time. We're engineering the oxide at the atomic level, building it step by step." According to Clavel, this method results in high quality oxides that help improve the electrical characteristics of their devices. "We're still in the early phases of the project, but we're excited about the progress we've made so far," says Goley.

Lower Power Devices

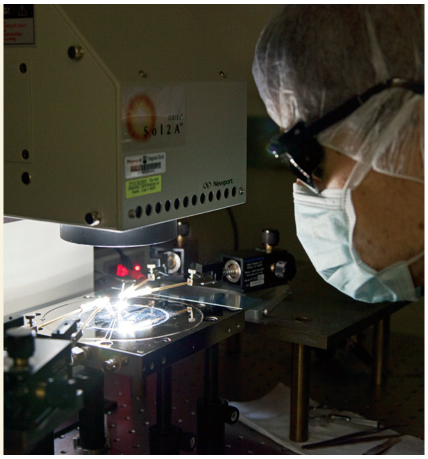
Not only is the ADSEL group trying to make faster transistors, they're also reducing their power consumption. "With each transistor getting smaller, the performance is increasing," notes Zhu, "but the leakage power is also increasing sharply." He is working to create a device that can be operated at low power without sacrificing speed.

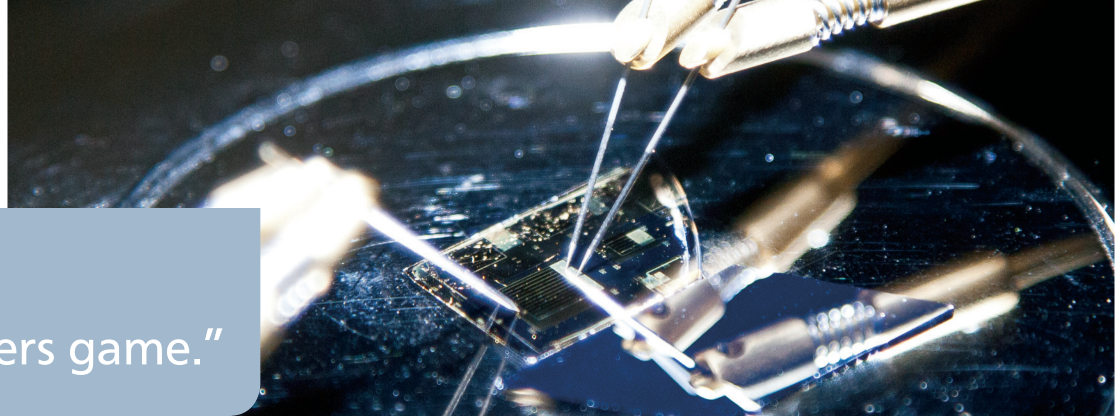
Central Processing Units (CPUs) use Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) that require a certain amount of energy to force electrons to jump the energy barrier and operate the device. Zhu is working on Tunnel Field Effect Transistors (TFETs) that instead use controlled quantum tunneling to move through the barrier. "This device can be operated at a very lower power,"

IN A DARKENED portion of the lab, Nikhil Jain and Patrick Goley test the new solar cells.

Importance of the dielectric

GOLEY EXPLAINS that "industry has transitioned from silicon dioxide as the main gate oxide to using Hafnium oxide (HfO2), which has a much larger dielectric constant. When you use HfO2 with germanium however, the materials like to interdiffuse, creating lots of defects that diminish channel mobility." Previously, if you wanted to increase the gate capacitance of a transistor you had to make the oxide layer thinner. The layers had become so thin, however, that electrons were jumping across it and generating leakage current, which wastes power. With HfO2, a thicker layer can provide the same high capacitance without the waste. "We need the higher oxide capacitance so that we can drive more current in the devices," says Kundu. "My plan is to improve the oxide capacitance that ultimately increases the transistor performance."





"It's all a numbers game."

TESTING of their first batch of solar cells, like the one above, has already demonstrated high efficiency.

he explains.

"We're using new materials, new growth techniques, and new architectures," says Zhu. Using group III-V materials (such as InGaAs) and Ge, they can create transistors with a lower band gap energy and higher carrier mobility. "So we can operate with lower voltage at higher speeds." They grow their materials using molecular beam epitaxy (MBE), which uses an ultra-high vacuum to eliminate contamination. "The pressure is very low inside the growth chamber," Zhu notes, "the vacuum level is almost as high as on the moon." They also use a new device architecture called vertical device architecture instead of the traditional planar architecture. "We have several different designs to upgrade the device performance….Our performance is promising," he says.

Aside from faster and lower energy computers, Zhu stresses that these improvements could impact many areas of our lives. It can be used inside microprocessors and memory for next generation computers, but because battery life will be better, it can also be implanted inside humans for biomedical applications. "Using MOSFETs costs a lot of power and generates a lot of heat," he says, "also, if we can use TFETs people won't have to change the batteries as often."

More Efficient Solar Cells

By integrating III-V materials onto a silicon substrate, the team is also helping to create affordable, highly-efficient solar cells by combining the high-efficiency of GaAs with the low cost of silicon. According to Jain, most solar cells use silicon materials, and their efficiency is only about 25 percent at best. Most commercial solar cells are limited to 21-22 percent by production constraints.

Triple junction solar cells, Jain admits, already use GaAs and can manage up to 44 percent efficiency. "These kinds of solar cells have dominated the space market," he says. "In space, you really care about performance. For terrestrial applications, cost is the driving force."

GaAs solar cells are expensive. Producing a GaAs solar cell that is approximately half the size of a silicon cell, may cost more than twice as much, according to Jain.

"It's all a numbers game," says Jain. "We need new approaches to target high performance at a lower cost. The winning technology for the future would be the one that combines the best of both."

To make these solar cells both efficient and affordable, Jain is working to integrate GaAs onto silicon. "Researchers tried this back in the 1980s, but the performance wasn't good. We're trying something different," he says. "The way we're growing these materials for solar cells and fabricating them is novel for this kind of work." He stresses that even if they can manage 25 percent efficiency for these cells, that will be remarkable. "This is a disruptive solar technology that I believe can be transformative." ■

Minimizing the defects

UNDERGRADUATE PETER NGUYEN has spent two semesters doing research in the Advanced Devices & Sustainable Energy Laboratory, and will continue there for graduate work, where he will implement Ge-based FinFETs as another alternative for low-power, cost-effective, and fast transistors. His undergraduate research has been to identify and to minimize the defects that occur when growing one substrate on top of another.

Nguyen has been working on an annealing method, which involves heating the devices to 400-700 degrees C. "What ends up happening is that the crystal lattice realigns itself in the process, which alleviates some of the defects," he explains. His job was to find the optimal thermal budget, or the amount of thermal energy transferred to the device, in order to reduce defects.

Nguyen, who came to Virginia Tech knowing that he wanted to study semiconductors, is enjoying his experiences: "I like the characterization aspect and being able to fabricate the transistors. I haven't had that experience yet, but it's fascinating. You do learn a lot from lectures and classes, but research is the frontier."

DEFINING **DISCIPLINARY** CULTURES

A GROUP OF VIRGINIA TECH PROFESSORS has received a $450,000 grant from the National Science Foundation (NSF) to investigate the cultures of different academic disciplines. ECE Professor Tom Martin is working with engineering education associate professors Lisa McNair and Marie Paretti to discover the cultural similarities and differences between disciplines.

THE INTERDISCIPLINARY TEAM (from left): Marie Paretti, Homero Murzi, Tom Martin, and Lisa McNair.

They are applying Geert Hofstede's cultural dimensions theory, typically used to understand specific cultural values of countries, to various academic disciplines. Hofstede's theory focuses on five features: power distance, individualism, uncertainty avoidance, masculinity, and long-term orientation. Martin explains that while differences in international cultures are generally understood, the Virginia Tech team wants to discover if there are disciplinary cultures as well. "If it turns out we're right, we'll have a theory with explanatory power."

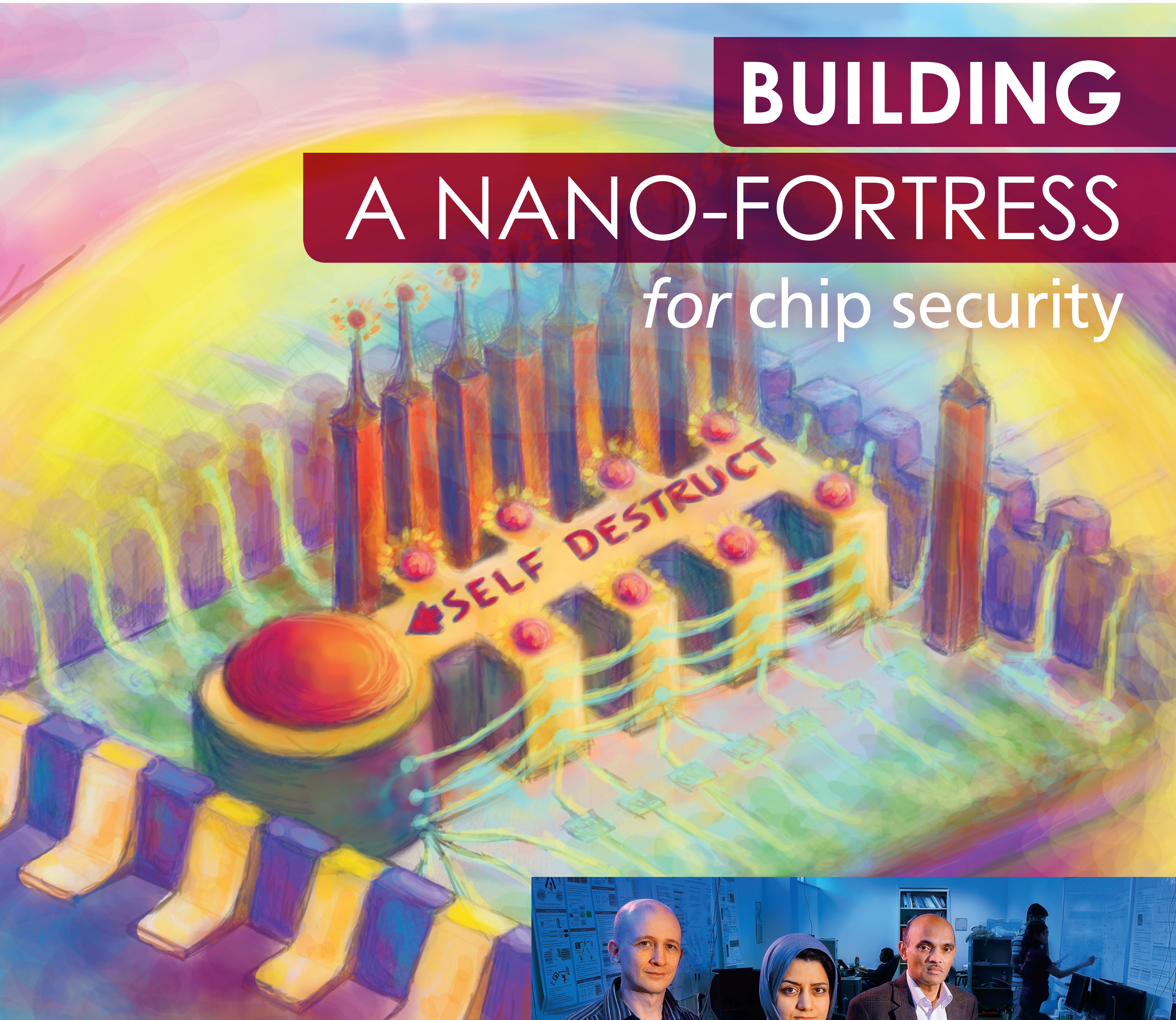
Their earlier studies found that ECE students scored significantly higher in uncertainty avoidance than did students from some other disciplines. According to Martin, who started noticing differences between students from different majors when teaching interdisciplinary classes, "it explained a lot that we had noticed." He described as an example that ECE students tended to move directly to building or designing something as soon as they found anything that they knew they could do—whether or not it was the right thing to build. In contrast, Martin mentions that design students tend to have lower uncertainty avoidance, and don't even mind not knowing precisely how their grade is calculated. "The difference in uncertainty avoidance was the starting point for the grant that we have now," says Martin.

If their research finds that there are disciplinary cultures, it will trigger many more questions. "Did they come to school that way or did we make them that way?" asks Martin. "It's probably a little of both." With this grant, the professors will be studying several disciplines at several universities to find the answer. They will be piloting the program at Virginia Tech, studying ECE, industrial and systems engineering, and several non-engineering disciplines. They will then study the same disciplines at six other institutions, and will conduct follow-up interviews with some students.

The data, however, is not going to be clean, says Martin. Not only will the results probably show a mix of self-selection and training, but Martin also emphasizes that "these survey results aggregate the data. Any individual is not going to match the average."

A Higher Education Research Institute (HERI) study showed that two-thirds of the variation in educational outcome is based on the entering student, and one-third is based on the institution he or she attended. Martin believes that greater understanding of how students self-select or are trained into different cultures, could help educational institutions better prepare their students for the workforce through teaching and curriculum changes. ■

BUILDING A NANO-FORTRESS *for* chip security



> "It's like building a little bunker for your chip."

THERE ARE MANY WAYS TO HACK A CHIP, including monitoring its power consumption, measuring the radiation it emits (side channel attacks), hitting it with a laser, and physically probing it (tampering). A group of Virginia Tech researchers is leading an effort to close these invasive and non-invasive security holes by meeting each threat with a strong defensive countermeasure—one based on nanomaterials and nanodevices.

They have gathered a team to map out a nano-shield to protect a standard CMOS chip. Led by Patrick Schaumont, an associate professor of ECE and expert in secure embedded devices, the team could be considered a special-forces unit of chip security. Schaumont is joined by associate professors Leyla Nazhandali, an expert in chip design, circuit design, and physical unclonable functions (PUFs), and Mantu Hudait, an expert in nanotechnology and FinFET device engineering. Nanotechnology experts from Rice University and cryptographic engineers from Worchester Polytechnic Institute round out the team.

