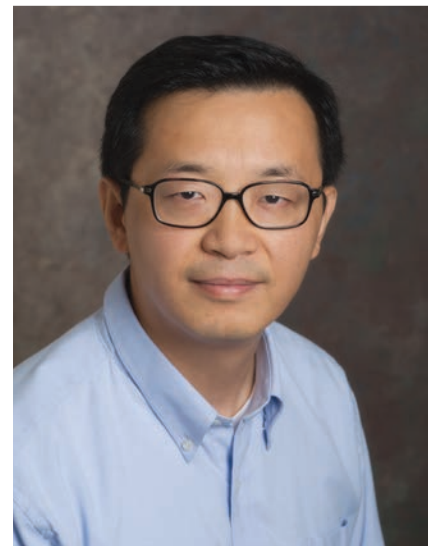
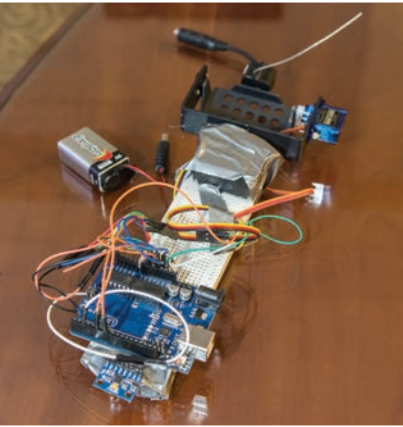


UNIVERSITY of DELAWARE

2015 | ELECTRICAL AND COMPUTER ENGINEERING **CURRENTS**



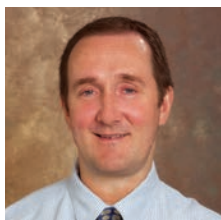
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UNIVERSITY OF
DELAWARE

College of Engineering

DEPARTMENT OF ELECTRICAL
& COMPUTER ENGINEERING

MESSAGE FROM THE CHAIR



DEAR FRIENDS AND COLLEAGUES,

I am pleased to share the latest *Currents*, highlighting news and achievements from UD's Department of Electrical and Computer Engineering (ECE). Inside you will see how our students, faculty and alumni are driving dynamic changes and innovations in our field.

UD ECE has improved 23 places over the past five years in the *U.S. News & World Report* departmental rankings, and is now ranked 52. UD ECE student enrollment now exceeds 550, including over 200 MS and PhD students. Enrollment gains are fueled by our new Cybersecurity Minor and MS degree programs, with the student population poised to grow further as fully

online Cybersecurity MS and ECE MS degree programs launch in Spring 2016.

ECE Research Day celebrated scholarship, innovation and accomplishments by students, faculty and alumni. Highlights included student capstone projects and research posters, and a Distinguished Lecture by **JAN P. ALLEBACH** (EE'72), Hewlett-Packard Distinguished Professor of ECE, Purdue University. Dr. Allebach was honored with the *ECE Distinguished Achievement Award*. Also recognized for their accomplishments were fellow alumni **ERIC KEMELIS** (EE'99, M'04), **RAY SOKOLA** (EE'76) and **GUOLIANG FAN** (PhD'01). Mark your calendars now for the 2016 ECE Research Day on March 9, which will feature a Distinguished Lecture by **DAVID MUNSON** (EE'75), dean of engineering and professor of ECE, University of Michigan.

Faculty continue to pursue leading research, such as Prof. **DENNIS PRATHER**'s Integrated Photonics work as part of the \$610-million public-private AIM Photonics National Network of Manufacturing Institutes (NNMI) award. Students continue to excel individually

and collectively. **HAROLD MIKOLAITIS** and **WILLIAM CARSON** received the *Outstanding Capstone Senior Design Project Award* for their project Renewable Generation Battery Charging Pack. And the UD Epsilon Omicron Student chapter of IEEE-Eta Kappa Nu was again honored with an Outstanding Chapter Award, recognizing their excellence in chapter activities.

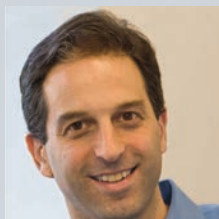
I am extremely proud of the accomplishments showcased in the following pages and I am confident that as UD ECE continues on its strategic path as a field leader, even greater achievements will be realized. I thank our many alumni, friends and industry partners who provide the support that is integral to our efforts for excellence in education and research.

As always, feel free to contact me at barner@udel.edu with your ideas and feedback.

Kenneth E. Barner, PhD

*Professor and Chair,
Electrical and Computer Engineering*

2015-16 Distinguished Lecture Series



OCTOBER 7, 2015

Ron Weiss

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

*"Synthetic Biology: From Parts to
Modules to Therapeutic Systems"*



NOVEMBER 11, 2015

Gerhard P. Fettweis

TU DRESDEN

"The Tactile Internet"



MARCH 9, 2016

David C. Munson, Jr.

UNIVERSITY OF MICHIGAN

*"Engineering Education:
Preparing Students to Change
the World"*



APRIL 20, 2016

John A. Rogers

UNIVERSITY OF ILLINOIS

"Electronics for the Human Body"

2015

Electrical and Computer Engineering *Currents*

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peers of the College of Engineering.

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ELECTRICAL AND COMPUTER ENGINEERING *CURRENTS*

2015

SECTIONS

- 04 Research
- 06 Focus on Cybersecurity
- 10 News & Events
- 12 Students
- 18 Leading the Way

ON THE COVER

Left to right, top row:

1, 2: 2015 Capstone senior design projects. 3: Michael Chertoff, former secretary of the U.S. Department of Homeland Security, gives first UD Cybersecurity Initiative Distinguished Lecture. 4: Harold Mikolaitis and William Carson, from left to right, winners of 2015 Capstone senior design award.

Left to right, bottom row:

1: Victoria Carey, winner of 2015 IEEE Women in Engineering Award.
2: Awardees at ECE Research Day, from left to right, Jan Allebach, EE'72, Eric Kelmelis, EE'99, M'04, Ray Sokola, EE'76, Guoliang Fan, PhD'01, Ramsey Hazbun, Yuan Xue and Angela Cuadros. 3: Professor Haining Wang.

