2013 | Electrical & Computer Engineering *CURRENTS*

INSIDE: *Read how students, faculty and alumni are driving dynamic changes and innovations.*

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UNIVERSITY OF DELAWARE | College of Engineering
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

MESSAGE FROM THE CHAIR

KENNETH E. BARNER

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.

Emblematic of faculty innovation, ***Prof. Chengmo Yang*** offers a novel approach to hardware failure resiliency in computing systems, work funded by a National Science Foundation CAREER Award — NSF's prestigious award supporting junior faculty who are exemplary teacher-scholars. ***Prof. Abhyudai Singh*** received the Ralph E Powe Junior Faculty Enhancement Award for pioneering work on how cells make decisions — research that pushes the boundary of ECE fundamentals into interesting biological problems, with results holding genuine promise in addressing HIV and cell disorder challenges.

UD ECE research is featured in the highest impact journals. Three ***Nature*** publications report recent results, including ***Prof. Singh's*** research on the dynamics of gene-expression, ***Prof. Hochberg's*** advances in silicon photonics and ***Prof. Prather's*** development of groundbreaking systems for imaging and communications systems in the 30-100 GHz frequency range. UD is a clear leader in revolutionizing silicon chip development, where the fundamental currency is light rather than electrical signals. Likewise, UD fabricated gigahertz systems are exceeding previously known capabilities in high-frequency imaging and communications, making through-material imaging and ultrafast wireless communications a reality.

The department's inaugural ECE Research Day celebrated scholarship, innovation and accomplishments by students, faculty and alumni. Highlights included student research posters and awards, and a Distinguished Lecture by Fred Kitson (B74), EVP & CTO of DTS Inc.; who along with fellow alums Karen Bloch (B1985, M1997, PhD2004), Thomas McCormick (B1981), and Casey Xia (PhD2001) was recognized with an alumni award. Mark your calendar now for the 2014 ECE Research Day on March 4th, which features a Distinguished Lecture by David Welch (B1982), co-founder & president Infinera Corp.

ECE educational programs continue to attract students — enrollment is up over 40% in five years, with more than 300 undergraduate and 170 graduate students enrolled. This growth is fueled by new, innovative course and program offerings in areas such as cybersecurity, alternative energy and the smart grid. UD ECE continues to attract exceptional talent, including undergraduates ***Casey Richard Casalnuovo*** and ***Nicole Marie Wells*** who were among only 14 graduating seniors to achieve perfect 4.0 averages. Students also use their talents to give back, developing a mobile app for the United Way, participating in the Clinton Global Initiative and leading outreach efforts to regional high school students.

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, Ph.D.
Professor and Chair
Electrical and Computer Engineering

Be sure to *like* the *University of Delaware Electrical and Computer Engineering Department* Facebook page!

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Electrical & Computer Engineering