The team is known for many first-of-a-kind demonstrations of scientific concepts, including pioneering research in nanotechnologies and hardware Trojan detection, the demonstration of the first Advanced Encryption Standard (AES) chip, the demonstration of the first SHA-3 chip, and the first demonstration of a side-channel attack on a commercially deployed key lock system.

The chip fortress they plan to design will require all their skills and expertise—and more first-of-kind technologies. "We are exploring two security concepts in parallel," says Schaumont. "First, we will develop novel security countermeasures based on nanomaterial shields. Second, we will develop novel nanodevices as active components within a chip."

PATRICK SCHAUMONT, Leyla Nazhandali, and Mantu Hudait are working to create an impregnable chip.

Layers of shields

The team is building shields to reduce leakage of sensitive information. Some of these security measures can be layered above and below the main portion of the chip, including on-chip batteries and a Faraday cage. "If no signal has to pass in or out, it becomes much more difficult to figure out what the chip is doing," according to Schaumont. "It's like building a little bunker for your chip."

A classic side-channel attack is to monitor a chip's power consumption. "If you have the battery on the chip, it's completely inaccessible to an attacker." On-chip batteries are usually too costly to be used, but new materials make this countermeasure possible with capacitors, supercapacitors, and nanobatteries, Schaumont says.

The team also wants to place the entire chip inside a Faraday cage. "We want an EM shield that protects the entire chip, not just a single module," he explains. Once an entire chip can be protected, individual protection of IP cores is no longer necessary and protection becomes less expensive and more transferrable, while development time is slashed.

Nanomaterial shields to eliminate physical tampering are also being developed. "The density and sensitivity of nanomaterials like graphene makes conventional tampering, such as focused ion beams infeasible," he says.

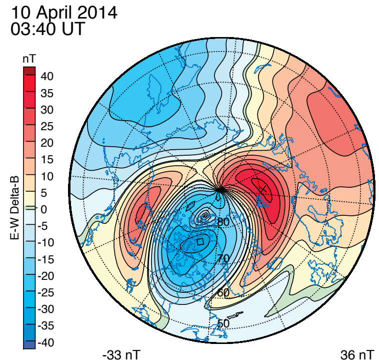
Devices and primitives

While shielding is critical for security, the team is also devising devices that aid in protection, including tamper sensors, secure storage, and even a kill switch. "We want to make the chip aware of any attempt to tamper with it, and able to shut down or destroy itself as necessary," says Schaumont.

Another strategy is to build a small, secure storage area into the chip, "like a lockbox inside a chip," says Schaumont. "Some secret bits can be stored in there, and even if you know where to look, you can't find their value." For that, they look into nanotechnology inspired PUFs.

The final point of defense would be a self-destruct option. Although fuses are already used for this sort of application, current CMOS fuses can be mended. "We're going to build irreparable nano-fuses," asserts Schaumont.

The team is considering multiple, composable countermeasures for protection. This is important, Schaumont says. "Our threat model assumes adversaries may be in physical proximity or even in possession of the chip. It may sound surprising that someone would try to physically tamper your computer," he says. "Nevertheless, this is implied by our desire to take our computers anywhere, and to embed them in everyday objects like credit cards, passports and USB dongle's." Threats to the physical security cannot be addressed by changing the application software, or by changing the cryptographic algorithms, he adds.



A VISUALIZATION of East-West perturbations of Earth's magnetic field from Weimer's computer model.

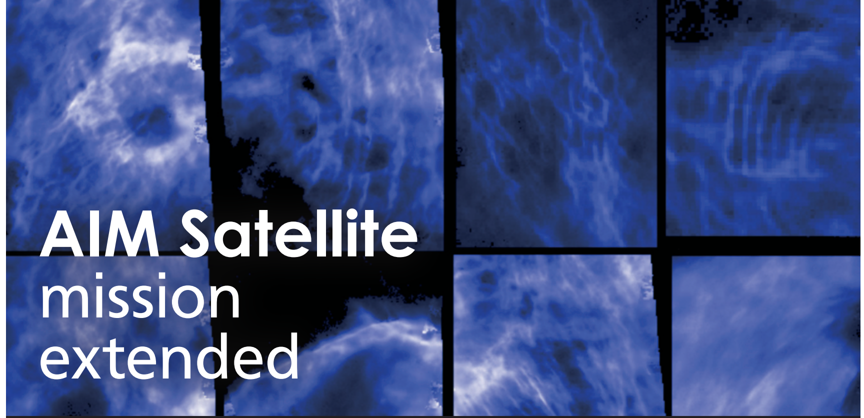
Geomagnetic Prediction Model Selected by NOAA

The National Oceanic and Atmospheric Administration (NOAA) Space Weather Prediction Center (SWPC) has selected two models for predicting geomagnetic field variations, for future use in daily operations. One of these is an empirical model developed by ECE Research Professor Daniel Weimer.

"This model calculates how the magnetic field at the surface of the Earth varies," explains Weimer. The model can predict these variations approximately an hour in advance, using real-time measurements of the Interplanetary Magnetic Field (IMF) from a satellite that is positioned ahead of the Earth in the "upstream" solar wind.

NASA's Community Coordinated Modeling Center (CCMC) has been evaluating several competing models over the past few years. According to Weimer, most of the other models, including the other that was selected, require a supercomputer while his model "obtains solutions many times faster on just a desktop computer." During the next year, the NOAA SWPC will be working to transition the selected models to an operational status.

In 2009 Weimer received a $313,000 grant from the National Science Foundation's (NSF) National Space Weather Program to develop this model.



AIM Satellite mission extended

An extension of a NASA research mission is enabling space scientists to study noctilucent (night-shining) clouds for almost an entire solar cycle. NASA recently extended the Aeronomy of Ice in the Mesosphere (AIM) mission, which originally launched in 2007.

Usually NASA missions led by universities are two-year missions, and researchers can apply for an extended mission, explains ECE's Scott Bailey, deputy principle investigator on the project. NASA has extended the AIM mission three times, with funding through 2018. Bailey explains that since researchers will be able to collect data for 10 of the 11 years of the solar cycle, "this allows us to get observations at all levels of radiation. It's a big deal to us to observe for an entire solar cycle."

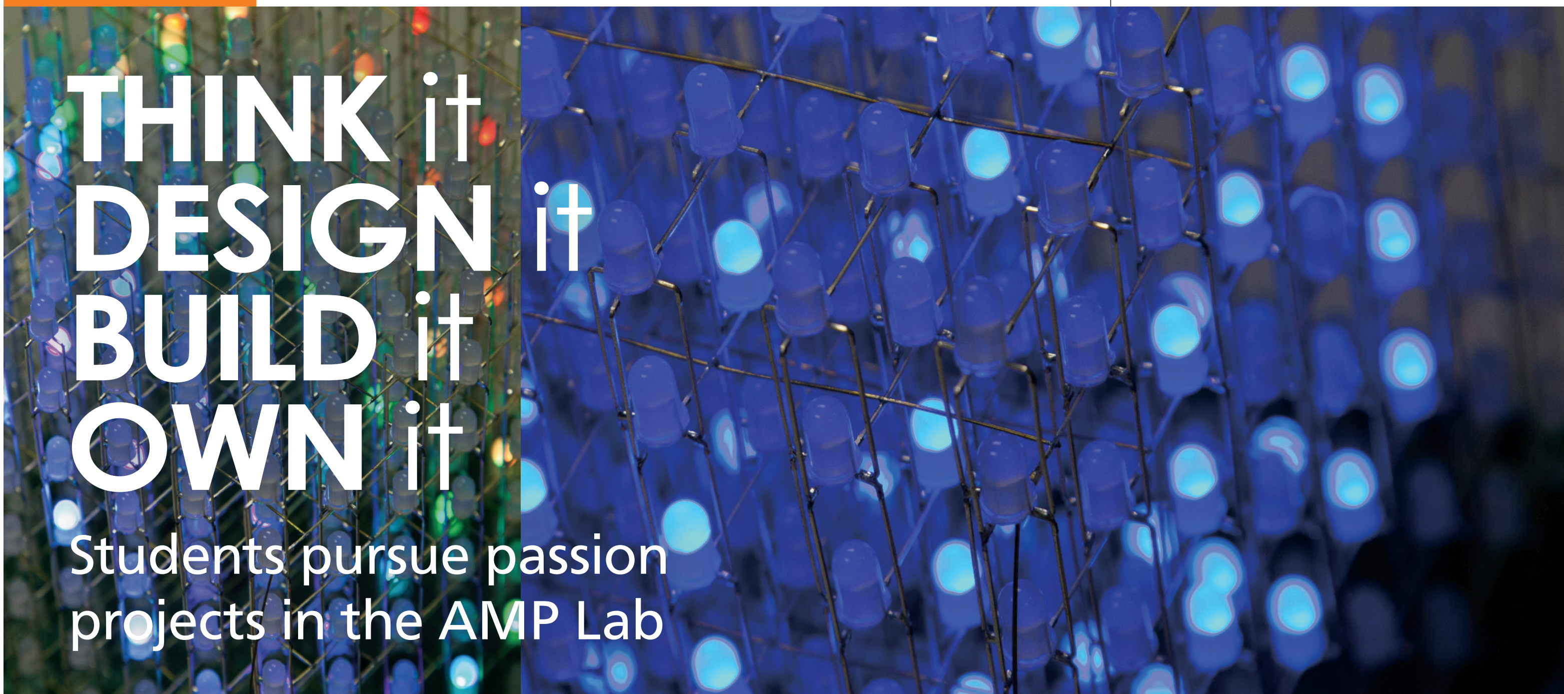
The group hopes to extend the mission even past 2018. Bailey admits that "things get challenging once the spacecraft has been up there, but we don't see anything that would stop us. Everything is functioning just fine."

The AIM mission is the first satellite mission dedicated to studying polar mesospheric clouds. Instruments observe the cloud visually, and measure temperatures and water vapor. The researchers hope to discover why these clouds form and why they vary so widely. "They've gone from never being observed, to being routinely observed every summer," says Bailey.

In the seven years since the satellite launched, space scientists have already learned much about these clouds. "The clouds look much different than we expected," notes Bailey. "There's a lot of variability. Sometimes the whole polar cap is covered, some days it's spotty. You could never say it's anything approaching a uniform cloud, but nor is it a bunch of individual clouds." Although the data is more complicated than initially anticipated, "the complexity you see is reflecting the complexity of the atmosphere," Bailey says, explaining that the polar mesospheric clouds change based on effects, such as thunderstorms, in areas both far beneath them and even from the pole in the opposite hemisphere. Bailey summarizes the AIM experience, saying "we got a lot more science than we expected, and our whole view has changed."

Sounding Rockets

Tapping experience from a previous mission, ECE Associate Professor Scott Bailey and his students are preparing to launch an experiment on a NASA sounding rocket in January 2016. Researchers from Virginia Tech are leading researchers from the University of Colorado Laboratory for Atmospheric and Space Physics, Utah State University, Artep, and NASA to launch a new experiment to study nitric oxides in high altitudes. Bailey says he is looking forward to the launch. "We know we can do it, we've done this before."



THINK it DESIGN it BUILD it OWN it

Students pursue passion projects in the AMP Lab

THE SMART CUBE: Kevin Lee (CPE '13) designed his LED cube to be a "flashy impressive display for the AMP Lab." He has invited his labmates to program animations and games for the cube (above).

WHAT COULD STUDENTS CREATE if they were given 24/7 access to a fully-equipped lab, free materials, and skill-specific mentorship? What would happen if you took away grades and deadlines, and gave students the freedom to pursue self-directed passion projects?

Inspired by the possibilities, ECE's Bob Lineberry founded the Autonomous Mastery Prototyping (AMP) Lab with the tagline "Think it; Design it; Build it; Own it."

The AMP Lab has been open since fall 2012 for any motivated student with a creative idea and a desire to learn. Current projects are diverse, and include a robotic arm that can mimic human gestures, a synthetic aperture radar, and a "Request a Ride" app.

"Working in the AMP Lab is a release from classwork that also helps you in class," says Callie Johnston (CPE '14). "In the AMP Lab, you start with this huge problem that you have to break down into smaller parts. So when you are assigned semester-long class projects, you know how to manage them."

The AMP Lab membership process begins with an initial interview with one of the lab's student leaders. The interested student shares project ideas and gets matched with a peer mentor. Some students also choose to collaborate with teammates.

"You find a mentor that can help based on the needs of your project," explains Johnston, who mentors labmates in software and currently leads a quadrotor helicopter project. "It's a low stress interaction where you can bounce ideas."

Johnston's first project at the AMP Lab—currently on hold—was a neuro-controlled exoskeleton that would allow wearers to control prosthetic limbs

"No one thought it was crazy that I wanted to make a neuro-controlled exoskeleton. No one said 'no, you can't do this.'"

GETTING AMPED
Alexander DeRieux works on his wireless environment sensor (left). William Gerhard is programming a color and location recognition camera to guide his autonomous robot (center). AMP Lab students take a break to play TRON on the LED cube built by Kevin Lee (right).

with their thoughts. "You go in having this huge, big, grand idea and then you realize this is really hard to do," Johnston says.

The best feature of the AMP Lab, according to Johnston, is the freedom to attempt the seemingly impossible. "No one thought it was crazy that I wanted to make a neuro-controlled exoskeleton," she says. "No one said 'no, you can't do this.'"

Lineberry says that one motivation for establishing the AMP Lab was to facilitate student investigation into different areas of engineering. "A student discovers her or his passion by exploring attractive projects," he says.

For William Gerhard (EE '16), a major perk of the AMP Lab is the opportunity to explore disciplines outside of electrical and computer engineering. "I get to integrate mechanical and electrical systems into one complete project," he explains.

Gerhard is leading an AMP Lab team that is developing a high-speed autonomous ground vehicle. After building a plastic prototype of the vehicle, the team is designing a fully aluminum version. "Right now, one of our challenges is designing a suspension system that can adapt to changing terrain while remaining watertight," he says.

Alexander DeRieux (EE '15) is working with a team to build a wireless environment sensor that will feed data from the AMP Lab to Lineberry's cell phone. The project will allow him to check on the temperature of the room, and determine whether or not the doors are locked and the lights are turned on.