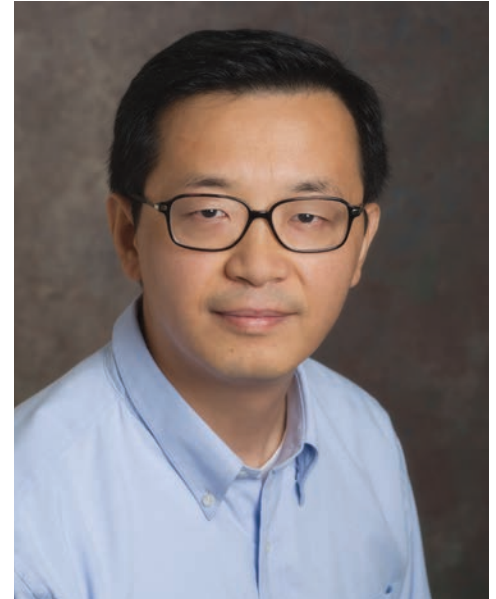
POWER ATTACKS

Professor **Haining Wang** has received a three-year, \$2-million grant from the Department of Homeland Security to investigate energy and power safety in data centers, partnering with Ohio State University and IBM Research.

Energy, power, and thermal attacks are very different from conventional DDoS (distributed denial of service) attacks in terms of their purpose, methodology and effects. In a DDoS attack, numerous compromised systems attack a single target with a flood of incoming messages, thereby denying service to legitimate users. In contrast, with these new types of threats, traffic behaviors look

similar to those of normal users, but their consequences can actually be more serious, as they aim to generate energy, power and thermal emergencies.

“Current power management and security mechanisms provide virtually no defense against these novel and dangerous attacks,” Wang says. To cope with power and thermal attacks, the researchers plan to implement online power estimation and measurement for incoming service requests, server temperature modeling and prediction, and power and thermal balancing in data centers. Accurate power and thermal estimation and prediction will enable the timely detection of any power and thermal anomalies, so that proactive defense strategies can be activated to prevent power outages, server overheating, and server shutdowns. ■



Haining Wang

CHEMICAL DETECTION

Led by Professor **Mark Mirotznik**, the Electromagnetic Materials Laboratory at UD is working with the Army Research Office to engineer nanoplasmonic surfaces—materials structured at the atomic scale to interact with light in unusual, specific ways.

Such structures could, for example, help detect dangerous biochemical compounds by changing color if contaminated. “If you monitor what gets reflected back [using a laser], you can detect that a certain chemical is present, even at a distance,” says Mirotznik. In the future, the military could use these materials—scattered over a wide area—to check for substances like anthrax or TNT. “We’re using nanotechnologies to engineer tiny little metal patterns at optical wavelengths,”

says Mirotznik. “A human hair is about 50 microns across. We’re working on a scale hundreds of times smaller than that.” By patterning the nanoscale structure, these researchers in effect “dye” surfaces, giving them specific optical properties.

The potential for nanoplasmonic surfaces has captured the imagination of U.S. Army officials who see a potential application for calibrating military equipment. For example, high-tech sensors could allow the Army to analyze the chemical contents of a smoke plume just by looking at reflected light. Calibrating these sensors requires a substance with known, constant optical properties. The colors of many substances change with time and context, but the way a nanoplasmonic surface reflects light is directly and precisely built into its structure. Researchers from the nearby U.S. Army Edgewood Chemical Biological Center visit regularly to work with Mirotznik and his students. “That sort of interaction makes it really interesting,” Mirotznik notes. “I’m having a lot of fun.” ■



Mark Mirotznik

INTEGRATED PHOTONICS

UD is part of a consortium selected by the Department of Defense to receive \$610 million in public-private funding to help strengthen high-tech U.S.-based manufacturing.

Led by the Research Foundation for the State University of New York (RF SUNY), the new American Institute for Manufacturing Integrated Photonics (AIM Photonics) includes 55 companies, 20 universities, 33 community colleges, 16 non-profit organizations and 20 states. The effort at UD will be directed by College of Engineering Alumni Distinguished Professor **DENNIS PRATHER**.

Photonics is the science of using and controlling photons—the smallest unit of light—to convey information and images. Just as integrated electronic circuits allow for advanced processing in computers and cell phones, integrated photonic components can pack even more processing power into a single chip, creating new possibilities for computing and communications.

“UD’s selection to be part of this major new initiative is a testament to the strength of our photonics program and to Dennis Prather’s expertise and reputation,” said

Babatunde Ogunnaike, dean of the College of Engineering. “He is a nationally known leader in the area of radio-frequency photonic elements and their integration into imaging, communications and radar systems for security applications.”

In announcing the establishment of this institute in Rochester, New York, on July 27, Vice President Joe Biden, a UD alumnus, said the U.S. needs to do two things to keep its edge: build the most modern infrastructure in the world and have the most skilled workforce in the world.

The new photonics institute is one of nine announced as part of the National Network of Manufacturing Institutes (NNMI), and these institutes are charged with developing advanced manufacturing technologies, helping businesses that otherwise couldn’t invest in advanced manufacturing research, and building a pipeline of talent that can support advanced manufacturing. ■



Dennis Prather

Photonics is the science of using and controlling photons—the smallest unit of light—to convey information and images.



Hui Fang (on left) has been promoted to Associate Professor. Her research interests focus on text information management, especially in the areas of information retrieval (i.e., search engine technology), text mining and bioinformatics.

CYBERSECURITY MASTER'S DEGREE PROGRAM APPROVED

A motion to add a master of science degree in cybersecurity was approved during the April 6th meeting of the UD Faculty Senate. Geography provides UD with a special advantage since it sits between New York City, the important financial sector of the country, and Washington, D.C., the seat of national and military power. Delaware is also the corporate hub of the U.S., with 70 percent of all Fortune 500 companies incorporated in the state so UD is well situated to be corporate America's hub for cybersecurity.

The Cybersecurity Initiative (CSI) was established at UD in 2014 as a partnership among the state, the University, federal agencies, and the private sector to address the growing problem of cyber attacks, which cost billions of dollars a year, through education, workforce training, and research and development. The focus of this initiative includes education and training of current and future students. UD is offering a minor in cybersecurity that is open to all University undergraduate majors and allows them to infuse cybersecurity fundamentals into other degree programs.

UD is also offering a master's program structured to provide professionals with advanced training in the field. To complete this degree, a student must take five courses that cover the fundamentals of cybersecurity and five courses in one of the concentration areas shown: Secure Software for developing secure software systems; Secure Systems for developing secure systems that can include wireless and network communication systems, embedded systems, and related physical systems; Security Analytics for utilizing big data, analytics, and statistical learning methods to identify and characterize anomalous behavior and security risks; and Security Management for instituting and managing security controls within an enterprise.