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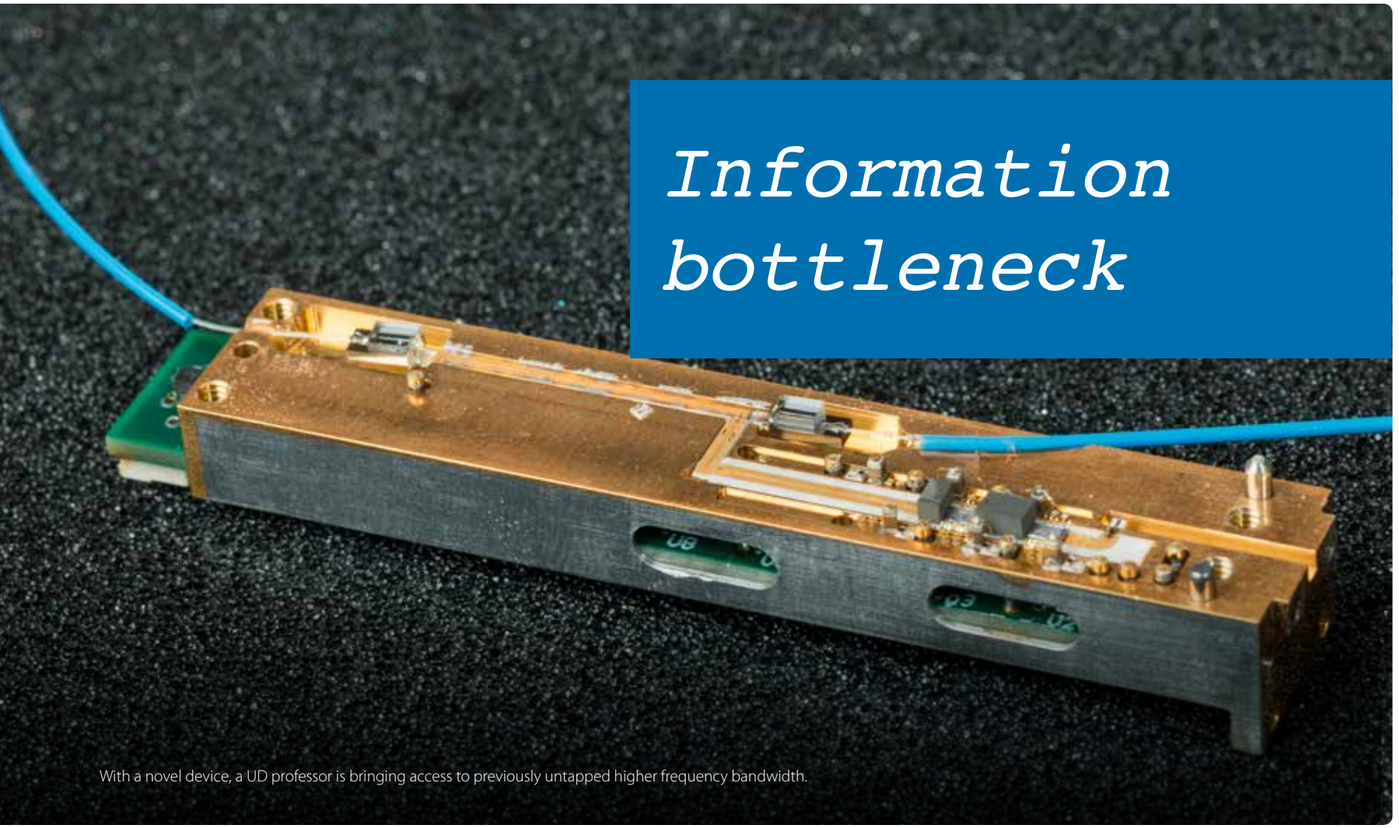


Information bottleneck

With a novel device, a UD professor is bringing access to previously untapped higher frequency bandwidth.

Reaching untapped frequencies: UD professor brings access to higher frequency bandwidth

Society's increasing technology use and data consumption is causing an information bottleneck, congesting airwave frequencies and sending engineers searching for access to higher capacity bandwidths.

Mature technologies, such as radio, operate at lower frequency ranges because it's easy to manipulate. Communications become difficult at larger bandwidths.

For the military, finding a way to access higher frequencies is imperative because civilian networks are increasingly crowded. Until now, no technology has existed to tap into and successfully use these frequencies, which span 30-100 gigahertz.

"It's like having a highway where you can drive 1,000 miles per hour, but there aren't any cars that go that fast," said **DENNIS PRATHER**, College of Engineering Alumni Professor of Electrical and Computer Engineering (ECE), who with his team has created a novel device that opens access to this new bandwidth.