In the fall, DeRieux used the AMP Lab to plan and test an automated menu ordering system that

he built at HackDuke, a 24-hour hackathon. Called napkis, the system transforms a paper menu into a touchscreen that is activated by conductive ink or pencil lead.

"The key to the AMP Lab is getting students to do what they learn about in the classroom," says DeRieux. "I was working on the HackDuke project while I was taking a microcontroller course. Not only was I learning the material in class, but I could go to the AMP Lab the next day and apply what I learned."

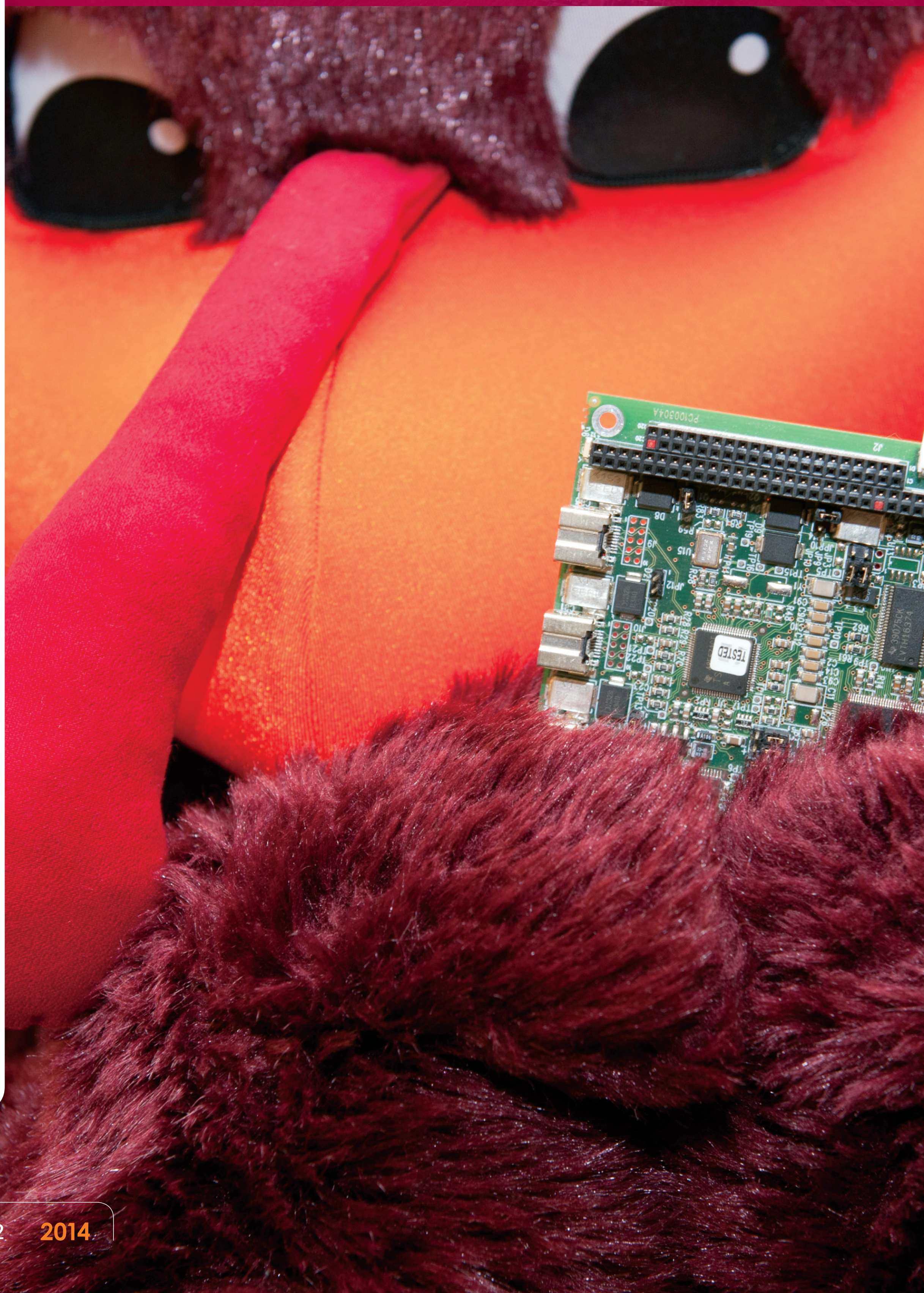
In an effort to increase hands-on learning opportunities, the AMP Lab launched a student-led workshop series this semester. One recent seminar gave students the chance to try on Google Glass, explore the development software, and brainstorm application ideas together. "The best part of the AMP Lab is the collaboration with like-minded people," says DeRieux.

Although there are no set deadlines, students are encouraged to stay on track by sharing progress reports at weekly lab meetings and posting regular updates on project web pages. At the end of each semester, the lab hosts an open house to demonstrate projects to the entire ECE department.

"The innovation in the lab has been to let students choose and manage their own projects with the idea that self-motivation and peer management can be powerful motivators," says Dennis Sweeney, ECE's director of instructional laboratories. "We haven't been disappointed." ■

CHEERLEADING
Fonte Clanton flies the quadrotor helicopter that he is developing with his mentor Callie Johnston (left). AMP Lab founder Bob Lineberry manages the operations of the lab and serves as a "cheerleader," but he encourages students to seek help and learn from each other (right).

A new option will help ECE students build their soft, people skills



Hi-Reliability Capacitor Investigation
BAE Systems
Manassas, Va.

Design/Fabricate/Evaluate Photovoltaic Cells
Micron Technology
Manassas, Va.

Stopgap Wireless Provisioning for Residence Halls
Virginia Tech Information Technology
Blacksburg, Va.

Design/Build/Evaluate Multi-Channel Sensor Interface
Measurement Specialties Inc.
Hampton, Va.

Develop Low Rate "Under" Communications Capability
Inmarsat

ece LAUNCHES

New industry-sponsored capstone design projects

STARTING THIS FALL, ECE is offering a two-semester capstone design sequence that provides a technical design experience plus an industry-like environment that strengthens students' business, project management, and teamwork skills.

Project management and teamwork skills are critical to industry, according to Gino Manzo, who has joined ECE to serve as the lead instructor and program coordinator. "Over my career, I've hired many young, graduating engineers," he says. "My peers and I never question the technical talents of these graduates, but we always worry about them fitting into our teams. Will they get along? Will they be a leader?"

More than a dozen firms of all sizes are sponsoring a total of 20 different projects—limiting the experience to 100 students for the program's rollout.

The projects cover a range of technologies and applications, including designing and fabricating photovoltaic cells, sponsored by Micron Technology; refining and building a sensorless maglev system, sponsored by National Instruments; and developing a web-enabled high voltage waveform generator, sponsored by General Electric.

The projects are determined by the sponsors and can feed into their products and services, or can be representative of the type of work the organization does. Intel, for example, is sponsoring a project on reliable low K interconnect structures and offering a bonus for conclusive results on the root cause of time-dependent gate oxide breakdown (TDDB) in the structure.

The industry sponsors will act as the customers. The students will go through a full business acquisition/deliverables cycle, including responding to a request for a proposal (RFP), developing the statement of work and technical specifications, negotiating deliverables, designing and developing the technology, and final turnover. Each team will work with three mentors: an industry contact, a subject matter expert, and the course instructor.

"Everybody is a winner," says Manzo. "The motivation for industry is to expose students to the human side of what they are doing in school. Industry sponsors also get to audition potential hires over the course of a year." The students, he says, will get exposure to what work in industry is really like while

THE NEW CAPSTONE option is the brainchild of Department Head Luke Lester and the ECE Industrial Advisory Board.

Radiation Test Methodologies, Hardware, Test Database
VPT Inc.
Blacksburg, Va.

High Speed Switch Fabric: Modems to Transceivers
Northrop Grumman Corp.
San Diego, Calif.

Sensorless Magnetic Levitation System
National Instruments
Austin, Texas

IC Building Blocks: Design and Simulation
Lockheed Martin
Manassas, Va.

Self-Organizing Coherent Distributed RF Transmitter
Johns Hopkins Applied Physics Lab
Laurel, Md.

How to SPONSOR A PROJECT

TEAM SPONSORS contribute $5,000 per project and commit to spending four hours per month to serve as the customer. Sponsors define their project and expectations. Projects cannot require confidentiality agreements. Sponsors can be companies, organizations, or faculty members who establish a fictitious company to serve as the customer.

building their networks. Students planning on graduate school will benefit by seeing the cutting-edge problems in the field and enhancing their professional development, he adds.

Students electing the new capstone alternative will earn three technical credits and three capstone design or design technical elective credits for the two-course sequence, ECE 4805 and ECE 4806. The classes will incorporate lectures, team time, customer time, and instructor mentoring.

During the fall semester, the students will spend half their time in technical design, building the concept, detailed design, and initial simulations. The rest of the course will cover the business process, project management, communication, and professional development—including leadership/team skills, listening skills, and strengths and weaknesses.

"These soft, people skills are very important," Manzo says. "Your strengths, weaknesses, ethics, how you deal with diverse perspectives, are all critical to a project's success." Diversity, in particular, is important, he says. "The more diverse your team is, the better your solutions."

The spring semester will be about 60 percent design implementation, including simulations, prototyping, design of experiments, and testing and validation. The remaining 40 percent of spring semester will cover project management, communication, and professional development. All the projects will be presented in a public forum.

The previous two-semester project courses are still available for students, as are the traditional, single-semester capstone design courses. ■

Design/Fabricate/Evaluate IC Transistors/Circuits
Micron Technology
Manassas, Va.

Asymmetric Material Design Analog Circuit
Lockheed Martin
Manassas, Va.

Commodity Computing Core and Storage Platforms
Virginia Tech Information Technology
Blacksburg, Va.

Infrared Sea Surface Temperature (SST) Sensor
Johns Hopkins Applied Physics Lab
Laurel, Md.

Web-Enabled High Voltage Waveform Generator
General Electric
Salem, Va.

INDUSTRY'S TAKE ON CAPSTONE DESIGN

LOCKHEED MARTIN is a strong supporter of the new ECE capstone program and is sponsoring three different projects. "We see a tremendous value in being part of forming the next generation of engineers," says Kenneth Schulz, responsible for Lockheed Martin's RFIC Design Center Strategy and Research and member of the ECE Industrial Advisory Board.

"These are real projects that give the students the chance to deal with a customer and overcome the pitfalls—in an academic environment," he says. For a small investment in time and money now, "we think we'll have more of the graduating engineers be more ready for what they'll face in industry."


COURTESY OF KENNETH SCHULZ
KENNETH SCHULZ

Lockheed Martin's three projects involve IC design, nanotechnology, and data encryption; two relate to skills and technology needed today, and the third relates to technology the firm expects to engage with in the near future. The first project involves the design and simulation of IC building blocks. The students on this project will gain a basic understanding of what it takes to design and to simulate a circuit, using the same software tools used in industry. The process is very complex and most undergraduates do not get the experience, Shulz says, adding that the center typically hires only graduate students for this reason. "This project gives the opportunity for an undergraduate to get hired directly into our center or be able to transfer into the MICS group."

A second project that relates to current needs involves data stream compression and encryption IC

MEET GINO MANZO

GINO MANZO is the lead instructor and co-ordinator of the industry-sponsored capstone design program. Manzo retired in 2014 from his position as director of Microelectronics Technology and Products and Manassas Site Executive for BAE Systems. (BAE Systems is sponsoring a project on high reliability capacitors for space computers.)

Manzo attended the United States Military Academy at West Point, N.Y. He earned a BSEE and MEng from Cornell University in 1975 and 1976 respectively, then started his career as a digital board designer and test engineer with IBM in Owego, N.Y. In 1979, Manzo transferred to Manassas, Va. and became part of the Semiconductor Technology Center (STC) team. Over the past 37 years, he has held a host of technical and management positions within all of the electronic systems microelectronic facilities in Manassas, Lexington, Mass., and Nashua, N.H. He also has served as a program manager within the Space Business Area. As the Manassas site executive, he was responsible for the safety, security, working conditions, and community outreach for the 280 Manassas employees.

Manzo serves on the Virginia Tech ECE Industrial Advisory Board and on the Semiconductor@VT and Space@VT advisory boards, and is the assistant chair of the Commonwealth of Virginia Microelectronics Consortium Committee.

design. Students will design a circuit that can take an unspecified 32 bit wide stream of data, compress it, and apply an encryption algorithm. "This is a real-world problem right now," Schulz says, referring to the rise of corporate hacking and cyber warfare.

The third project, asymmetric material design analog circuit, is more future oriented, according to Schulz. "We're seeing that nanotechnology will someday impact electronic circuits, and this project gives the students the opportunity to do research and experimentation with materials that have 'nano' properties, without requiring all the instruments in a nano tech lab." He referred to new materials such as conductive inks, dielectric polymers, powders, nanomaterials, and "organic electronics" that are now available from a range of catalog sources.

LOCKHEED MARTIN

Lockheed Martin has strong expectations for its student teams. "We expect the students to do basic research in the topic area, create realistic project plans, make corrections along the way—all while keeping the customer priorities intact," Schulz says. They expect students to learn project planning skills, risk management methods, how to adapt a plan while keeping delivery commitments, communication skills, teamwork, and a sense of ownership.

Virginia Tech is a particularly important school for Lockheed Martin technology, says Schulz. "Not only is it very strong academically, but Virginia Tech goes out of its way to synchronize and collaborate with industry." The faculty really seems to care if its students are successful in industry, and "I think that's fantastic."

LOCKHEED MARTIN

Data Stream Compression and Encryption IC
Lockheed-Martin
Manassas, Va.

prime photonics

Fluxgate Magnetometer Drive
Prime Photonics
Blacksburg, Va.

intel

Reliability Low K Interconnect Structures
Intel Corporation
Hillsboro, Ore.

Simultaneous Programming of Multiple ID Tags
General Electric
Salem, Va.