"Students with a traditional background in engineering, computer science, information systems, or a related field will gain strong security skills through the master's program," says **Ken Barner**, chair of Electrical and Computer Engineering. ■

www.csi.udel.edu

CYBERSECURITY MS DEGREE REQUIREMENTS

Ten courses (30 credits)

- Five courses in the Fundamentals of Cybersecurity
- Five courses in a Cybersecurity Concentration Area

Cybersecurity Concentration Areas

Secure
Software

Secure
Systems

Security
Analytics

Security
Management

The Cybersecurity MS and
ECE MS degrees are available
fully online.

ONLINE GRADUATE DEGREE INFORMATION
landing.online.udel.edu



Michael Chertoff

BATTLING CYBER ATTACKS:

Cybersecurity
expert Chertoff says
constant peril makes
partnerships essential

As Americans slept last night, they were out there, trying this password and that, sending tantalizing links in emails that have recognizable return addresses, notifying recipients of huge sums of money just waiting for them to fill in a convenient deposit form, and hoping they will find that cat video irresistible enough to “click here.”

On February 10, Michael Chertoff, one of the nation’s top security experts and the former secretary of the U.S. Department of Homeland Security, outlined many such perils and left

no one with a false sense of security as he delivered the first UD Cybersecurity Initiative Distinguished Lecture. “One hundred percent protection is not possible,” he said. “Chasing that leads to unproductive pathways.”

But helping to solve difficult problems is the kind of challenge that appeals to many students, including **DYLAN ROSS**, an engineer and first-year doctoral candidate doing research in electromagnetics and photonics. “What drives me is solving problems,” he said, “and no one’s ever cracked this one. No system is perfect, every design is going to have some kind of flaw. . . . But solving a specific problem—for a lot of students in science and engineering, that is what drives them.”

Managing the risk

The only sure defense against cyber attack is unplugging from the Internet, a step easier said than done, Chertoff said. But the cost of that decision is great. The Internet brings many benefits and has revolutionized how services are delivered and networks are developed worldwide.

The challenge, he said, is to build a strategy that allows access to those benefits while holding the line against intruders. The smart strategy against cyber attacks, Chertoff said, is to recognize that breaches will happen and do . . . what can be done to control, manage and mitigate the risk. This strategy is found in the kinds of partnerships now under construction through UD’s Cybersecurity Initiative, where government, industry and academic leaders will work together to identify threats, share what they know about them, and develop effective defenses.

Chertoff’s visit to UD came on the same day President Barack Obama announced the creation of a federal Cyber Threat Intelligence Integration Center to collect and share intelligence, much as the nation did with its counter-terrorism initiative. It is an appropriate triage, in Chertoff’s opinion. He places cyber threats among the greatest dangers to the United States’ national security, with consequences as paralyzing, destructive and deadly as the violence perpetrated by ISIS, Boko Haram, and other terrorist networks. ■

ENHANCING NATIONAL CYBERSECURITY:

University to serve on council for federal cybersecurity center

UD is one of nine universities chosen by The MITRE Corporation to serve on the Academic Affiliates Council, formed to support the company's operation of the nation's first federally funded research and development center (FFRDC) solely dedicated to enhancing cybersecurity and protecting national information systems. Through a competitive process, the U.S. Commerce Department's National Institute of Standards

and Technology (NIST) selected MITRE to operate the FFRDC.

The FFRDC will support the National Cybersecurity Center of Excellence (NCCoE), which was established in 2012 by NIST, the state of Maryland, and Montgomery County, Maryland, to help businesses secure their data and digital infrastructure by bringing together information security experts from industry, government and academia. To execute the goals of the newly established FFRDC, MITRE is partnering with the University System of Maryland (USM) and collaborating with other universities, nonprofits and organizations that advocate and perform cybersecurity research to ensure a broad perspective and the best expertise available.

UD is among the universities involved in the new council, including the University of Alabama at Birmingham, George Mason University, Massachusetts Institute of

Technology, Purdue University, University of California, Berkeley, University of Illinois, University of Texas at Dallas and University of Texas at San Antonio. The new FFRDC will help to further the NCCoE's goal to accelerate the adoption of secure technologies through public-private collaborations that identify and address today's most pressing cybersecurity challenges.

"I am proud that the University of Delaware has been selected to advise MITRE in its operation of the NIST Cyber Security Federally Funded Research and Development Center," said U.S. Sen. Tom Carper, chairman of the Senate Committee on Homeland Security and Governmental Affairs. "Businesses rely on a safe and secure Internet, so it is vital that we work together to prevent cyber attacks. As an academic partner in this public-private initiative, UD will bring its ability to perform cyber training and conduct outreach to major corporations and small businesses alike." ■

"I am proud that the University of Delaware has been selected to advise MITRE in its operation of the NIST Cyber Security Federally Funded Research and Development Center."

—U.S. SEN. TOM CARPER



UD ECE students were among the multi-disciplinary group of 66 students invited from various UD departments, Wilmington University, Delaware Technical Community College, Delaware State University and several regional high schools, along with local security professionals, to participate in the 2015 United States Cyber Challenge (USCC) camp hosted this summer at the Delaware Technical Community College, Dover campus. USCC is a national program that works with states to identify, attract, recruit and place the next generation of cybersecurity professionals.



Panelists at SWIFT conference, including UD Electrical and Computer Engineering Associate Professor Stephan Bohacek (on left), discuss cybersecurity issues.

COMBATING CYBER THREATS: The SWIFT cybersecurity conference

Today over 15 billion devices are connected to the Internet; in the next five years, that number will grow to 50 billion. With each new device presenting an opportunity to be infiltrated and compromised by hackers, it's easy to understand why the importance of cybersecurity continues to skyrocket.

So explained keynote speaker Elizabeth Petrie, director of strategic intelligence analysis for Citigroup, who kicked off a one-day conference on May 18 at UD on cybersecurity issues impacting the global financial industry. The SWIFT Institute partnered with UD's Cybersecurity Initiative (UDCSI), Alfred Lerner College of Business and Economics and College of Engineering to host this conference that considered several important questions: As cyber threats rise in number and grow in sophistication, what key cybersecurity strategies should banks and financial institutions utilize today? What is needed to protect information and critical financial systems? What cooperative initiatives are needed in the industry, and what coordinating support must the public sector provide?

The conference was chaired by **STARNES WALKER**, founding director of the UDCSI, and former chief technology officer for the U.S. Navy's U.S. Fleet Cyber Command and director of research at the U.S. Department of Homeland Security. Conference panelists included cybersecurity experts from a variety of businesses, governmental and academic institutions including the FBI, Deloitte, IBM, Barclays, AT&T and others. The four panel discussions covered New Financial Products and their Security Vulnerabilities; Malicious Insider Threats; Cyber Security Tools: What is coming and what more is needed?; and Information Supply Chain Post-Snowden.