Reaching untapped frequencies

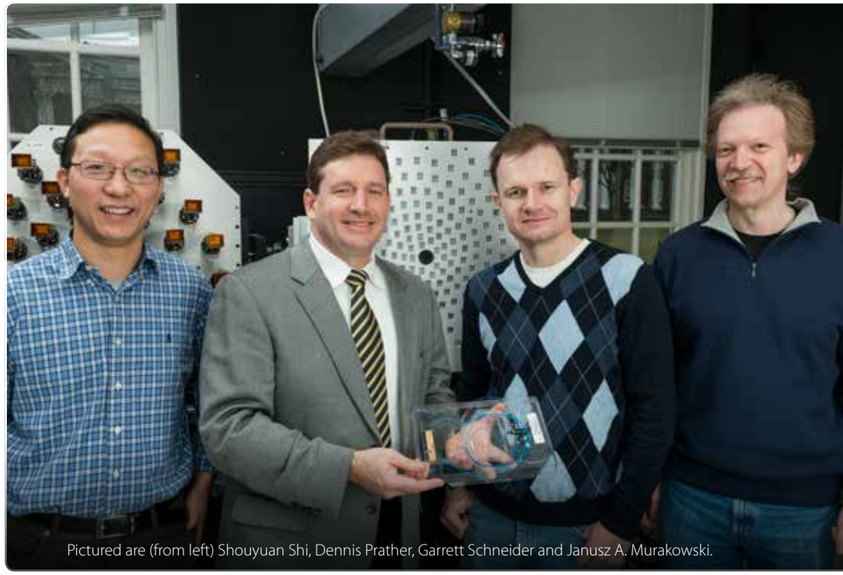
Capitalizing on photonic-based radio frequency systems, Prather's latest invention offers seven octaves of operation and unprecedented fidelity and allows the user to transmit everything from voice and data communications, to satellite communications or radar signals.

The device uses a technique of sideband injection locking, developed by Prather in his lab.

"Think of a piano where every eight keys the notes repeat, just at a higher pitch. The differing pitches are harmonics, or related frequencies, of the first tone," he said. "If we put a radio signal with an antenna into a custom-made modulator and then connect a laser beam to the device, it generates harmonics."

By inputting a related frequency into the laser beam, Prather is able to generate a shifted harmonic or octave. When mixed, they cancel what is identical, leaving the user with only the signal's difference frequency. The difference is how far apart they are – creating a trustworthy way to "hop" from signal to signal and securely transmit military information.

"The ability to harness the capacity of a spectrum at higher frequencies is huge – no one is saying 'give me a slower network.' We're the first to do it at this frequency, with this kind of fidelity, in this particular way," said Prather, who is working with the Office of Economic Innovation and Partnerships to patent the concept.



Pictured are (from left) Shouyuan Shi, Dennis Prather, Garrett Schneider and Janusz A. Murakowski.

Recently reported in *Nature Photonics*, the research is funded in part by the Air Force Office of Science Research, the Air Force and other governmental agencies. Co-authors on the paper include **GARRETT SCHNEIDER**, the lead author and a UD research associate, and **CHRISTOPHER SCHUETZ**, assistant professor of ECE, both UD alumni.

Schuetz is former chief technology officer of Phase Sensitive Innovations (PSI), a UD spin-off that grew out of his UD doctoral work. In FY 2012 it was the number one federally funded research and development company in the entire state of Delaware. Also involved from UD were research associates Janusz A. Murakowski and Shouyuan Shi.

PSI originally built the modulators used in Prather's new system for passive millimeter wave imagers designed to see through weather conditions such as blowing sand, smoke, clouds or rain. Researchers later realized they could be used to dynamically hop from one place in the spectrum to another, something Prather calls "spread spectrum."

The system's flexibility across multiple information platforms means less equipment to perform multiple functions, less training for operators and a chameleon-like product that can adapt to capture or transmit varying information.

"We want the application to define the limits, not our ability to harness one particular portion of the spectrum," said Prather.

Made from fiber optic cables and nanoscale devices, the lightweight system may ultimately be printed in 3D on wafer-thin paper and deployed on the wings of unmanned aerial vehicles or drones.

The next step is to cost efficiently commercialize the technology. Prather has received $1.6 million in new funding to take the technology to the nanoscale, work that will likely include collaboration with ECE colleague, associate professor **MICHAEL HOCHBERG**. That could ultimately occur the Interdisciplinary Science and Engineering Laboratory's nanofabrication facility.