VirginiaTech
Invent the Future

Mobile Single Sign On
Virginia Tech Information Technology
Blacksburg, Va.

ece STUDENTS FIND INSPIRATION IN LABORATORY FROM THE PAST

ENGINEERING DISCOURSE IS DOMINATED by all things cutting-edge, innovative, and high-tech. Yet some engineering students have discovered that inspiration can be found not only by looking ahead, but also by looking to the past.

A class project led students to the mountain community of Wytheville last spring, where a piece of southwest Virginia history lies nestled along Reed Creek. Built in 1902, and rebuilt after a fire in 1934, Reed Creek Mill has powered a variety of enterprises over the years, including streetlights, grain processing mills, and an iron foundry.

COURTESY OF ROBERT DOWNEY

The mill closed in 2004 and lay abandoned until Robert Downey purchased the property in 2012. After renovating the house and old mill buildings, Downey became interested in restoring the mill itself and selling hydroelectric power to the grid. He reached out to the Virginia Tech Service-Learning Center and was connected to students who agreed to conduct a feasibility analysis for ECE 4634: Alternate Energy Systems, taught by Saifur Rahman, the Joseph Loring Professor of ECE.

The student team visited the mill several times to evaluate its design and collect data. “I think it was a true laboratory for them,” Downey says. “They got to do things you read about in class.”

Rudolph Cuffee (CPE ’13), the project’s leader, describes his first visit to the mill as “mind-blowing.”

“Seeing the 12-foot walls and hearing the water flowing over was amazing,” Cuffee says. “The mill had history and walking around on the inside and seeing the old tech and mechanicals was inspiring.”

The students computed the mill’s estimated flow rate and consulted with a hydro systems company to determine the optimal turbine and generator for maximum power production. They added the costs of this equipment to the cost of safety devices and expected maintenance fees to determine Downey’s

PHOTOS COURTESY OF RUDOLPH CUFFEE

DEAN MANNO uses a flow meter to measure the velocity of the water entering the reservoir (left). Jennifer Armstrong takes notes as Buzayehu Ejigu discusses the best approach to flooding the raceway with the mill's groundskeeper (center). A network of shafts and fabric belts underneath the floor transfers the mechanical energy from the water to these milling grinders (right).

total expected investment.

Arriving at this number was a true team effort, Cuffee says. The team included engineers from various disciplines: electrical, computer, power systems, mechanical, and industrial systems. "We all had to figure out what we excelled at."

The team calculated expected annual revenue based on the price per kilowatt-hour offered by the local power company. By comparing expected revenue to estimated costs, the students concluded that it would take Downey more than a decade to break even on his investment.

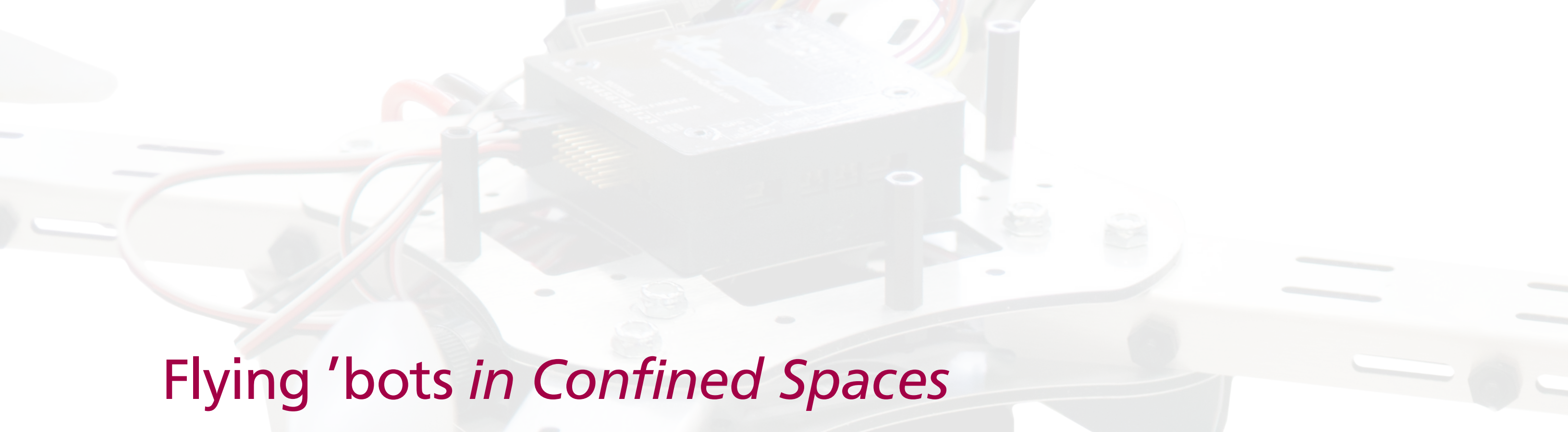
"The students confirmed what I expected to be true—that it would not be profitable to upgrade the mill to sell power to the grid," Downey says. "They wrote a very good report."

Yet Downey did not give up on the prospect of restoring the mill to working order. Motivated by the mill's iconic status within the community, he is now working to refurbish the mill's existing turbines,

"The mill had history and walking around on the inside and seeing the old tech and mechanicals was inspiring."

which are more than 100 years old. He hopes to use the mill to generate power on a small scale and light up a historic bridge and a greenway park being developed on the property.

The students' analysis serves as a solid foundation for further research, Downey says, and he plans to invite other student groups to complete the next phase of the project. Modern engineering may get historic Reed Creek Mill's lights burning bright once more.



Flying ’bots *in Confined Spaces*

DON’T HIT THE

WHY WALK when you can fly? The U.S. Navy is interested in a scenario where flying robots replace humans for inspecting a ship’s tanks and the irregular areas around them for corrosion.

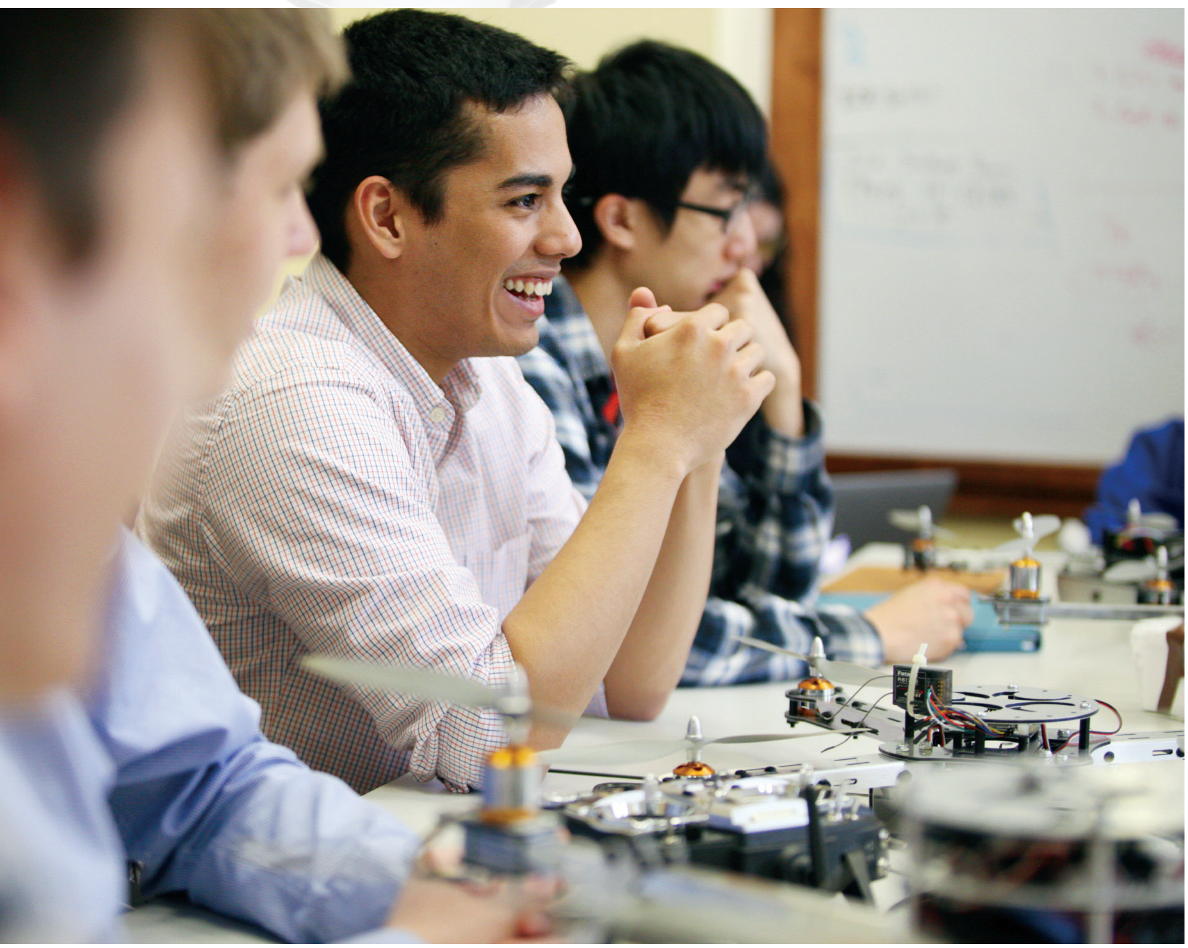
With funding from the Navy Engineering Education Consortium (NEEC), Professor Dan Stilwell and a team of graduate and undergraduate students in the Autonomous Systems and Controls Laboratory are building autonomous drones to do the job.

Because ships reside in saltwater, they tend to rust, Stilwell explains, and the Navy must check the tanks regularly to make sure the ships are safe. “It’s time consuming and expensive,” says Stilwell. “We’re building a robot to fly into the unknown area and check for corrosion.”

Ph.D. candidate Matthew Bailey is working on a ducted-fan unmanned aerial vehicle. This is a flying vehicle with a single propeller that operates inside a duct. This configuration maximizes propulsive efficiency and increases endurance. Because the ducted-fan vehicle is expensive, a team of undergraduates is doing some initial work with a small fleet of more affordable quadcopters.

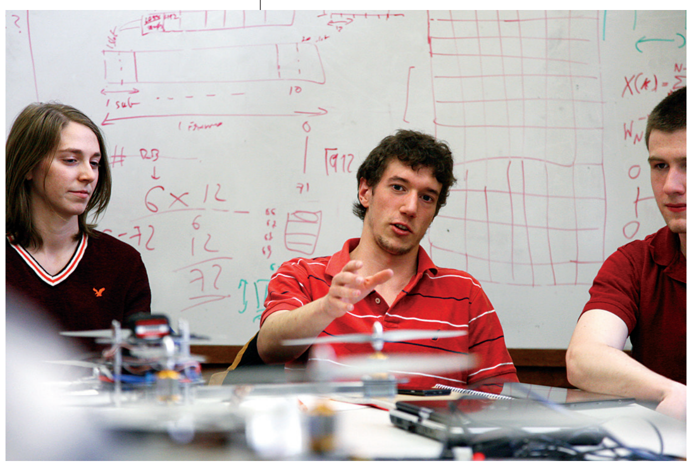
The undergraduate team consists of four seniors, two juniors, and five sophomores: Jyssica Baehr, Xin Gan, Griffon Jarmin, Ryan McCall, John McDouall, Marc Murphy, Randolph Peterson, Peter Quan, James Reed, Zhun Shi, and Ryan Willard. They have divided into four smaller groups, each working on its own quadcopter.

THE STUDENTS DISCUSS their progress at the weekly meeting.



WALL

JYSSICA Baehr, Randolph Peterson, and John McDouall discuss the next steps for their project (left). A close-up of one of their quadcopter's propellers (right).



The students are working to control the quadcopters when flying inside—a task complicated by the dynamics of the airflow generated by the copter itself, Stilwell explains. "The copter moves a lot of air in order to generate lift, and if it gets up close to something indoors the motion of the air can change and the copter might just fall to the ground."

The students' first task was choosing and building the quadcopters. They selected their quadcopters because of the open source software used for the flight controllers. "If we want to reprogram some of the behavior of the flight controller, we can do that," Reed explains. "With a proprietary system, it would be a black box and we would have to make compromises."

By making open source controllers a priority, they chose a quadcopter that was more difficult to build and fly than other commercial varieties. "The instructions to build these are pretty horrific," says Peterson. However, the team does not regret the challenge.

Jarmin explains that "there's not much assembly instruction, because it's up to you what to do with it. It leaves you to act just like an engineer. Which is what we're trying to be." Also, he continues, "building is what allowed me to understand every aspect of how it works. It's how you learn what you need for the control algorithms."

Their next challenge is to make the drones approach a wall and fly along it. Flying the quadcopters inside is easy, according to Reed, "as long as you don't get close to walls."

Shi explains that features like following along a wall aren't available for commercial quadcopters. "We want to add new features to what is available," he says.

According to McDouall, "a big part of the project is going to be stability in unpredictable conditions."

Peterson continues, "when you get close to the wall, the air currents change. We have to account for that and maintain stability."

The students are enjoying the hands-on experience and the freedom they have to solve the problem. "Our goals are dynamic. If we stumble on something cool, we have free range to see where it goes," says Jarmin.

Eventually, these drones will also be required to explore and map the area it is checking for corrosion. The mapping will also help compensate for the indoor airflow problem, according to Stilwell. "As we build a map, we can anticipate the airflow," he explains, "so we can fly in very complicated areas."

A Taste of Research
MOTIVATES UNDERGRADS

DESIGNING SATELLITES, thwarting malware, developing a motion-capture jumpsuit—these are not your typical summer jobs. But for the undergraduates who came from around the country to engage in research with ECE last summer, working on projects like these was just another day at the office.

Four ECE-affiliated research centers—Space@VT, Wireless@VT, the Center for Embedded Systems for Critical Applications (CESCA), and the E-Textiles lab—host NSF Research Experiences for Undergraduates (REU). The program aims to attract, retain, and prepare students for careers in science and engineering through immersive research with faculty mentors.