This cybersecurity event showed just how challenging it is for financial institutions to keep pace with the ever changing cybersecurity landscape. However, the level of attendance and engagement suggested that financial institutions are taking these threats seriously. Along with academics, consultants and technology providers, they are working hard through research, testing and networking via forums to uncover new ways to help mitigate these challenges.

"Cybersecurity is not the next big industry; it is the industry," Petrie said during her keynote speech. "We are all in it today, actively working together to figure out how to mitigate the threats that are coming at us each and every day." ■



Panelists and presenters at the SWIFT conference included leaders from a variety of fields.



David Farber

Farber computing cluster named for UD professor, Internet pioneer

Building on the success of the Mills High-Performance Computing (HPC) cluster, UD is deploying a second community cluster to perform complex computational tasks for researchers in engineering, in physical, natural, social, policy and decision sciences, and in finance. The new cluster has been named Farber in honor of **DAVID FARBER**, UD professor and Distinguished Policy Fellow in the Department of Electrical and Computer Engineering.

Farber was one of the innovators of the early Internet and its subsequent development into today's modern Internet. He has had a renowned career, including two intervals as a UD faculty member, from 1977–88 and from 2011 to present. Farber is one of the pioneers who helped develop the U.S. Department of Defense's ARPANET into the modern Internet. His work on CSNET, a network linking computer science departments across the globe, was a key step between the ARPANET and today's Internet.

Farber left UD to become the Alfred Fitler Moore Professor of Telecommunication

Systems at the Moore School and professor of public policy at the Wharton School at the University of Pennsylvania. Farber also served as the chief technologist at the Federal Communications Commission (FCC) from 1999–2000 and as Distinguished Career Professor of Computer Science and Public Policy at Carnegie Mellon University.

Today, Farber's work focuses on the translation of technology and economics into policy, the impact of multi-terabit communications, and new innovations of future Internet protocols and architectures. He was named to the Internet Society's board of trustees in 2012.

The Farber cluster will give more UD researchers access to HPC resources and will provide faculty with faster compute nodes and more storage than is available on Mills. The University uses community-cluster architecture for HPC systems. Periodically, IT staff work with University faculty to develop the specifications for an HPC cluster, with the purchase financed both by IT (cluster infrastructure, storage, and networking) and by individual faculty researchers (individual compute nodes). The community cluster model is advantageous for researchers, allowing them priority access to high performance computing power while sparing them the ongoing financial liability of purchasing and running their own computing clusters. ■

ECE Research Day annually recognizes alumni achievements and undergraduate and graduate research in the areas of signal processing, communications and controls, nanoelectronics, electromagnetics and photonics, computer engineering and biomedical engineering. Special thanks to event sponsors IEEE, DTS, ETI and JPMorgan Chase.



JPMORGAN CHASE & CO.



Jan Allebach and Eric Kelmelis



Ray Sokola and Guoliang Fan

2015 ECE Research Day



UD's Department of Electrical and Computer Engineering held its annual Research Day on March 11 to showcase department research and alumni achievements. The guest lecturer was **JAN P. ALLEBACH**, a 1972 alumnus who is the Hewlett-Packard Distinguished Professor of Electrical and Computer Engineering at Purdue University and who was honored with the 2015 Distinguished Achievement Award. He spoke on "Digital Printing: The Transformation of a 2,000-Year-Old Technology and What It Means to You."

Allebach has developed technologies in his laboratory that have been licensed to major vendors of printers and can be found in products that have sold hundreds of millions of units. He was named Electronic Imaging Scientist of the Year by the Society for Imaging Science and Technology (IS&T) and SPIE, and was named an honorary member of IS&T, its highest award. He has received the IEEE Daniel E. Noble Award and was elected to the National Academy of Engineering and the National Academy of Inventors. ■

ALUMNI AWARDS

JAN ALLEBACH, EE'72

Distinguished Achievement Award
Hewlett-Packard Distinguished Professor,
Electrical & Computer Engineering,
Purdue University

ERIC KELMELIS, EE'99, M'04

Entrepreneurial Innovation Award
CEO of EM Photonics, Phase Sensitive
Innovations, and Lumilant

RAY SOKOLA, EE'76

Outstanding Service Award
VP future technology, TE Connectivity and VC,
Cellport Systems

GUOLIANG FAN, PHD'01

Young Alumni Achievement Award
Cal and Marilyn Vogt Professor, Electrical
& Computer Engineering, Oklahoma State
University

STUDENT AWARDS

ANGELA CUADROS

Coded Aperture Design in Compressive Low-Dose X-Ray Tomosynthesis

RAMSEY HAZBUN

X-Ray Characterization of Group IV Epitaxy

YUAN XUE

High-speed Self-adaptation in NVM-based FPGAs through Logic Similarity Exploitation

WILLIAM CARSON, HAROLD MIKOLAITIS

Capstone senior design project winners
(pictured on cover)

POWER-UP: Renewable Generation Battery Charging Pack.

VICTORIA A. CAREY

IEEE Women in Engineering Award
(pictured on cover)
Engineered LWIR-Signature Surfaces

Mark your calendar **FOR THE NEXT ECE RESEARCH DAY ON MARCH 9, 2016**



Junior Michael Ivey, left, receives scholarship award from Joe Portale, chief technologist for mobility solutions at Lockheed Martin.

ECE undergrad awarded Armed Forces scholarship

Junior **MICHAEL IVEY** received an Afghanistan and Iraq War Veterans Scholarship from the Armed Forces Communications and Electronics Association (AFCEA) Educational Foundation. Ivey, who repaired Lockheed C130 aircraft during his stint in Afghanistan, works part-time at Delta Engineering in New Castle. He plans a career in the aviation or biomedical field after graduation. ■

Citizenship award: ECE student honored by state attorney general

An English Language Institute (ELI) alumnus and current UD ECE undergraduate has been honored as a local hero for saving an elderly Delaware man from becoming a victim of a financial scam. For his quick thinking and good deed, **JAOUAD EZZAHER** was awarded a Citizenship Award by Delaware Attorney General Matt Denn. Ezzaher came to the U.S. from Morocco in 2009 and supports himself through his own taxi company—FEZ Taxi—named after his hometown. ■

Epsilon Omicron wins Outstanding Chapter Award

The IEEE-HKN Board of Governors conferred on UD's Epsilon Omicron Chapter the 2013–14 IEEE-HKN Outstanding Chapter Award, presented in recognition of excellence in their Chapter administration and programs. ■

ECE JUNIOR BEN SAMPSON EARNs CAPITAL ONE/ COSIDA DISTRICT 2 ALL-ACADEMIC HONORS FOR SECOND STRAIGHT YEAR

ECE junior **BEN SAMPSON** of UD's men's soccer team was selected to the CoSIDA/ Capital One District II All-Academic Men's Soccer Team in October 2014. Sampson, a second-year starter, has recorded one goal and one assist this season while he maintains a 3.98 grade point average, the second highest in District II.