Article by Karen B. Roberts | Photos by Evan Krape

Supercomputing leader

Supercomputing leader: Gao, ETI participate in $60 million Department of Energy computing initiative

Two teams with University of Delaware connections were among just eight selected by the Department of Energy's (DOE) Office of Advanced Scientific Computing Research to receive a combined $60 million in funding under a supercomputing program called 2012 X-Stack: Programming Challenges, Runtime Systems and Tools.

GUANG GAO, Distinguished Professor of Electrical and Computer Engineering (ECE) is part of an Intel-led team selected to address extreme-scale computing issues in scalability, programmability, portability, resilience, energy efficiency and interoperability. ET International Inc. (ETI), a UD spin-off company founded by Gao, also was awarded funding under the program.

Intel-led project

As scientific discovery and national security needs advance, and as data consumption and creation accelerates, Gao believes the next generation of scientific breakthroughs in extreme scale science will require major, novel advances in computer technology.

"We cannot outsource our exa-scale computing research and development needs elsewhere," he said. "Strategically it is too important to our national security and to maintaining leadership in science and technology."

On the Intel-led X-Stack project, Gao is leading research at UD to develop a novel program execution model and self-aware system software framework.

As computational power grows from peta- to exa-scale — a three order of magnitude change that promises a thousand-time increase in performance — parallel processing problems become more complex and irregular.

Gao and his team at the Computer Architecture and Parallel Systems Laboratory will develop a self-aware operating system model to reduce energy consumption and save power on these extreme-scale systems. The system will use a novel control model and methodology created by Gao's team that employs machine learning to help the system adapt to its environment and effectively "turn off" unnecessary switches as needed to reduce energy consumption.

"This foundational research is needed to bring these computers within range where we can build them, said Wilfred Pinfold, director of extreme scale programs at Intel Labs.

ETI-led project

Under a separate award, ETI serves as the lead-principal investigator institution on the Brandywine X-Stack Project.

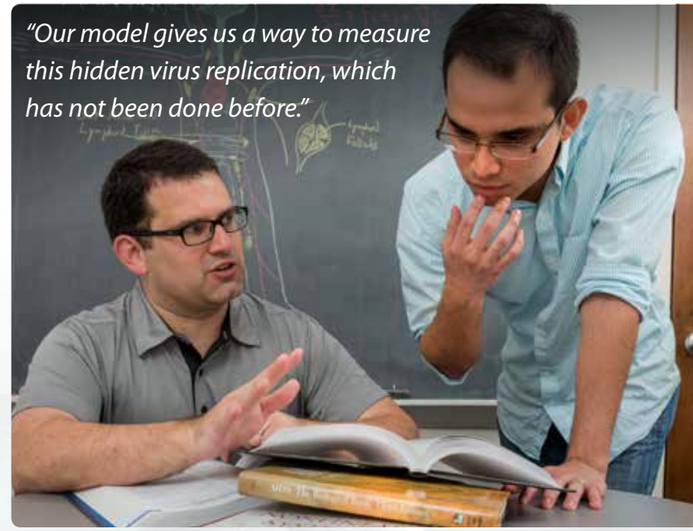
According to **DAVID WEIR**, director of UD's Office of Economic Innovation and Partnerships, start-up companies like ETI play a key role in fostering the high risk, high payoff ideas needed to advance society. Weir has worked with Gao since 1998 and has had an instrumental role in helping protect his intellectual property, expand his faculty research program to include a start-up company, license the technology and systems, and form a corporation.

ETI continues to strengthen ties with UD, employing more than 20 people, with more than half a dozen UD alumni — including **RISHI KHAN**, B2000, PhD2007, the company's vice president of research and development. Dozens of UD students have interned with ETI over the years.

"This new award is clear evidence of ETI's growth from a university spin-off to a maturing, independent high technology company that is attracting national and international recognition," said **KENNETH E. BARNER**, professor and chair of ECE.

Article by Karen B. Roberts | Photo by Evan Krape

HIV advance: Professor's mathematical model helps measure hidden HIV



Ryan Zurakowski (left) has reported a new modeling technique that reveals HIV may be replicating in the body even when undetectable in the blood. With him is Fabian Cardozo, a UD doctoral student and co-author of the paper.