According to Scott Bailey, who leads the Space@VT REU site program with Robert Clauer, undergraduate research gives students a better understanding of the graduate school experience. "The REU allows us to bring students from around the country to get them excited about grad school," he says. "It's a good way to show students what research with us is like."

PATRICK HERRITY helped design a rocket that the Space@VT REU students launched during a space science and engineering day camp for local students. "The kids went wild," he says.

During its inaugural session, Space@VT hosted six REU students, alongside three alternately funded students. The session began with a week of lab tours, research presentations, and mentor introductions. Then, students had two months to complete research projects ranging from satellite payload design to radar and sounding rocket observations.

Peter Marquis (AOE '14) was tasked with modeling a satellite payload that will be launched through the NASA ELaNa (educational launch of nanosatellites) program. "We had to divvy up space between four different subsystems to make sure they would all fit in the CubeSat," he says, "I like the challenge of figuring out all of the technical aspects and overcoming each obstacle."

The experience of working on large-scale projects can teach problem-solving lessons that are difficult to replicate with coursework. During Taylor Pearman's (EE '15) REU with the E-Textiles lab, "a lot of time was spent on troubleshooting," he says. "We developed troubleshooting skills."

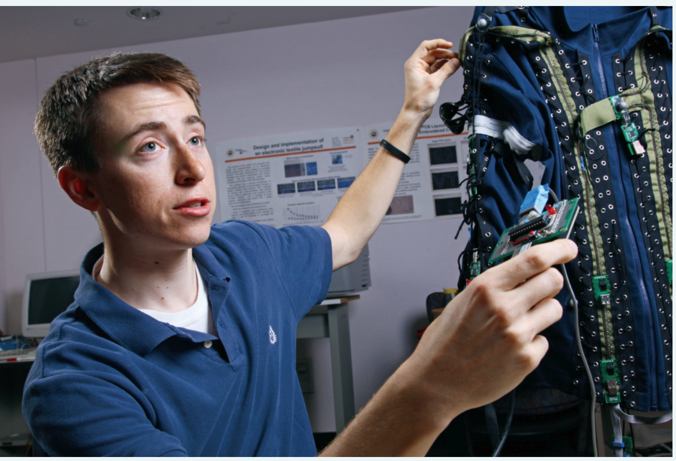
Mentored by Tom Martin, Pearman partnered with John New (CPE '15) to work on a jumpsuit that uses accelerometers and gyroscopes to monitor the wearer's movements. "I was able to come in at the right level. I already knew a lot from classes, but I was learning new stuff," he explains. "REU programs allow you to apply what you learn in the classroom."

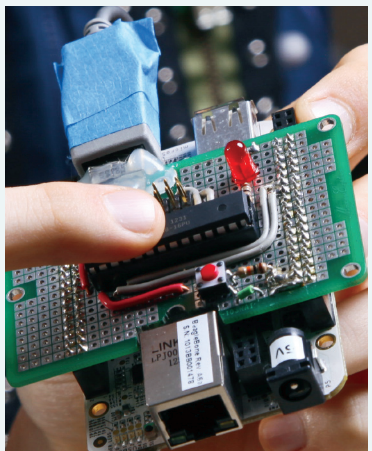
While some REU students select a site that is closely aligned to their interests and skills, others choose a program that allows them to explore an entirely new topic.

For Hannah Bowers, an engineering science student at Sweet Briar College, the highlight of her involvement with the Wireless@VT REU in cognitive communications was "being so involved in a subject that I had never heard of before."

Bowers and her project partner developed a malware detection software program for cognitive radios. "I learned a lot and would like to continue to work in security and software engineering," she says. "The REU helped me to see a clearer picture of what

“The REU helped me to see a clearer picture of what research at graduate school would be like.”





TAYLOR PEARMAN worked on a converter board that translates data between the sensors and central processing unit of a motion capture jumpsuit.

research at graduate school would be like.”

During its five years of operation, the Wireless@VT REU has been consistently successful at encouraging and preparing students to attend graduate school. According to Mike Buehrer, faculty mentors have seen a majority of the site’s participants go on to pursue graduate degrees. (E-Textiles has hosted REU students for about 10 years and also has a strong track record for graduate school recruitment.)

“We work closely with the undergraduate research office to put together a lot of programming for students in terms of professional development,” says Carl Dietrich, principal investigator of the Wireless@VT REU site. A new addition to the 2013 program was a trip to the International Conference on Cognitive Radio Oriented Wireless Networks (CROWNCOM) in Washington, D.C—an experience that Dietrich calls “very relevant to what we were doing.”

Under the mentorship of Chao Wang, two of CESCA’s 2013 REU students also gained valuable conference experience. Markus Kusano (CPE ’14) and Kevin Hoang (CPE ’14) each published a paper about their projects at prominent software engineering conferences.

Moreover, Kusano released the mutation testing tool that he built as open-source software, and both students helped lead the NSF STEP outreach program for incoming college students at Virginia Tech. “They were quite productive,” comments Wang.

In spite of their compelling projects, REU students are decidedly not “all work and no play.” Participants enjoy opportunities to learn from the diverse perspectives of their colleagues from different majors and universities—both inside and outside of the lab.

Getting to know visiting students in the Space@VT REU was one of the most exciting aspects of the program, says Patrick Herrity (EE ’14), who completed data analysis of atmospheric gases measured by the SABER satellite. “We went on hikes and went out to local restaurants,” he recalls. “They told me a lot about their experiences at their colleges and engineering programs.”

This summer, the REU faculty mentors at Virginia Tech will be working together to promote interaction between the various REU sites on campus. “All REU students will probably be together in one dorm,” says Bailey. “There will be a seminar series about the nuts and bolts of going to grad school.”

Bailey is looking forward to bringing in a new group of students for the 2014 REU, praising the merit of the program for students and faculty alike. “It changes the whole energy of the place when you double the number of students,” he says. “You can get a lot of work done. Students do great things.”

OUTFITTING ASTRONAUTS

Students tackle NASA design challenges

"It was the first time that I worked on a project where there were no clearly defined objectives. We had to figure out how to pace ourselves and set goals."

LAST SPRING, ECE STUDENTS took "real world experience" to new heights with out-of-this-world projects for a high-profile client.

NASA invited interdisciplinary teams from Virginia Tech's intelligent textiles programs to tackle design challenges faced by the agency. The students developed working prototypes and presented their concepts during a wearable technology symposium at the Johnson Space Center in Houston, Texas.

Advised by ECE's Tom Martin and Paola Zellner of the School of Architecture and Design, students completed two projects: a hands-free jetpack controller and a real-time visualization of fabric structures that unfold and inflate in space.

Working with intelligent textiles was a new experience for some of the ECE students, including Mark Koninckx (CPE '16). His goal was to "see if I could do a real-world project to solve a real-world problem for a real-world customer."

Koninckx teamed up with Mahmood Alwash (EE '13) and Chris Drudick (ARCH '13) on the inflatable structure visualization project. "The problem is that the structures sometimes won't inflate properly because the layers of fabric get snagged," he explains. "It's easy to detect and fix these problems on the ground, but in a launch situation you can't see the structures very well."

Koninckx and his team developed a prototype that uses a network of bend sensors to detect the shape of fabric. The sensors interface with a microcontroller that provides a real-time, 3-D output of the structure to a laptop.

"It was really cool to go from a problem statement to a working proof-of-concept," recalls Koninckx. "It was the first time that I worked on a project where there were no clearly defined objectives. We had to figure out how to pace ourselves and set goals."

The experience of working with an interdisciplinary team provided a fresh perspective, according

BEND SENSORS detect the shape of fabric so that astronauts can troubleshoot problems that prevent structures from unfolding and inflating properly.

to Koninckx. "It was interesting to work with a different department that is just as rigorous as ECE, but focused on a different expertise."

John Murphy (CPE '15) had the challenge of being the only ECE student on his project team, which was tasked with building a shoe insert to provide astronauts a hands-free method of controlling their jetpacks.

Murphy handled wiring and circuit design for the foot sensor assembly, while his teammates Kate O'Connor (ARCH '13) and Ashleigh Otto (ID) were responsible for designing the shoe and determining sensor placement. "Trying to explain things in non-engineering ways was pretty tough," Murphy says. "I struggled at first."

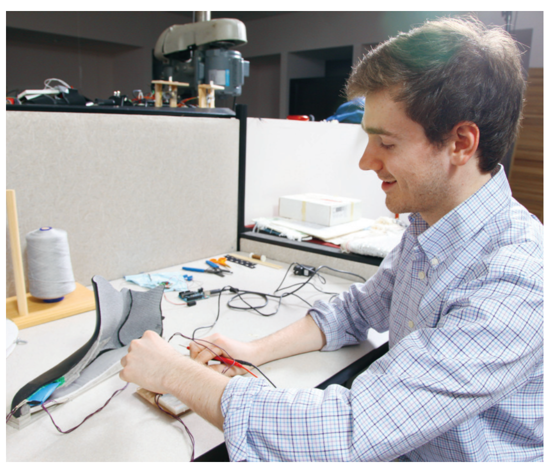
The team overcame the jargon barrier by working closely together in the same space, and teaching each other new skills—"learning how to sew was fun," says Murphy. As the project progressed, "everyone on the team had a better grasp of what was going on."

The shoe insert that Murphy and his teammates developed uses force sensors placed above and below the toes in the boot. The sensors detect the up and down motion of the astronaut's toes and send signals to a microcontroller that interfaces with the jetpack controls.

According to Murphy, the highlight of the experience was his trip to the Johnson Space Center. Joined by teams from Georgia Tech and the University of Minnesota, the Virginia Tech students toured the facility and presented their projects to NASA. "The best part was seeing our visualization of what was going on actually work when we were presenting—seeing everything come together in the end," says Murphy.

The students made a favorable impression, and NASA invited Virginia Tech to complete another round of projects this spring. The new challenges are a noise-canceling collar that will dampen the sound of noisy space stations, an integrated sensor system for space gloves, a flexible electronic checklist display for spacesuit cuffs, and a one-handed keyboard that will be compatible with space gloves.

The teams received funding for the projects from the Virginia Space Grant Consortium and from ICAT—Virginia Tech's Institute for Creativity, Arts, and Technology. ■



MARK KONINCKX demonstrates his inflatable structure visualization project. Koninckx was responsible for most of the programming for the system, which provides a real-time 3-D output of the structure to a laptop (above).

JOHN MURPHY designed and wired the circuit for a shoe insert that provides astronauts hands-free control of their jetpacks (left).

2013 | 2014 BRADLEY & WEBBER HONORS

Thaddeus Czauski

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

Advisor: Jeffrey Reed
Research: He is developing methods to improve the efficiency of large industrial control systems using cyber-physical systems, wireless communications, and mobile cloud computing. His project uses cyber-physical provisioning to automatically identify devices in the field and provide technicians' smartphones with appropriate software to access and maintain those devices. He is working to apply similar technology with patients and clinicians in a medical setting.

BRADLEY ALUMNI

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

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

Shawn Addington, P.E. (F)
(BSEE '90, MSEE '92, Ph.D. '96)
ECE Department Head
Virginia Military Institute
Lexington, Va.
Supervising student involvement in undergraduate research in microelectronics and semiconductor devices.

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

Christopher R. Anderson (S/F)
(BSEE '99, MSEE '02, Ph.D. '06)
Associate Professor
U.S. Naval Academy
Annapolis, Md.
He received tenure and was promoted to associate professor in 2013.

Matthew E. Anderson (S)
(BSCPE '08)
Graduate Student
Virginia Tech

Nathaniel August (F)
(BSCPE '98, MSEE '01, Ph.D. '05)

Stephen P. Bachhuber (F)

Matthew Bailey (F)
(BSCPE '09)
Graduate Student
Virginia Tech

Mark Baldwin (F)
(BSEE '93, MSEE '05, Ph.D. '08)

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

Benjamin Alan Beasley (S)
(BSEE '09)
Associate
Zeta Associates Inc.
Fairfax, Va.
Pursuing an MSEE.

Brian Berg (F)
(BSEE '90, MSEE '91, Ph.D. '01)
President and Founder
Dimmersion LLC
Agoura Hills, Calif.
Launched a social media company that allows users to synchronously play media tracks with existing audiovisual content without violating copyrights.

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

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

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

Kirsten Ann Rasmussen Brown (S)
(BSEE '94)
Vice President, Office of the Chairman
MicroStrategy Inc.
Tysons Corner, Va.
In addition to executing the CEO's vision and company priorities for MicroStrategy, Brown is a member of the ECE Advisory Board.

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

Mark B. Bucciero (F)
(BSCPE '01, MSCPE '04)
Computer Engineer
Logos Technologies
Raleigh, N.C.

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

Charles Bunting (F)
(MSEE '92, Ph.D. '94)
Associate Dean of Research, College of Engineering, Architecture and Technology
Oklahoma State University
Stillwater, Okla.
Director of the Robust Electromagnetic Field Testing and Simulation Lab at Oklahoma State. Serving on the IEEE Electromagnetic Compatibility Society board of directors.

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

Scott Cappiello (S)
(BSCPE '94)

Matthew Carson (S)
(BSEE '98)
Logistics Coordinator
He is currently in South Asia, learning a new language. He will be doing logistical support for other foreigners in the country and assisting NGOs there.

Matthew Carter (F)
(BSEE '09)
Graduate Student
Virginia Tech

Ricky Castles (S)
(BSCPE '03, MSCPE '06, Ph.D. '10)

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

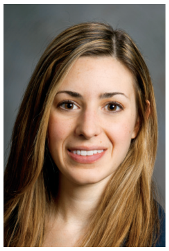
Daniel (Dae) Cho (S)
(BSEE '06)
Intellectual Property Attorney
Winston & Strawn LLP
Los Angeles, Calif.

Jeffrey R. Clark (F)
(MSEE '03, Ph.D. '06)
Proprietor
Black Dog Writing & Editing
Blacksburg, Va.
He provides technical writing and editing services and is a novelist.

Paul Uri David

Bradley Fellow
BSEE '13
Clemson University

Advisor: Robert McGwier
Research: Software-defined radios and cognitive radio. He is working on a Wireless@VT project to defend Long-Term Evolution (LTE) cellular networks against jamming by developing simulations of malicious scenarios and mitigation strategies. He is also working on a project with the Hume Center for National Security and Technology.