Sampson, who also earned the selection last year, is on UD's Dean's List and was named to the Colonial Athletic Association Academic Honor Roll in both his freshman and sophomore years at Delaware. The midfielder conducted academic research for Delaware in the summer of 2014 and won the UD Presidential Achievement Xerox Scholarship. ■

ECE STUDENTS ARE AMONG THE FINALISTS OF THE HORN PROGRAM'S HEN HATCH COMPETITION

The Horn Program in Entrepreneurship announced the finalists of Hen Hatch, UD's premier business startup funding competition, and ECE students were among the three winners chosen in the student track. GoHappy, led by ECE graduate student **ELPINIKI APOSTOLAKI-IOSEFIDOU**, is an application that provides real-time notifications of offers, specials and deals of local businesses. The Practice Set, led by ECE student **KEITH DOGGETT** and finance student Jordan Gonzalez, is a website aimed at providing in-depth solutions and problems to students taking upper level science, technology, engineering and mathematics (STEM) courses. The Hen Hatch finalists pitched their ideas to a panel of seasoned entrepreneurs, investors and business executives at the Horn Program's inaugural Innovation and Entrepreneurship Showcase in April. ■



SPIN IN SHOWCASE:

Student savvy helps
entrepreneurs get
products to market

They went back to the proverbial drawing board time after time, four teams of inventive UD students testing this equation, that logo and yet another configuration. What they came up with were innovative projects that were part of the Spin In Student Showcase, sponsored by the Office of Economic Innovation and Partnerships (OEIP), supported by the National Science Foundation's Experimental Program to Stimulate Competitive Research (EPSCoR), and held at the Delaware Biotechnology Institute. This UD program offers students practical business experience and gives entrepreneurs access to their expertise to solve a problem or refine a process.

Three of the four interdisciplinary teams that participated this year included students from the ECE department.

CONNECTHUB: App for sales reps

ConnectHub was developed for entrepreneur John Royer by a team that included ECE students **LINFENG LI** and **JACOB NACHMAN**. It is a smartphone app that pharmaceutical sales representatives can use when they are on the road so their managers can coach them and evaluate their performance along the way.

POCKETFARMER: High-tech farming

PocketFarmer was designed by a team that included ECE student **AKUMA AKUMA-UKPO**, on right. This app has a powerful database that helps Christmas tree growers identify and treat diseases that can devastate their trees.

MTRIGGER: PT assist

mTrigger was created by a team that included ECE student **ADAM ENGELSON**. This device plugs into the headphone port of an iPhone, and via sensor pads tracks a patient's progress as he/she performs physical therapy exercises.

The interdisciplinary work done in these Spin In projects adds a unique component to these students' undergraduate experience. "From the beginning it was really weird integrating a lot of people," said Adam Engelson. "You have chemical engineers and political science majors and you learn how to work together. I learn social policy, you learn electronics. We learn to work together with a graphic designer, a chemical engineer and a business analyst, and you get exposed to the whole product life cycle." ■

ROBOT BLOCK PARTY:

UD's 'Brobot' competes at 2015 Brown Robotics Olympiad

Juniors **ADAM ENGELSON**, right, and **ZACHARY PEARSON**, left—both ECE majors—represented UD at Brown University IEEE's Brown Robotics Olympiad held April 11. Teams of students from several universities competed to design a robot that would traverse and solve a 256-tile maze in the fastest time. The competition was a featured exhibit at Rhode Island's annual Robot Block Party.

Starting in January, Engelson and Pearson designed, built and coded their submission for the Olympiad, named the "Brobot." They faced many challenges, requiring them to combine Engelson's knowledge of hardware and embedded systems with Pearson's software expertise, truly forming an interdisciplinary team.

"I thought this would be a quick and easy project. The problem is that the algorithms that I use as a computer scientist solve problems easily in a virtual world, but they do not translate well to the physical world," said Pearson. "It took us several long nights and many attempts just to get a robot that was able to effectively navigate a maze."

At the Brown Robotics Olympiad the Brobot finished seventh out of 18 in the competition, beating several Ivy League teams. Only the team from Brown University was able to solve the maze. Nevertheless the team was proud of the performance of their robot.

"We used all of the skills we learned in our courses to make the best robot we could," said Engelson. "It would not have been possible to design such an efficient robot without the knowledge learned from our professors." ■



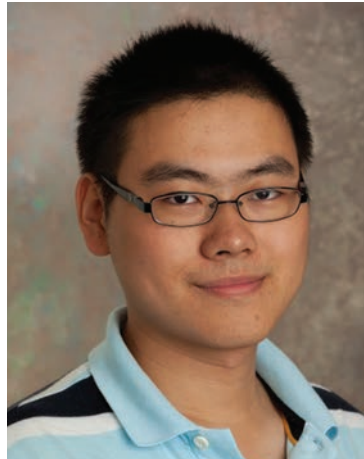
ECE graduate student wins first place at IEEE International conference

ECE graduate student **AUSTIN GOOD**, second from right, advised by Professor **MARK MIROTZNIK**, won first place in the student paper competition at the 2015 IEEE International Symposium on Antennas and Propagation. Good was initially selected as one of 13 semifinalists from a pool of 173 paper submissions from around the world, and he went on to win the competition based on a poster presentation to several judges and other guests at the conference. His paper, "In-plane Characterization of Graded Dielectrics Fabricated Through Additive Manufacturing," details a method for integrating electromagnetic properties into a structural composite by 3D-printing dielectric powder between layers of the structure in spatially varying patterns and densities. ■