Scientists have long believed that measuring the amount of HIV in a person's blood is an indicator of whether the virus is actively reproducing.

A University of Delaware-led research team reports new evidence that hidden virus replication may be occurring within the body's tissue, despite undetectable virus levels in the blood.

The findings were reported in the *Journal of the Royal Society* in a paper titled "Modelling HIV-1 2-LTR dynamics following raltegravir intensification."

The discovery came after the paper's lead author, **RYAN ZURAKOWSKI**, assistant professor of electrical and computer engineering, and his research team created a mathematical model to represent how HIV infected cells reproduce.

According to Zurakowski, antiviral therapy suppresses HIV replication in most patients until the concentration of virus in a blood sample is undetectable. It is unclear whether similar suppression occurs in other tissues, known as sanctuary sites, including lymph nodes where most HIV is found.

"The majority in the HIV community have always believed that the drugs are penetrating sanctuary sites perfectly well and that the blood is a good surrogate measurement of these sites," he said. "Our model gives us a way to measure this hidden virus replication, which has not been done before."

The research team used the model to analyze data from a clinical study in which researchers added a new drug, an integrase (enzyme) inhibitor, to the cocktail HIV patients were already taking. Patients tested were on a steady three-drug protocol for at least two years before adding the fourth drug, and never exhibited any measurable virus in their bloodstream.

According to Zurakowski, the inhibitor prevented the HIV DNA from integrating into a cell's chromosomes and caused the HIV DNA to bind its two ends together making a small DNA circle called a 2-LTR. The team's mathematical model revealed that 2-LTR circles can be measured in the blood and demonstrate virus replication in other tissues. It also showed that several patients with undetectable virus levels in their blood nevertheless had significant uncontrolled HIV replication in other tissues

"The genius of looking for 2-LTR circles is that infected cells can't survive the trip from the sanctuary site to the blood, and neither can the HIV, but the 2-LTR circles live as long as the cells that they are resident in, which is about 10-20 days," Zurakowski said. He added that the only thing stopping the virus from infecting more cells was that it was running out of healthy cells to attack

The team calculated that the virus infected and killed between 1 million and 100 million cells daily, numbers Zurakowski said are high enough that eventually it would lead the patient to develop a drug-resistant HIV virus and to experience treatment failure.

Zurakowski said that for 30 percent of the patients in the study, adding integrase inhibitor caused 2-LTR measurements only explainable if the patient had uncontrolled virus replication in sanctuary sites in the body.

The discovery implies that current antiretroviral therapies may not be as complete in suppressing HIV as previously hoped. Because the fourth drug causes additional 2-LTRs to be created, the model may also offer a new way to measure, through a blood test, whether HIV is reproducing in sanctuary sites in the body.

Zurakowski's team is collaborating with researchers at the IrsiCaixa Institute in Barcelona, Spain, and at the University of California, San Francisco, to design a new study to confirm these findings, and to quantify the HIV turnover rates in the sanctuary sites. Ultimately, they hope the model can suggest new, more effective treatment approaches.

Article by Karen B. Roberts | Photo by Kathy F. Atkinson

Smart ship structures

Professors use supercomputer to design multifunctional materials for electromagnetic applications

Electrical and computer engineering professor **MARK MIROTZNIK** and **SHRIDHAR YARLAGADDA** are helping the U.S. Navy realize its vision for the ship of the future to have electromagnetic devices, such as antennas, integrated directly into the load-carrying structure.

Accomplishing the goal will require marrying traditional ship materials, such as structural composites, with radiating antenna elements, frequency selective surfaces and other electromagnetic (EM)-based components.

Mirotznik, associate professor, and Yarlagadda, assistant professor and assistant director for research at UD's Center for Composite Materials (CCM), are well aware of the challenges. First, the mechanical properties of the materials have to be maintained at the same time that an EM-friendly environment is created.

Second, the constituents of advanced composites — the fibers and matrix — can be combined in a broad array of architectures, setting the stage for almost limitless possibilities, but the researchers have to sift through all of these options to identify the best material for a specific application.