Christina DiMarino

Webber Fellow
BSE '12
James Madison University

Advisor: Dushan Boroyevich
Research: After characterizing various types of 1.2 kV SiC power transistors (including MOSFETs, BJTs, and normally-on and normally-off JFETs), she is exploring higher voltage transistors (1.7 kV and 10 kV) and modeling the devices.
Awards: Best Student Paper at High Temperature Electronics Network (HiTEN) 2013, Oxford, UK; Top Student Oral Presentation Award at the 2013 IEEE Energy Conversion Congress & Expo, Denver, Colo.

Michael Drescher

Bradley Fellow
BSCPE '13
Virginia Tech

Advisor: Binoy Ravindran
Research: Expanding the capability of Virginia Tech's Popcorn Linux, in which each CPU in a system runs its own kernel. He is extending the messaging layer to span across systems with heterogeneous elements, such as GPUs and low-power ARM processors. When complete, Popcorn Linux will be the only multi-kernel Linux OS that can run on heterogeneous systems, allowing servers with many cores to improve speed and energy consumption.

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

Ross Clay (S)
(CPE '09)
Software Developer
Amazon
Palo Alto, Calif.
Working on DynamoDB, Amazon Web Services' database service. He is enjoying the fast-paced work at the peak of applied research into scalability and durability in modern distributed systems. "Virginia Tech set me on the right path," he reports.

Brittany Clore (S)
(BSCPE '10, MSCPE '12)
Information Assurance Staff
The MITRE Corporation
McLean, Va.
Working on cybersecurity policy, cross domain solution evaluations, and risk decision processes.

Kevin B. Cooley (S)
(BSEE '02)
Electrical Engineer
Industrial Automation Specialists Corp.
Hampton, Va.
Home automation humidistat project recently funded on Kickstarter.

Thomas Alan Cooper (S)
(BSEE '10, MSEE '12)

Carrie Aust Cox (F)
(MSEE '00)

David Casteel Craven (S)
(BSCPE '08)

Stephen Douglas Craven (F)
(Ph.D. '08)
Electrical Engineer
Tennessee Valley Authority
Chattanooga, Tenn.

Cass Dalton (S)
(BSCPE '03)

Phillip A. Danner (S)
(BSCPE '91)

Bradley A. Davis (F)
(BSEE '86, MSEE '88, Ph.D. '00)
Vice President, Engineering
Nanosonic
Pembroke, Va.

Daniel A. Davis (S)
(BSCPE '99)
Principal Member of the Technical Staff
AT&T
Chesapeake, Va.
Serving as senior network security engineer.

Scott Davis (S)
(BSCPE '00)

T. Shaver Deyerle (F)
(BSEE '10, MSEE '13)
Graduate Student
Virginia Tech

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

Brian Michael Donlan (F)
(MSEE '05)

Thomas H. Drayer (F)
(BSEE '87, MSEE '91, Ph.D. '97)

Bradley Duncan (F)
(Ph.D. '91)

Gregory D. Durgin (F)
(BSEE '96, MSEE '98, Ph.D. '00)
ECE Associate Professor
Georgia Tech
Atlanta, Ga.
Earned the 2013 Richard Bass Award for Outstanding Teacher in Georgia Tech's school of ECE.

William Ashley Eanes (S)
(BSEE '95)

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

Brian Flanagan (S/F)
(BSEE '97, MSEE '98)
Senior Design Engineer
Intel
Austin, Texas

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
Laurel, Md.

Michael Fraser (F)
(BSEE '09, MSEE '12)
Graduate Student
Virginia Tech

Jayda Blair Freibert (S)
(BSEE '98)
Segment Sales Manager
GEA PHE Systems
York, Pa.

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

Bradley Heath Gale (S)
(BSEE '97)

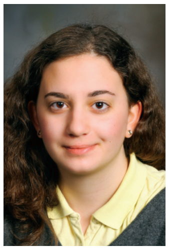
Robert Matthew Gardner Sr. (F)
(BSEE '03, MSEE '05, Ph.D. '08)
Consulting Engineer
Dominion Resources
Richmond, Va.
Elevated to IEEE Senior Member.

Kelson Gent (F)
(MSCPE '13)
Graduate Student
Virginia Tech

Daniel Joshua Gillespie (S)
(BSCPE '95)

Brian Gold (S)
(BSEE '01, MSCPE '03)

BRADLEY & WEBBER FELLOWS *CONT.*



Lucy Fanelli

Webber Fellow
BSECE '12
Brown University

Advisor: Gregory Earle
Research: Space@VT instrumentation. She is designing and testing electronics for the first retarding potential analyzer that is compatible with a CubeSat platform. The CubeSat will measure ion concentration, composition, temperature, and velocity in the ionosphere.

Kristen Hines

Webber Fellow
BSECE '13
Tennessee Tech University

Advisor: Tom Martin
Research: Embedded systems and wearable computing. Her project is a "forgettable ambulatory monitoring system" that works with minimal input from the wearer, who forgets that she or he is being monitored. Hines is expanding the activity classifier and developing a software/hardware layer between the sensors and classifier to eliminate the need to adapt to each other.

Nicholas Shao Hsien Hu

Bradley Fellow
BSEECS '06
Chung Yuang Christian University
M.S. Earth and Space Sciences '08
North Central University
MSEE '13
North Carolina State University

Advisor: Steven Ellingson
Research: He is using a self-developed monitoring system to investigate radio frequency interference (RFI) at L-Band. He is specifically targeting RFI at the National Radio Astronomy Observatory in Green Bank, W.Va., where nearby aviation radars are suspected RFI sources. His work can be used to inform regulations on RFI emissions and spectrum usage in radio astronomy bands.

BRADLEY ALUMNI *CONT.*

Jonathan Graf (S)
(BSCPE '02, MSCPE '04)
Director of Technology
MacAulay-Brown Inc.
Roanoke, Va.
Develops secure computing and communications technologies for the federal government.

Timothy Gredler (S)
(BSCPE '03)
Design & Development Leader
Lutron Electronics Co. Inc.
Coopersburg, Pa.
Oversees software development team for Lutron's EcoSystem product line, which can save 40-70 percent of electricity used for lighting in a commercial building.

Christopher Griger (S)
(BSCPE '02)

Daniel Hager (S)
(BSCPE '08, MSCPE '09)

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

Alexander Hanisch (S)
(BSCPE '03)
Modeling and Simulation Scientist
Joint Warfare Analysis Center
Dahlgren, Va.
Received the Joint Civilian Commendation Award and the Global War on Terrorism Civilian Service Medal for his analysis efforts in Afghanistan.

Nathan Harter (F)
(MSEE '07)
Systems Engineer
G3 Technologies Inc.
Mount Airy, Md.

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

William C. Headley (F)
(BSEE '06, MSEE '09)

Matt Helton (S)
(BSEE '01)
Control Systems Support Supervisor
Eastman Chemical Co.
Kingsport, Tenn.
Appointed supervisor of Eastman's new PLC & Hardware Group.

Ben Henty (F)
(MSEE '01)

Jason Hess (F)
(BSEE '97, MSEE '99)
Manager for HW Engineering, Internet of Things Group
Cisco Systems
Austin, Texas

Erik Hia (F)
(BSCPE '99, MSCPE '01)
Manager, Engineering-Software
Overture Networks
Morrisville, N.C.
Managing the Core Platform Software group and its Overture 6500 platform—a scalable, high-resiliency Carrier Ethernet aggregation and switching platform.

Daniel J. Hibbard (F)
(BSEE '02, MSEE '04)
Project Manager, Radar Systems
Trident Systems
Fairfax, Va.

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

Hugh Edward 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)

Andrew Scott Hollingsworth (S)
(BSCPE '03)

Michael Hopkins (F)
Graduate Student
Virginia Tech
Working on dynamic locomotion strategies for compliant legged robots.

Ellery L. Horton (S)
(BSCPE '04)
QA Engineer
ChannelAdvisor
Roanoke, Va.
Received a patent for systems and methods for functional testing using leveraged dynamic linked libraries.

Keith C. Huie (F)
(MSEE '02)

Ryan Hurrell (S)
(BSEE '03)
Senior Engineer
Siemens-Healthcare Molecular Imaging
Knoxville, Tenn.
Team lead for the patient handling system used for Siemens PET/CT imaging.

John Todd Hutson (S)
(BSEE '93)

Ryan Irwin (F)
(M.S. '10, Ph.D. CPE '12)

Daniel A. Johnson (F)
(BSEE '98, MSEE '01)

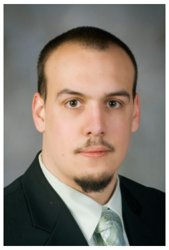
Edward Andrew Jones (S)
(BSEE '07)
Graduate Research Assistant
University of Tennessee
Knoxville, Tenn.
Pursuing a Ph.D. in power electronics and energy science, working with the Center for Ultra-wide-area Resilient Electric eNergy Transmission (CURENT) and the National Transportation Research Center.

Nicholas Kaminski (F)
(BSEE/BSCPE '10, M.S. '12, Ph.D. '14)

Chris Jelesnianski

Bradley Fellow
BSECE '13
Rutgers University

Advisor: Binoy Ravindran
Research: He is working on Virginia Tech's Popcorn Linux project, which aims to build an operating system for heterogeneous hardware. He is developing programs to run on top of Popcorn Linux. He is currently developing automatically partitioning programs so that each part will run on the optimal hardware.



Nicholas Kaminski

Bradley Fellow
BSEE/BSCPE '10, Ph.D. '14
Virginia Tech

Advisor: Charles Bostian
Research: In February, he defended his Ph.D. dissertation, "Social Intelligence for Cognitive Radios." His work introduces the concept of an artificial society based on the use of an action based social language combined with the behavior-based approach to the construction of multi-agent systems to address the problem of developing decentralized, self-organizing networks that dynamically fit into their environment.

Virginia Li

Webber Fellow
BSEE '13
Virginia Tech

Advisor: Qiang Li
Research: High-frequency, high-density Point-of-Load (POL) converter design. Pushing the operating frequency of POL converters naturally decreases component sizes and reduces the footprint to increase device power density. However, for low-power applications the currently available discrete devices can create bottlenecks. She is investigating integrated structures that can reduce system volume and parasitic inductance.

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

Basil Thomas Kalb (S)
(BSEE '98)

Adam Steven Kania (S)
(BSEE '01)
Customer Support Territory Manager
Caterpillar Inc.
Hamburg, Germany
Managing customer support for Caterpillar marine engine dealers in Europe and Africa.

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

Dimosthenis Katsis (F)
(BSEE '95, MSEE '97, Ph.D. '03)
President
Athena Energy Corp.
Bowie, Md.
Developing alternative energy products and consulting on DoD power supply design projects.

Nathan Kees (F)
(M.S. '13)
Graduate Student
Virginia Tech

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)
ECE Professor
Kansas State University
Manhattan, Kan.
Recent funded NASA project on biomedical sensors and associated wireless links for astronauts on long-duration missions.

Zachary La Celle (S)
(BSCPE '09)

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

Jeff Laster (F)
(BSEE '91, MSEE '94, Ph.D. '97)
Principal Technical Manager, Raytheon
Mentor Graphics
Dallas, Texas

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

Charles Lepple (F)
(BSEE '00, MSEE '04)
Senior Research Engineer
Johns Hopkins University
Applied Physics Laboratory
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 A. Hodges Longfellow (S)
(BSCPE '01)
Senior Software Developer
Acronis
Arlington, Va.

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

Andrew Love (F)
Graduate Student
Virginia Tech

Amy Malady (F)
(BSEE '09)

Annie Martin (F)
(M.S. '13)
Graduate Student
Virginia Tech

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

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

Michael Frederic Mattern (S)
(BSEE '02)
Systems Lead – Telematics
Cummins Inc.
Columbus, Ind.

Christopher Allen Maxey (S)
(BSCPE '02, MSEE '04)
Associate
Booz Allen Hamilton
Arlington, Va.
Pursuing a Ph.D.

Eric J. Mayfield (S)
(BSEE '97, MSEE '98)
Technical Director
Department of Defense
Ft. Meade, Md.

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

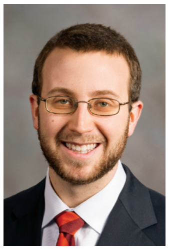
Patrick McDougle (S)
(BSEE '03)

Brian J. McGiverin (S)
(BSCPE '96)

John McHenry (F)
(BSEE '98, MSEE '90, Ph.D. '93)
Senior Electrical Engineer
Department of Defense
Fort Meade, Md.
He is also a member of the ECE Advisory Board.

Keith McKenzie (F)

BRADLEY & WEBBER FELLOWS CONT.



Robert Lyerly

Bradley Fellow
BSCPE/BSCS '12
Virginia Tech

Advisor: Binoy Ravindran
Research: Optimization and scheduling of applications on heterogeneous hardware. He is applying compiler analysis and optimizations to facilitate the scheduling of applications across emerging architectures to achieve the performance benefits afforded by these architectures.

Elliott Mitchell-Colgan

Bradley Fellow
BSECE '12
Lafayette College

Advisor: Virgilio Centeno
Research: Integration of intermittent renewable systems to the power grid. He is developing methods for improving the reliability of power systems that include intermittent renewable energy sources. During large power system disturbances, part of the system may be disconnected to facilitate stable recovery of system frequency. Unfortunately, intermittent renewable source exacerbate the challenge of minimizing partial blackouts because of the uncertainty in their power output.

Timothy Pierce, Jr.

Bradley Fellow
BSEE '13
Hampton University

Advisor: Louis Beex, Alfred Wicks (ME)
Research: Hybrid power systems. He is investigating the integration of hybrid technologies and renewable energy sources to produce a mobile power system. A key aspect of his project is developing control algorithms to combine multiple sources into a useful output.

BRADLEY ALUMNI CONT.

David Robert McKinstry
(MSEE '03)
Principal Systems Engineer
3 Phoenix Inc.
Chantilly, Va.