Little Bob Initiative receives Clinton Global Initiative U seed funding

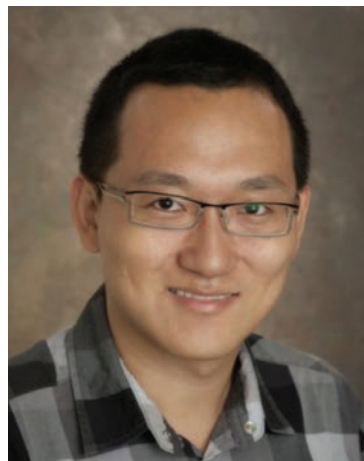
Fifteen UD students attended Clinton Global Initiative University (CGI U) this spring after having developed “Commitment to Action” initiatives, and one team chosen to receive seed funding was made up of senior ECE student **THOMAS BRADY**, left, and his teammate Garrison Davis, right, a senior organizational and community leadership major. Brady and Davis created the Little Bob Initiative, a project focused on the fitness facilities in UD’s Carpenter Sports Building. They are working to create a prototype stationary bike that through use will generate electricity, thus creating clean energy through an activity UD students already do—exercise. ■



Chen Liu

Two ECE graduate students recognized by the Office of Graduate and Professional Education

CHEN LIU, a PhD student advised by Assistant Professor **CHENGMO YANG**, has received the University Graduate Fellow Award. This award recognizes a student’s academic achievement since being admitted to the doctoral program as well as his/her professional commitment and potential contribution to the field of study. Liu works on developing countermeasures against cyber-attacks, especially those targeting embedded systems.



Yue Wang

YUE WANG, a PhD student advised by Assistant Professor **HUI FANG**, has received the University Dissertation Fellow Award. This award, established by the Office of the Provost, enables and supports PhD students to devote their full attention to completing their doctoral dissertation. Wang researches domain-specific information retrieval, with an emphasis on using domain knowledge to improve retrieval performance. He currently focuses on two projects in the clinical decision support area and in the mobile app retrieval and review mining fields. ■



George Montgomery

At the spring graduation, **President Harker** recounted the persevering spirit of several members of the Class of 2015 who met challenges and overcame adversity.

One member was **George Montgomery**. Profoundly deaf by kindergarten, Montgomery received a cochlear implant at age six. By middle school he became fascinated by the amazing technology that had changed his life.

In May, Montgomery graduated from UD’s college of engineering with an honors degree in computer engineering with minors in computer science and mathematics. “He wants a career with impact, possibly working on devices like his cochlear implant so others can benefit as he did,” said Harker.

DISSERTATION/THESIS TITLES **FALL 2014–SUMMER 2015**

PhD Dissertation

Overhead, Uncertainty, and Interference in Wireless Networks

HAO FENG

Adviser – Leonard Cimini

Developing Novel Hybrid Heterojunctions for High Efficiency Photovoltaics

NICOLE KOTULAK

Adviser – Robert Opila

Design and Packaging of Ultra Broadband Lithium Niobate Modulator for Millimeter-Wave Applications

JULIEN MACARIO

Adviser – Dennis Prather

Resource Management for Multi-User MIMO Systems

QI WANG

Adviser – Leonard Cimini

Sparse Signal Processing for Machine Learning and Computer Vision

YIN (JOE) ZHOU

Adviser – Kenneth Barner

Estimation and Control with Censored Data

CORY MILLER

Adviser – Ryan Zurakowski

Analog Joint Source-Channel Coding for Non-Standard Scenarios

BO LU

Adviser – Javier Garcia-Frias

Building an Optimized Passive Optical Component Library for Silicon Photonics Platform

YANGJIN MA

Adviser – Mark Mirotznik

Simulation Methodology and Tools for the Development of Novel Program Execution Models and Architectures

ROBERT PAVEL

Adviser – Guang Gao

Hybrid Laser Integration for Silicon Photonics Platform

SHUYU YANG

Adviser – Mark Mirotznik

Design and Fabrication of Planar Structures with Graded Electromagnetic Properties

BRANDON GOOD

Adviser – Mark Mirotznik

Entity Centric Information Retrieval

XITONG LIU

Adviser – Hui Fang

Exploiting Prior Knowledge in Compressed Sensing Wireless ECG Systems

LUISA POLANIA CABRERA

Adviser – Kenneth Barner

Toward Non-Reciprocal Chip-Scale Silicon Photonics

YISU YANG

Adviser – Mark Mirotznik

Master Thesis

The Effect of Silicon and Copper-Indium-Gallium-Selenide Based Solar Cell Structures and Processing on Temperature Dependent Performance Losses

JUDITH HSIEH

Adviser – Steven Hegedus

Inter-Chip Optical Waveguide Coupling Analysis

CHUN-YU LIU

Adviser – Michael Haney

A Study of Localization Methods on Mobile Platform and WIFI-Based User Movement Detection

YONGWEI MA

Adviser – Stephan Bohacek

Passive Millimeter Wave Simulation in Blender

MACIEJ MURAKOWSKI

Adviser – Dennis Prather

Optoelectronic Characterization of Wide-Bandgap (AgCu)(InGa)Se₂ Thin-Film Polycrystalline Solar Cells Including the Role of the Intrinsic Zinc Oxide Layer

UWADIAE OBAHIAGBON

Adviser – Steven Hegedus

Coded Aperture Design for X-Ray Tomosynthesis

KAI WANG

Adviser – Gonzalo Arce

Development and Implementation of an FPGA-Based Control System for a Passive, Distributed Aperture Millimeter-Wave Imaging System

JAMES BONNETT

Adviser – Dennis Prather

Real Time Mitigation of Atmospheric Turbulence in Long Distance Imaging Using the Lucky Region Fusion Algorithm with FPGA and GPU Hardware Acceleration

CHRISTOPHER JACKSON

Adviser – Fouad Kiamilev

Leveraging Discriminative Dictionary Learning Algorithms for Single Lead ECG Classification

SHERIN MATHEWS

Adviser – Kenneth Barner

Design and Fabrication of a Recycled Carrier Modulator

UGOCHUKWU NSOFOR

Adviser – Dennis Prather

Higher Order Discretization Model for Coded Aperture Spectral Imaging Systems

HOOVER RUEDA-CHACON

Adviser – Gonzalo Arce

Design and Development of an Open Source Programmable DC Electronic Load

YINGBO WANG

Adviser – Fouad Kiamilev

Best Practices in Online User Authentication: An Analysis and Survey

FATEMA BANNAT WALA

Adviser – Chase Cotton

Design and Characterization of a Mixed-Signal PCB for Digital-to-Analog Conversion in a Modular and Scalable Infrared Scene Projector

JACOB BENEDICT

Adviser – Fouad Kiamilev

Non Linear Joint Source Channel Coding for Broadcast Channels

MOHAMED HASSANIN

Adviser – Javier Garcia-Frias

95 GHZ Silicon Germanium Low Noise Amplifier as Front-End Receiver for Sparse Aperture Millimeter Wave Imaging

ANDREW WRIGHT

Adviser – Dennis Prather

A Novel Similarity-Search Method for Mathematical Content in Latex Markup and its Implementation