Enter CCM's supercomputer, a Silicon Graphics Altix UV1000, affectionately known to center researchers as Veyron for its speed and power.

Phase 1 of the project, in collaboration with the Naval Surface Warfare Center, Carderock Division, focused on developing codes to analyze existing composite structures.

"We now have efficient models for predicting the electromagnetic and mechanical properties of woven fabric composites over a very wide bandwidth," said Mirotznik. "Now, in Phase 2, we're going in the other direction – we're developing design tools that will enable hybrid structural fabrics with prescribed properties to be synthesized.

"This is a much more computationally intense task that involves a lot of intelligent guessing," he said. "The supercomputer is ideally suited for the task because it has a massive number of processors, enabling us to run multiple geometries at once, analyze them simultaneously, and then combine the best results to further narrow our search for the best material for a given application."

Veyron's capabilities will be complemented by those of a computerized loom in UD's Composites Manufacturing Science Laboratory, which was purchased by a grant from the Navy.

"The loom enables us to make a broad array of custom composite fabrics," said Yarlagadda. "Just about anything we can design, we can make with this piece of equipment. Overall, we believe the tools we're developing in this project will result in a powerful means of designing useful multifunctional structures, such as radomes, by creating stacks of custom-designed hybrid fabrics."

Mirotznik views CCM as a national treasure. "When I travel to give talks, everyone seems to know the composites center and has an appreciation for how good it is.

"I did this type of work before I came here, but everything I did was on the computer," he said. "Now I'm in a place where we can make just about anything we can dream up.

Article by Diane Kukich | Photo by Evan Krape

MEET VEYRON

The Altix UV1000 is made by Silicon Graphics International. CCM's Veyron was initially configured with 384 cores (4.1 teraflops), 2.5 terabytes (TB) of globally shared memory, and 38 TB of hard disk space. It is scalable up to 2,048 cores and 16 TB of memory (21.8 teraflops in a single system image).

Mark Mirotznik (left) and **Shridhar Yarlagadda** work at the computerized loom in the Composites Manufacturing Science Laboratory at UD, which enables the researchers to make a broad array of custom composite fabrics for multifunctional structures.

What's that noise?

Paper describes new method to understand sources of noise in gene-expression

ABHYUDAI SINGH, assistant professor of electrical and computer engineering, describes a new method to understand sources of "noise" in gene-expression that create variability in protein levels in a paper published in ***Molecular Systems Biology***, a publication of Nature.

This noise is expressed as variability in the levels of proteins/mRNAs in a cell.

Understanding which biochemical processes contribute to this variability is an important problem, since protein variability plays important roles such as driving genetically identical cells to different cell fates and buffering cell populations from unpredictable and hostile changes in their environment.

The paper, entitled "Dynamics of Protein Noise Can Distinguish Between Alternate Sources of Gene-Expression Variability," develops a new method that uses changes in protein levels inside single cells to pinpoint the primary source of gene-expression noise.

In collaboration with Prof. Leor Weinberger's group at the Gladstone Institute of Virology and Immunology, San Francisco, Singh applied this method to the Human immunodeficiency virus (HIV) system, where gene-expression noise can drive the HIV virus into latency, a dormant drug-resistant state.

The results revealed that random bursts of mRNA production drive variability in the levels of key viral regulatory proteins during human cell infection.

"We believe that understanding the source of viral gene-expression noise will have important implications in designing therapies for preventing HIV entering latency," Singh said.

Adapted from an article by Karen B. Roberts | Photo by Ambre Alexander

ECE researchers featured in *Nature* publications

Two of Singh's ECE colleagues have also been recently published in Nature publications. **DENNIS PRATHER**, professor, and **MICHAEL HOCHBERG**, associate professor, co-authored a commentary titled *"Myths and Rumours of Silicon Photonics"* in the April 2012 issue of ***Nature Photonics*** dispelling common misconceptions about silicon photonics. ***Nature Photonics*** publishes original research and news related to emerging optical technologies.