James W. McLamara (F)
(BSEE '02)
Electrical Engineer
Lockheed Martin Laser Systems
Apex, N.C.
Pursuing a Ph.D. at North Carolina State University

Garrett Mears (S)
(BSCPE '00)
Chief Technology Officer
Codilink
London, U.K.
Leading the technology team for an Internet startup company.

Vinodh Menon (S)
(BSCPE/ISE '02)
Received an MBA from Duke University in 2013.

Michael Mera (S)
(BSEE '03)
Lead Electrical Engineer
Picatinny Arsenal
New Jersey
Leading a research and development team for U.S. Army weapon systems.

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

John Morton (F)
(MSEE '98)
Lead Member of Technical Staff
Bandspeed Inc.
Austin, Texas
Responsible for developing, modeling, and implementing signal processing algorithms used in Bandspeed ICs to detect, classify, and avoid RF interference that impairs 802.11 networks.

Christian Murphy (F)

Stephen Nash (S)
(BSCPE '03)
Senior Software Engineer
Verite Group
Dulles, Va.
Serves on the Civil Air Patrol.

Troy Nergaard (F)
(MSEE '02)
Seattle, Wash.

Michael Newkirk (F)
(BSEE '88, MSEE '90, Ph.D. '94)
Principal Professional Staff
Johns Hopkins University Applied Physics Laboratory
Laurel, Md.
ECE Advisory Board Chair
Serves as assistant group supervisor for the Radar System Analysis and Phenomenology Group in the Air and Missile Defense Department.

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

J. Eric Nuckols (F)
(BSEE '97, MSEE '99)
Communications Engineer
Zeta Associates
Fairfax, Va.

Abigail Harrison Osborne (S)
(BSCPE '04)

Neal Patwari (S)
(BSEE '97, MSEE '99)
ECE Associate Professor
University of Utah
Salt Lake City, Utah
Serves as director of research for Xandem Technology, an RF sensing system manufacturer.

Joseph Allen Payne, Jr. (S)
(BSEE '00)
Advisory Engineer
Northrop Grumman
Linthicum, Md.

Linh My Pham (S)
(BSCPE '07)
Post-Doctoral Fellow
Harvard University
Cambridge, Mass.

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

Yaron Rachlin (S)
(BSEE '00)

Parrish Ralston (F)
(BSEE '06, MSEE '08, Ph.D. '13)

David Reusch (F)
(BSEE '04, MSEE '06, Ph.D. '12)
Director of Applications Engineering
Efficient Power Conversion Corporation
Blacksburg, Va.

Justin Rice (F)

Richard Steven Richmond (F)
(MSEE '01)

Amy M. Ridenour (F)
Lead Power Conversion Engineer
GE Energy Management
Salem, Va.
Develops power converters for wind and solar applications.

Christian Rieser (F)
(MSEE '01, Ph.D. '04)
Capabilities & Innovation Leader
The MITRE Corporation
Charlottesville, Va.

Jamie N. Riggins (S/F)
(BSEE '04, '06)
Software Analysis Engineer
United States Air Force
Wright Patterson Air Force Base, Ohio

Gray Roberson (F)
(Ph.D. '07)
Technical Staff Engineer
Kollmorgen
Radford, Va.

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

Richard Tillman

Bradley Fellow
BSEE '12
Virginia Tech

Advisor: Steven Ellingson
Research: Radiometry/radio astronomy. His research uses precision measurement of astrophysical source flux densities below 100 MHz for array calibration. He is developing an interferometer that uses high-linearity front ends with internal noise calibration. He is investigating the use of 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: He is assembling abstracted hardware development environments for researchers in the life sciences. The goal of his research is to mitigate bottlenecks in big-data research by enabling non-engineers to use high-performance heterogenous computing platforms with minimal engineering aid. He is collaborating with the Virginia Bioinformatics Institute.
Honors: He studied at the Institute for Information Processing Technology (ITIV) in Karlsruhe, Germany in 2013.

Jason Ziglar

Bradley Fellow
BSEE/Biomedical Engineering '05
Duke University
M.S. Robotics '07
Carnegie Mellon University

Advisor: Tomonari Furukawa (ME)
Research: Robotics. He is the software and perception lead for Virginia Tech's Team THOR, which is developing a disaster-response robot for the DARPA Robotics Challenge. His research explores methods for improving sensory interpretation and communication between robots and remote human operators in unstructured scenarios.
Industry Experience: 5+ years as Robotic Engineer at NREC

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

Thomas Rondeau (S/F)
(BSEE '03, MSEE '06, Ph.D. '07)
Rondeau Research LLC
Shelburne, Vt.
His company develops GNU radio. Also serves as a research associate at the University of Pennsylvania.

Thomas Rose (S)
(BSEE '94)
Senior Engineer
Boeing
St. Louis, Mo.
Designs radar and other sensors for airborne platforms.

Jonathan Scalera (F)
(MSCPE '01)
Radiology Fellow
Brigham and Women's Hospital
Boston, Mass.
Serving a two-year fellowship in abdominal imaging and intervention and image guided therapy.

Javier Schloemann (F)
Graduate Student
Virginia Tech

Amy L. Schneider (S)
(BSCPE '03)

David Craig Schroder (S)
(BSEE '05)

Steven Schulz (F)
(MSEE '91)

Ian Schworer (F)
(BSCPE '03, MSEE '05)
Vice President
TriplePoint Capital
Menlo Park, Calif.
Manages equity and debt investments in emerging technology companies. Serves as a liaison between venture capitalists and startups at UC Berkeley.

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

Kashan Ali Shaikh (S)
(BSCPE '02)

Adam Keith Shank (S)
(BSCPE '07)
Software Engineer
IBM
Raleigh, N.C.

Raymond Ashley Sharp (S)
(BSEE '02)

Rebecca Kay Shelton (F)
(MSEE '08)
Electronics Engineer
United States Army Primary Standards Laboratory
Huntsville, Ala.

Jacob R. Simmons (S)
(BSCPE '08, MSEE '10)

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

Chelsy Smidler (S)
EE Student
Virginia Tech

Jeff Smidler (S)
(BSEE '99)

Amanda Martin Staley (S/F)
(BSEE '99, MSEE '01)
Lead Engineer
The MITRE Corporation
McLean, Va.
PI on research to provide common situation awareness to non-colocated members of the FAA traffic flow management team. Pursuing her Ph.D. at Virginia Tech.

Graham D. Stead
(BSCPE '93)

Jennifer Hastings Steele (S)
(BSEE '96)

Neil Steiner (F)
(MSEE '02, Ph.D. '08)
Computer Scientist
USC Information Sciences Institute
Arlington, Va.
Recently awarded three research proposals, and serving as technical lead on projects for DARPA and AFRL. Overseeing Torc, an open-source tool set for reconfigurable computing hardware.

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

Scott Stern (S)
(BSEE '93)
Program Manager
Compunetix Inc.
Monroeville, Pa.
Managing development of mission-critical conferencing systems for the government and military. His current project focuses on replacing voice systems for U.S. homeland air defense.

Samuel Spencer Stone (S)
(BSCPE '04)
Associate
Wolf, Greenfield & Sacks
Boston, Mass.
Serves as a mentor for the MIT $100K Entrepreneurship Competition.

Anne Palmore Stublen (S)
(BSEE '91)

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

Juan Suris (F)
(Ph.D. '07)

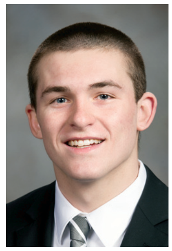
Ethan Swint (F)
(Ph.D. '12)
Motor Designer
Applimotion Inc.
Loomis, Calif.

David L. Tarnoff (F)
(BSEE '87, MSEE '91)
Associate Professor, Applied Science & Technology
East Tennessee State Univ.
Johnson City, Tenn.
Teaches hardware, embedded systems, iOS application development, and web technologies. Research includes embedded systems, and applications using ARM-based processors.

BRADLEY SCHOLARS

Callie Johnston
BSCPE '14
Mentor, Ohio

Why ECE: ECE has always fascinated me. The complexity of hardware and software and the accomplishments that it can achieve are very rewarding.
Why Virginia Tech: Virginia Tech has some amazing opportunities available to students, both inside and outside the classroom.
Honors & Activities: Eta Kappa Nu, Tau Beta Pi, SalsaTech, Association of Women in Computing, AMP Lab mentor (read article on p. 19).



Derek O'Connor
BSEE and BSCPE '17
Clifton Forge, Va.

Why ECE: My interest in electrical engineering grew during my governor's school physics class. I really enjoyed the sections on electricity.
Why Virginia Tech: My grandfather and father both graduated from Virginia Tech and it was important to carry on that legacy. Most importantly, engineering at Virginia Tech is world renowned.
Most Memorable Tech Experience: Attending Hokie Camp, where I made many new friends and learned what being a Hokie is really all about.

BRADLEY ALUMNI *CONT.*

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

Daniel J. Tebben (F)
(Ph.D. '06)
Section Supervisor
Johns Hopkins University
Applied Physics Laboratory
Laurel, Md.
Works in the network modeling and simulation section of the communication and networking technology group.

Benton Thompson (F)
(MSEE '11)
Software Engineer
G3 Technologies
Ashburn, Va.
Designs software for mobile radio.

Jerry Towler (S)
(BSEE '08, MSEE '11)
Research Engineer
Southwest Research Institute
San Antonio, Texas

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 Vercellino (F)

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

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

Kristin Weary (S)
(BSEE '03)

Michael Lee Webber (F)
(BSEE '02, MSEE '04)
Chief Engineer
United States Air Force
Wiesbaden, Germany

Paul C. Weinwurm (S)
(BSEE '03)

Matt Welch (S)
(BSEE '09)
Test Engineer, Fleet and Prototype Test Engineering
GE Power and Water
Greenville, S.C.
Test lead engineer for gas turbine plant field testing.

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)

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

Ben York (F)
(MSEE '10, Ph.D. '13)
Senior Project Engineer
Electric Power Research Institute
Knoxville, Tenn.

Phillip Andrew Zellner (F)
(BSEE '07)
Graduate Student
Virginia Tech

Richard Zimmermann (S)
(BSCPE '07)

Gregory A. Zvonar (S)
(BSEE '90, MSEE '91, Ph.D. '98)

STUDENT AWARDS

Bharat Kunduri (Ph.D. '13) won first place in a student poster competition at the Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Workshop, Boulder, Colo., June 2013.

Min Li (Ph.D. '12) and Kelson Gent (Ph.D. '15), with Michael Hsiao, received the Best Paper Award with Student as Primary Author at the International Test Conference, Anaheim, Calif., September 2013.

Carlo del Mundo (CPE '14) won the best undergraduate research award for the ACM Student Research Competition at the International Conference for High Performance Computing, Networking, Storage and Analysis (SC13), Denver, Colo., November 2013.

Christina Marie DiMarino (Ph.D. '17) Best Student Paper at High Temperature Electronics Network (HiTEN), July 2013, Oxford, UK; Top Student Oral Presentation Award at the September, 2013 IEEE Energy Conversion Congress & Expo (ECCE), Denver, Colo.

Bryan Yanchulis (BSEE '15) and his teammates in Virginia Tech's Collegiate Aerial Robotics Demonstration (CARD) group won first place at the 2013 Collegiate Aerial Robotics Exhibition.

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2012 2013 PH.D. DEGREES AWARDED

Arghandeh Jouneghani, Reza
Distributed Energy Storage Systems: Critical Microgrid Application, Market-Based Optimal Operation and Harmonic Analysis
Committee Chair: Centeno, V. A.

Ashry, Islam A.
Investigating the Modification of Spontaneous Emission using Layer-by-Layer Self-Assembly
Committee Chair: Xu, Y.

Azab, Mohamed M.
Cooperative Autonomous Resilient Defense Platform for Cyber-Physical Systems
Committee Chair: Hou, T. Y.

Bordikar, Maitrayee R.
Analysis of Plasma Wave Irregularities Generated During Active Experiments in Near-Earth Space Environment
Committee Chair: Scales, W.A.

Carstens, Justin N.
Understanding Uncertainties for Polar Mesospheric Cloud Retrievals and Initial Gravity Wave Observations in the Stratopause from the Cloud Imaging and Particle Size Instrument
Committee Chair: Bailey, S. M.

Chavali, Venkata G.
Signal Detection and Modulation Classification in Non-Gaussian Noise Environments
Committee Chair: da Silva, C.

Cho, Younghoon
Multi-Branch Current Sensing Based Single Current Sensor Technique for Power Electronic Converters
Committee Chair: Lai, J.

Cong, Alexander X.
Inverse Problems in Optical Molecular Imaging
Committee Chair: Wang, G. (Biomedical Engineering)

Dong, Bo
Fiber Optic Sensors for On-Line, Real Time Power Transformer Health Monitoring
Committee Chair: Wang, A.

Dong, Dong
Ac-dc Bus-interface Bi-Directional Converters in Renewable Energy Systems
Committee Chair: Boroyevich, D.

Farag, Mohammed Morsy N.
Architectural Enhancements to Increase Trust in Cyber-Physical Systems Containing Untrusted Software and Hardware
Committee Chair: Patterson, C. D.

Feng, Weiyi
State-Trajectory Analysis and Control of LLC Resonant Converters
Committee Chair: Lee, F. C.

Frangieh, Tannous
A Design Assembly Technique for FPGA Back-End Acceleration
Committee Chair: Athanas, P. M.

Fu, Haiyang
Modeling of Plasma Irregularities Associated with Artificially Created Dusty Plasmas in the Near-Earth Space Environment
Committee Chair: Scales, W. A.

Ha, Sook S.
Dimensionality Reduction, Feature Selection, and Visualization of Biological Data
Committee Chair: Xuan, J.

Han, Chuan
Modeling and Optimization of Wireless Routing
Committee Chair: Yang, Y.

Hearn, Christian W.
Electrically-Small Antenna Performance Enhancement for Near-Field Detuning Environments
Committee Chair: Davis, W. A.