WEI ZHONG

Adviser – Hui Fang

Non-thesis MS graduates

PAUL FOX

CHRISTOPHER PEITSCH

WILLIAM HARCLERODE

SUMITHA BENNET

JOHN BONE

CHRISTOPHER CEREZO FALCO

WANZHU CHEN

BENHANG FAN

BRYAN FARLEY

WENJIAN HUANG

HAO LIU

CHRISTOPHER PRUST

JEFFREY SPAK

JASON TIESTE

YAO YAO

HAO ZHANG

CAPSTONE DESIGN EVENT

Students, their families, project sponsors, mentors and faculty members gathered in May for the annual senior capstone celebration breakfast and poster session

Department Chair **KEN BARNER** offered opening remarks, followed by Kenneth Fleetwood, Consumer & Community Banking Managing Director, JPMorgan Chase. Thomas A. McCormick, president of American Electrical, Inc., was the featured speaker.

Instructed by Professor **CHASE COTTON**, Senior Capstone Design is a six-credit, year-long capstone course structured to imitate the scenario a young engineer will experience in the workforce. Teams select a project, discover customer wants, benchmark the best practices

for each desired function, generate design concepts, build and test a prototype and make improvements, as necessary. The course provides a realistic industrial management structure and professional background for the design project activities. ■

2014–15 TEAMS

TEAM AUTONOMOUS

Adaptive Vehicle Autopilot

Larry Sell, Yuanqi Shen and Kun Xia

TEAM BAD (BELT AIRBAG DEVICE)

Personal Airbag

Peyman Barakhshan, Stephen Cockerill, Zaron Jacobs and Thaisse Dias Paes

TEAM BREADCRUMBS

Inertial Navigation System for Dead Reckoning Application

Rich Amos, Chris Gulledge, Teddy Katayama, Kory Mitchell and Aaron Zhu

TEAM KACHING

Online Banking with Transactional Processing in the Cloud

Nick Nicolini and Anders Van Winkle

TEAM OCULUS DRIFT

Remote Viewing
Controlled Steady
Camera

Kyle Leonard, Chaolong Lin and Puch Pu

TEAM POWER-UP

Renewable
Generation Battery
Charging Pack

William Carson and Harold Mikolaitis

TEAM QUADCOPTER

Drone Obstacle
Avoidance System

Benjamin Garrett, Kevin Hall and Nick Hudak

TEAM ROLE

Job and Project Managing Website

Keith Audino, Eric McClure, Swap Shrestha and Dexter Wilson

TEAM SCANNER

3D Modeling on a Budget

Mike Boch, Matt Howard, George Montgomery, Christopher Shaffer and Isaac Walker

TEAM THRIFTY

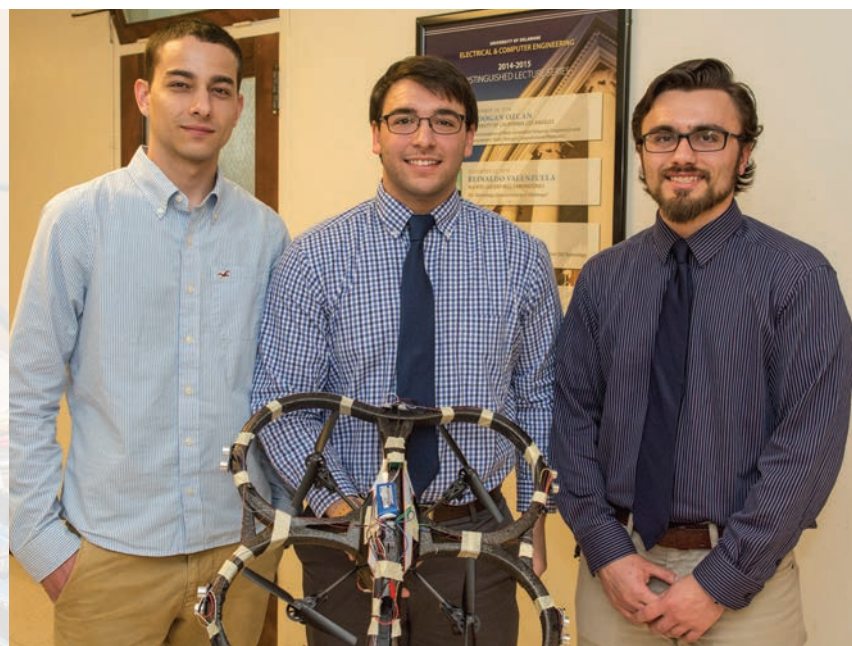
Storage and Utilization of Energy
Passively Harvested from Motion

Christian Marchena, Morgan McElhiney and Mac Tierney

TEAM UNDERGROUND

Overhead to Underground
Conversion of Main Street Power
Distribution System

Sean Buckley, Bryant Messick, Adam Richwine, Adam Schultz, Frank Sulpizio and Peter Yang



Benjamin Garrett, Nick Hudak and Kevin Hall (left to right) with quadcopter.

Interdisciplinary senior design participants

<i>Kyle Berry</i>	<i>Tim Johnson</i>
<i>Justin Chrono</i>	<i>Linfeng Li</i>
<i>Ken Goydan</i>	<i>Francis Rivera</i>
<i>Melissa Groome</i>	<i>Andy Sieben</i>
<i>Jared Grove</i>	



Council members met March 10–11 this year.

2014–15 ECE ADVISORY COUNCIL

Ms. Janine Barbacane, EE'01
AC Chair
 Account Executive, Oracle

Dr. Fil Bartoli
 Professor and Chair, Electrical & Computer Engineering, Lehigh University

Mr. Tyler Barton, EE'06
 Computer Engineer, U.S. Army CERDEC

Dr. Karen Bloch, EE'85, M'97, PhD'04
 Engineering Manager, DuPont Company

Mr. Terrance Bowman, EE'95
 Recruiting Manager, JPMorgan Chase

Dr. Edward Coyle, EE'79, M'81
 Arbutus Chair, Integration of Research & Ed., ECE Dept., Georgia Institute of Technology

Dr. Charles Johnson-Bey, M'93, PhD'94
 Senior Manager and Baltimore Site Lead for Engineering, Lockheed Martin Corporation

Dr. Daniel Lau, PhD'99
 Professor, University of Kentucky

Mr. Michael Lombardi
 Deputy Director, Intelligence & Information Warfare Directorate, U.S. Army CERDEC

Mr. Thomas McCormick, EE'81
 President and CEO, American Electrical, Inc.