Hochberg's work in developing shared production systems for manufacturing silicon photonics was also featured in a ***Nature*** article titled *"Photonic Chips Made Easier."*

Infrared technology

UD-led breakthrough may advance development of mid-infrared light sources, lasers

UD researchers have achieved a breakthrough in the emerging field of group IV semiconductor optoelectronic devices.

Led by **JAMES KOLODZEY**, Charles Black Evans Professor of Electrical and Computer Engineering, the team demonstrated that it is possible to use a combination of germanium and tin (GeSn) to create a light emitting diode (LED) that operates in the infrared spectrum, wavelengths invisible to the naked eye.

Optoelectronics uses hardware devices to convert signals and usable energy from electronics to light. Examples include solar cells, light-emitting diodes and optical fiber communication systems. Group IV semiconductors are made from elements found in the periodic table, namely carbon, silicon, germanium, tin and lead.

Until now, researchers were uncertain if germanium and tin were capable of efficient light emission. Kolodzey's team, however, showed clear and efficient performance in the mid-infrared spectrum. Fabricated and characterized on campus, the UD-created device functions like the semiconductors found in LED flashlights, but in the infrared, rather than the visible, wavelength range.

The mid-infrared spectrum is important for applications such as medical scanning and diagnostics, the remote sensing of biochemicals, communications and signaling, and security technology.

The Kolodzey research group first began growing GeSn samples in the lab using molecular beam epitaxy about three years ago. As they added increasing amounts of tin, they noticed that the optical wavelengths became longer, fundamentally changing the energy of the electrons present and increasing the spacing between the atoms.

"If you want to generate infrared signals, we've shown that using a combination alloy that includes germanium and tin provides a significantly higher power equivalent than using germanium alone," he said. "Specifically, we've shown that when tin concentrations in the alloy reach 6 to 7 percent, the light emitted from the alloy increases dramatically."

Their results suggest that GeSn-based materials may be useful for practical LEDs operating in the infrared at wavelengths near two micrometers, which is just below the visible spectrum.

The work may have health care applications, particularly in the detection of skin cancer. "Germanium-tin alloys may provide a new diagnostic tool for illuminating skin tissue and detecting skin changes visible only in the infrared spectrum. It may also have dental applications," Kolodzey said.

The team is creating and testing further samples to determine the exact proportions of germanium and tin needed to achieve the best performance. Understanding how the wavelengths change as more tin is added is also important because the more tin used, the more the energy wavelength moves from the visible to the infrared spectrum.

Ultimately, Kolodzey hopes to develop a GeSn mid-infrared laser that provides higher output power and a more easily controlled beam than an LED and that could be useful to develop new drugs and polymers, or for laser surgery techniques because the infrared lacks the harmful effects of some other light wavelengths.

"This is an important first step," he said.

The team recently published their findings in *Applied Physics Letters*.

Article by Karen B. Roberts
Photo by Evan Krape

> "Our UD group is one of the few in the world working in this new field, and by using tin we have achieved an operating LED device with higher power output and longer wavelength operation than any previous reports or publications in this area."
>
> --James Kolodzey, Charles Black Evans Professor of Electrical and Computer Engineering

Outsmarting Hackers

US Cyber Challenge puts UD student on fast track to outwitting hackers

As chairman of the Senate Homeland Security and Governmental Affairs Committee responsible for safeguarding the nation's cyberspace, U.S. Sen. Tom Carper (Del.) recognizes the role future cyber sleuths will play in addressing emerging cyber challenges.

Electrical and computer engineering major **BILLY BEDNAR** is just the kind of young adult the senator is keeping his eye on. In July, Bednar earned the top individual score in Delaware's annual U.S. Cyber Challenge camp's "Capture the Flag" competition, in which students defend their computer networks against hackers and real life security scenarios.