Hong, Sun K.
Resonance-Based Techniques for Microwave Breast Cancer Applications
Committee Chair: Davis, W. A.

Iskander, Yousef S.
Improved Abstractions and Turnaround Time for FPGA Design Validation and Debug
Committee Chair: Patterson, C. D.

Jiang, Canming
Some Optimization Problems in Wireless Networks
Committee Chair: Hou, T. Y.

Jones, Kevin D.
Synchrophasor-Only Dynamic State Estimation & Data Conditioning
Committee Chair: Thorp, J. S.

Kandas, Ishac L. N.
Silica Microspheres Functionalized with Self-Assembled Nanomaterials
Committee Chair: Xu, Y.

Lee, Joo Hong
Hybrid Parallel Computing Strategies for Scientific Computing Applications
Committee Chair: Plassmann, P. E.

Li, Min
Acceleration of Hardware Testing and Validation Algorithms using Graphics Processing Units
Committee Chair: Hsiao, M. S.

Lin, Hua
Communication Infrastructure for the Smart Grid: A Co-Simulation Based Study on Techniques to Improve the Power Transmission System Functions with Efficient Data Networks
Committee Chair: Shukla, S.

Liu, Tong
Nonvolatile and Volatile Resistive Switching – Characterization, Modeling, Memristive Subcircuits
Committee Chair: Orlowski, M. K.

Ma, Cheng
Modeling and Signal Processing of Low-Finesse Fabry-Perot Interferometric Fiber Optic Sensors
Committee Chair: Wang, A.

Mahmoudian, Alireza
New-Measurement Techniques to Diagnose Charged Dust and Plasma Layers in the Near-Earth Space Environment Using Ground-Based Ionospheric Heating Facilities
Committee Chair: Scales, W. A.

Mu, Mingkai
High Frequency Magnetic Core Loss Study
Committee Chair: Lee, F. C.

Pei, Guanhong
Distributed Scheduling and Delay-Throughput Optimization in Wireless Networks under the Physical Interference Model
Committee Chair: Vullikanti, A. (Computer Science)

Peng, Senlin
A Multi-Constellation Multi-Frequency GNSS Software Receiver Design for Ionosphere Scintillation Studies
Committee Chair: Scales, W. A.

Plymale, William O.
Pebbles and Urns: A Tangible, Presence-Based Service Delivery Framework
Committee Chair: Midkiff, S. F.

Quint, Ryan D.
Response-Based Synchrophasor Controls for Power Systems
Committee Chair: Centeno, V.A.

Ralston, Parrish E.
Design and Characterization of Liquid Metal Flip Chip Interconnections for Heterogeneous Microwave Assemblies
Committee Chair: Raman, S.

Sen Sharma, Kriti
Compressed Sensing Based Micro-CT Methods and Applications
Committee Chair: Wang, G. (Biomedical Engineering)

Shehata, Nader A.
Design of Optical Characteristics of Ceria Nanoparticles for Applications Including Gas Sensing and Up-Conversion
Committee Chair: Meehan, K.

Shen, Zhiyu
Online Measurement of Three-Phase AC Power System Impedance in Synchronous Coordinates
Committee Chair: Boroyevich, D.

Short, Nathaniel J.
Robust Feature Extraction and Temporal Analysis for Partial Fingerprint Identification
Committee Chair: Abbott, A. L.

Sun, Rui
Wide Area System Islanding Detection, Classification, and State Evaluation Algorithm
Committee Chair: Centeno, V.A.

Tania, Mutmainna
Wide Area Measurement Applications for Improvement of Power System Protection
Committee Chair: De La Ree, J.

Vasavada, Yash M.
An Iterative Confidence Passing Approach for Parameter Estimation and Its Applications to MIMO Systems
Committee Chair: Reed, J. H.

Veda, Santhosh S.
WAMS-Based Intelligent Load Shedding Scheme for Preventing Cascading Blackouts
Committee Chair: Thorp, J. S.

Wang, Ruxi
High Power Density and High Temperature Converter Design for Transportation Applications
Committee Chair: Boroyevich, D.

Wang, Shen
Design and Analysis of a Low-Power Low-Voltage Quadrature LO Generation Circuit for Wireless Applications
Committee Chair: Ha, D. S.

Wang, Ting
Wireless Network Physical Layer Security with Smart Antenna
Committee Chair: Yang, Y.

PATENTS AWARDED

"Multi-Channel Constant Current Source and Illumination Source," S. Ji, H. Wu, and F. Lee.

"Digital Hybrid V2 Control for Buck Converters," K.-Y. Cheng, F. Yu, P. Mattavelli, and F. Lee.

"Electrical Power System with High-Density Pulse Width Modulated (PWM) Rectifier," R. Wang, F. Wang, R. Burgos, D. Boroyevich, K. Rajashekara, and S. Long.

"Method of Manufacture of a Variable Inductance Inductor," M. Lim and J.D. van Wyk.

"Hardware-Facilitated Secure Software Execution Environment," M. Jones, P. Athanas, C. Patterson, J. Edmison, T. Mahar, B. Muzal, B. Polakowski, and J. Graf.

"Integrated Power Passives," H. Xie and K. Ngo.

"Method of Forming an Inverted T Shaped Channel Structure for an Inverted T Channel Field Effect Transistor Device," M. Orlowski and A. Wild.

"Method for Manufacturing a Non-Volatile Memory, Non-Volatile Memory Device, and an Integrated Circuit," M. Orlowski.

"Method for Controlling Motor Operation Using Information Characterizing Regions of Motor Operation," C. Hudson, N. Lobo, and K. Ramu.

"Resonant Converter Equipped with Multiple Output Circuits to Provide Multiple Power Outlets," Z. Nan, M. Xu, and Q.L. Chen.

"Method and Apparatus for Testing 3-D Integrated Circuits," L.-T. Wang, N. Touba, M. Hsiao, Z. Jiang, S. Wu."

Wang, Yunjing
Fiber-Optic Sensors for Fully-Distributed Physical, Chemical and Biological Measurement
Committee Chair: Wang, A.

Wang, Yunmiao
A Quasi-Distributed Sensing Network Based on Wavelength-Scanning Time-Division Multiplexed Fiber Bragg Gratings
Committee Chair: Wang, A.

Westin, Benjamin A.
Applications in Remote Sensing Using the Method of Ordered Multiple Interactions
Committee Chair: Brown, G. S.

Yan, Yingyi
Equivalent Circuit Model for Current Mode Controls and Its Extensions
Committee Chair: Lee, F. C.

Yang, Taeyoung
Fundamental Limits on Antenna Size for Frequency and Time Domain Applications
Committee Chair: Davis, W. A.

Yi, Ji Haeng
The Sapphire Pressure Sensor and Sapphire Welding Fume Sensor Application with Fiber
Committee Chair: Xu, Y.

York, John B.
An Isolated Micro-Converter for Next-Generation Photovoltaic Infrastructure
Committee Chair: Lai, J.

Young, Alexander R.
Unified Multi-Domain Decision Making: Cognitive Radio and Autonomous Vehicle Convergence
Committee Chair:
Bostian, C. W.

HONORS & ACHIEVEMENTS

FACULTY HONORS & AWARDS

Dushan Boroyevich was inducted into the National Academy of Engineering.

Tom Hou was named an IEEE Fellow for contributions to modeling and optimization of wireless networks. He is also received the 2013 Dean's Award for Excellence in Research from the College of Engineering.

Sandeep Shukla was named an IEEE Fellow for contributions to applied probabilistic model checking for system design.

Saifur Rahman received the 2013 Outstanding Power Engineering Educator Award from the IEEE Power and Energy Society.

Ray Greenwald delivered the Nicolet Lecture at the 2013 American Geophysical Union Fall Meeting.

Yingyi Yan (Ph.D. '13), **Fred Lee** and **Paolo Mattavelli**, received the 2013 Prize Paper Award from IEEE Transactions on Power Electronics.

Hassan Eldib (Ph.D. '16) and **Chao Wang**, won the best paper award at the Formal Methods in Computer-Aided Design Conference, Portland, Oregon, October 2013

Marius Orlowski received a Fulbright Fellowship award for travel to Politecnico di Torino, Italy for research on memristors.

Charles Clancy was named L-3 Communications Cyber Faculty Fellow of Electrical and Computer Engineering by the Virginia Tech Board of Visitors.

Patrick Schaumont was named College of Engineering Faculty Fellow.

Joseph Tront received the 2013 Dean's Award for Excellence in Service from the College of Engineering.

CONFERENCE CHAIRS

Peter Athanas was program chair of the Reconfigurable Architectures Workshop, Boston, Massachusetts, May 2013.

Tom Hou is the steering committee chair of IEEE INFOCOM (International Conference on Computer Communications) for 2013-2015.

Fred Lee was general chair of the International Future Energy Electronics Conference, Tainan, Taiwan, November 2013.

T.–C. Poon was chair of the Optical Information Processing and Holography Conference at Optics & Photonics Taiwan, the International Conference (OPTIC), Zhongli, Taiwan, December 2013.

Saifur Rahman was general chair of the IEEE Power and Energy Society Conference on Innovative Smart Grid Technologies, Washington, D.C., February 2014.

NATIONAL AND INTERNATIONAL SERVICE

Tom Martin is co-chair of the IEEE Special Technical Community on Wearable and Ubiquitous Computing.

Fred Lee was inducted into the Chinese Academy of Engineering as a foreign member and named a chaired professor of National Chiao Tung University, Taiwan.

T.-C. Poon serves as an adjunct professor for the Department of Optics and Photonics at National Central University, Taiwan and a visiting professor for the City University of Hong Kong, China and the Institute of Information Optics, Zhejiang Normal University, China. He was awarded the Visiting Professorship for Senior International Scientist of the Chinese Academy of Sciences (CAS) at the Shanghai Institute of Optics and Fine Mechanics (SIOM), China.

KEYNOTE ADDRESSES

Dushan Boroyevich was a keynote speaker at ECCE Asia DownUnder (International Energy Conversion Congress and Exhibition), Melbourne, Australia, June 2013.

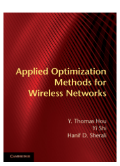
Fred Lee was a keynote speaker at the Chinese Power Supplies Association Annual Meeting, Hangzhou, China, November 2013.

Qiang Li gave a keynote presentation at the International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management (PCIM Europe), Nuremberg, Germany, May 2013.

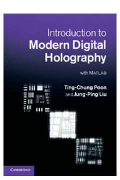
Saifur Rahman was a keynote speaker at IEEE EUROCON (International Conference on Computer as a Tool), Zagreb, Croatia, July 2013; the International Conference on Electric Power and Energy Conversion Systems, Istanbul, Turkey, October 2013; the International Conference on Instrumentation, Control and Automation, Bali, Indonesia, August 2013; and the International Conference on Power Systems, Kathmandu, Nepal, September 2013.

Patrick Schaumont delivered a keynote address at the International Conference on Security, Privacy, and Applied Cryptography Engineering (SPACE), Kharagpur, India, October 2013.

BOOKS



Tom Hou co-authored Applied Optimization Methods for Wireless Networks (Cambridge University Press, 2014).



T.-C. Poon co-authored Introduction to Modern Digital Holography with Matlab (Cambridge University Press, 2014).

EDITORSHIPS

Dhruv Batra is a guest editor for the IEEE Transactions on Pattern Analysis and Machine Intelligence Special Issue on Higher Order Graphical Models in Computer Vision: Modeling, Inference & Learning.

Rolando Burgos is a guest editor for the IEEE Journal of Emerging and Selected Topics in Power Electronics Special Issue on Modeling and Control of Power Electronics for Renewable Energy and Power Systems.

Tom Hou is an associate editor for IEEE Transactions on Mobile Computing, a technical editor for IEEE Wireless Communications, and an area editor for IEEE Transactions on Wireless Communications. He is on the editorial board of the IEEE Journal of Selected Areas in Communications—Cognitive Radio Series.

Michael Hsiao is an associate editor for IEEE Transactions on Computers. He serves on the editorial boards of IEEE Design & Test of Computers and the Journal of Electronic Testing: Theory and Applications.

Luke Lester was a guest editor for the IEEE Journal of Selected Topics in Quantum Electronics Issue on Semiconductor Lasers.

Allen MacKenzie serves as an area editor for IEEE Transactions on Communications and an associate editor for IEEE Transactions on Mobile Computing.

T.–C. Poon is a division editor for Applied Optics. He is on the editorial boards of Shanghai Jiao Tong University Press, 3D Research journal, the Journal of Holography and Speckle, and Optics & Laser Technology journal.

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

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

Sandeep Shukla is editor-in-chief of ACM Transactions on Embedded Computing Systems. **JoAnn Paul**, **Binoy Ravindran**, and **Patrick Schaumont** serve on the editorial board.

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Postdoctoral Associate

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Alumni Distinguished Professor Emeritus & Research Professor

Xia Cai
Research Scientist

Kristie Cooper
Research Associate Professor

Carl B. Dietrich
Research Associate Professor

Ray Greenwald
Research Professor

Krzysztof Kepa
Postdoctoral Associate

Hyomin Kim
Postdoctoral Associate

Michael Marcus
Adjunct Research Professor

Vuk Marojevic
Research Associate

Alastair Murray
Postdoctoral Associate

Roberto Palmieri
Postdoctoral Associate

Arun G. Phadke
University Distinguished Professor Emeritus & Research Professor

Ravi Raghunathan
Postdoctoral Associate

Jason Snyder
Project Associate

Kevin Sterne
Research Associate

Kenneth Stiles
CIA Officer in Residence

James S. Thorp
Hugh P. and Ethel C. Kelly Professor Emeritus & Research Professor

Brentha Thurairajah
Research Scientist

Yunjing Wang
Research Associate

Daniel R. Weimer
Research Professor

Zhonghua Xu
Postdoctoral Associate

Taeyoung Yang
Research Scientist

TENURE & PROMOTION

Tom Martin was promoted to professor.

Majid Manteghi was tenured and promoted to associate professor.

Mike Ruohoniemi was tenured as an associate professor.

THE **BRADLEY DEPARTMENT**
of Electrical & Computer Engineering

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