Dr. Kristofer Roe, EE'95, M'97, PhD'01
 Director, R&D Imaging, Smiths Detection

Mr. Ray Sokola, EE'76
 Vice President of Technology Planning, DTS, Inc.

Dr. Rick Taylor
 Chair, IEEE Delaware Bay Section

Dr. Wayne Westerman, PhD'99
 MultiTouch Architect, Apple Computer

RAISING CAIN:

Family represents nine decades of electrical engineering at UD

Members of Delaware's Cain family have been tied to electrical engineering at UD since the 1930s. **EUGENE CAIN** graduated from this department during the Great Depression in 1932, his son **DONALD** graduated in 1968, and Don's son **BRADLEY** made it three generations when he earned a bachelor's degree in 1995.

The youngest Cain, who went on to earn a master's degree in 1997, has followed the industry in the computer field, designing Internet data center products for a series of startups. Although computers hadn't yet been invented in Eugene Cain's time, both Don and Brad Cain had the opportunity to learn from the "giants" of the department. Don worked with early computer expert **DAVID ROBINSON**, and Brad worked on several projects with Internet pioneer **DAVID MILLS**, who became his graduate school adviser.

"David Mills introduced me to all of the heavyweights in the Internet world, and my master's thesis ended up becoming an Internet standard," Brad Cain says. "My success was due largely to what Mills had taught me and the connections he made for me."

KEN BARNER, professor and chair of Electrical and Computer Engineering, notes that the Cain family has spanned a period of tremendous change in the fields of electrical and computer engineering since the 1920s. ■



Brad and Don Cain



Innovation design studio rendering

iSUITE LABS:

Reimagining engineering educational laboratories

The ECE Department is reimagining engineering education. Essential components of the new curriculum are project-based courses that infuse entrepreneurial innovation and engage multidisciplinary teams. To immerse students in this innovative discovery and design, we are developing a comprehensive set of integrated next-generation facilities—the Innovation Suite (iSuite) Laboratories:

- Innovation Design Studio—an imagination space laboratory in which students conceive, design, prototype, and test their ideas and systems.
- Electronics Systems Laboratory—a core discipline laboratory with electronic test

and measurement equipment, electronic design and analysis software, RF circuit design capabilities, and network and wireless communication equipment.

- Collaboration Hub—the central facility of the iSuite Labs with a casual, multi-use environment where teams can think creatively, brainstorm project ideas, and present their ideas and projects to collaborators.

The iSuite Labs promise will only be realized through a partnership with our alumni, collaborators, and friends. To hear more about this project and how it will place UD ECE at the forefront of engineering education, please contact:

KENNETH BARNER ECE Prof. & Chair
barner@udel.edu
(302) 831-6937

BARBARA MAYLATH Dir. of Development
bmaylath@udel.edu
(302) 831-7273

Dave Robinson Fellowship

As a child, **BOB PRITCHETT**, EE'61, loved to tinker. He took things apart and put them back together again. And when it came time to choose a college—and a major—he picked his mother's alma mater. "There was never an option to look anywhere but UD," he says.

After Pritchett graduated, he went to work at Bell Telephone Laboratories, down the hall from William Shockley and Walter Brattain, inventors of the transistor and recipients of the 1956 Nobel Prize in Physics. While Pritchett's accolades weren't quite as prominent, his contributions were of tremendous significance to the digital revolution. During his 34-year career at Bell Laboratories, he developed 14 patents in the field of semiconductor fabrication and circuit design integrating analog and digital circuitry onto one computer chip for computer communications applications.

When his mother passed away in 2006, Pritchett established a scholarship in her honor. Then in 2013, Pritchett established the David M. Robinson Graduate Fellowship engineering scholarship in honor of his former UD professor and adviser, **DAVID M. ROBINSON**.

Today, Pritchett remembers Robinson as his biggest influence and calls UD "the place that made my career what it was. I was privileged to be at the right place at the right time. Without UD, none of it would have ever happened." Bob invites those who share his fondness to support future engineers in memory of Dr. Robinson. ■



David Robinson



College of Engineering

Electrical and Computer Engineering
140 Evans Hall
Newark, DE 19716



www.ece.udel.edu | www.facebook.com/UdeECE | twitter.com/UDelawareECE

UD ECE ADVANCES IN RANKINGS

The University of Delaware Electrical & Computer Engineering department's strong performance has yielded a 23-place improvement in the *U.S. News & World Report* departmental rankings over the last five years.

The University of Delaware does not discriminate on the basis of race, color, national origin, sex, disability, religion, age, veteran status, gender identity or expression, or sexual orientation in its programs and activities as required by Title IX of the Educational Amendments of 1972, the Americans with Disabilities Act of 1990, Section 504 of the Rehabilitation Act of 1973, Title VII of the Civil Rights Act of 1964, and other applicable statutes and University policies. The following person has been designated to handle inquiries regarding the Americans with Disabilities Act, the Rehabilitation Act, and related statutes and regulations: Tom Webb, Director, Office of Disabilities Support Services, 240 Academy Street, Alison Hall Suite 119, University of Delaware, Newark, DE 19716, 302-831-4643. The following person has been designated to handle inquiries regarding the non-discrimination policies and to serve as the overall campus coordinator for purposes of Title IX compliance: Bindu Kolli, Chief Policy Advisor, Office of Equity and Inclusion, 305 Hullahen Hall, University of Delaware, Newark, DE 19716, 302-831-8063. The following individuals have been designated as deputy Title IX coordinators: for Athletics, Jennifer W. Davis, Vice President for Finance and Administration, 220 Hullahen Hall, University of Delaware, Newark, DE 19716, 302-831-2769; and for Student Life, Dawn Thompson, Dean of Students/AVP for Student Life, 101 Hullahen Hall, University of Delaware, Newark, DE 19716, 302-831-8939. Inquiries concerning the application of anti-discrimination laws may be referred to the Title IX coordinators or to the Office for Civil Rights, United States Department of Education. For further information on notice of nondiscrimination, visit <http://wdcrobcolp01.ed.gov/CFAPPS/OCR/contactus.cfm> for the address and phone number of the U.S. Department of Education office that serves your area, or call 1-800-421-3481. 12-2013/q



MARK YOUR CALENDAR

ECE Research Day

March 9, 2016

With keynote address by

David C. Munson, Jr.

UNIVERSITY OF MICHIGAN

*"Engineering Education: Preparing
Students to Change the World"*