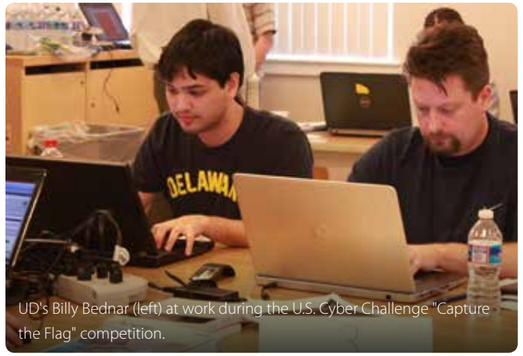
Now in its fourth year, the camp plays an important role in training students to outwit hackers that threaten the nation's information security.

"In order to address the growing cyber security challenges facing our increasingly technology dependent society, we must focus on encouraging the next generation of Americans to develop the technology skills necessary to defend our country in this emerging battlefield," said Carper.

"I'm proud of the students, like Billy, who participated in this year's U.S. Cyber Challenge. The skills they learned and honed during this week-long camp will give them, and our country, a leg-up on our competition."

Bednar joined about 45 other students for in-depth training, including penetration testing, reverse engineering and forensics, all taught by college faculty, SANS Institute senior instructors and other cyber security experts.

KENNETH E. BARNER, ECE department chair, called the U.S. Cyber Challenge competition the "perfect complement" to the growing cyber security research and education programs developing at the University of Delaware.



UD's Billy Bednar (left) at work during the U.S. Cyber Challenge "Capture the Flag" competition.

UD offered its first cyber security course last spring. Funded through a National Science Foundation grant and support from JPMorgan Chase, the course addressed the foundation of computer and network security, covering pertinent topics in cryptography, secure systems and security fundamentals, including policy and access control models.

Other UD cyber security-related courses under development include secure program design, web security, digital forensics, penetration testing, reverse engineering, and ethical hacking, cloud security and coding theory and cryptography.

"Our goal is to help the nation build a pipeline of graduates skilled in the theories and practices required to successfully respond to real life security threats, said Barner. "Addressing these challenges is a regional and national priority — one that is likely to be at the forefront for many decades."

Article by Karen B. Roberts | Photos courtesy of Wilmington University, Dana Hufe, photographer

U.S. Sen. **Chris Coons** (Del.), a member of the Senate Energy Committee, recently visited UD's STAR Campus for an update on the progress of eV2g. While there, he test drove a Mini Cooper, toured the facility, and met with **Willett Kempton** — research director for the Center for Carbon-free Power Integration and inventor of the innovative grid integrated vehicle technology — and representatives from private collaborators in the project.

An avid supporter of the grid integration technology, Coons called Kempton's vision "remarkable, compelling and creative."

Technology milestone: Electric vehicles at UD earn revenue from power grid

Daring to be first, the University of Delaware, through a project with NRG Energy Inc., has proven for the first time that all-electric vehicles can give and take power from an electric power grid *and* get paid for the service.

Fifteen vehicles officially connected with the grid located on UD's STAR Campus in February, operating as a mini power plant, giving and taking electricity on demand.

"It's a certified, registered electric system resource that has all of the legal authority of a power plant," said **WILLETT KEMPTON**, professor with dual appointments in the College of Earth, Ocean and Environment and the Department of Electrical and Computer Engineering. Kempton is research director for the Center for Carbon-free Power Integration and inventor of the innovative grid integrated vehicle technology.

FOUAD KIAMILEV, professor of electrical and computer engineering, played a key role in the project. "We developed the electronics that perform the vehicle-to-grid technology functions inside the electric vehicles and in the electric charging stations, and Milbank Manufacturing Company has licensed that technology," Kiamilev said.

Collaboration and partnership

Kempton's vision for grid integrated vehicles began in 1997 when he and a UD graduate student published a paper about the technology. After doing much of the initial development himself, Kempton realized that his dramatically different plan bridging three industries -— automotive, energy and electronics — needed more than academic publications to be realized. It required a dedicated campaign including gaining support from the state legislature, changing public policies and building strong partnerships.

UD's Office of Economic Innovation and Partnerships (OEIP) worked closely with UD's Office of General Counsel to help form a partnership known as eV2g with NRG, one of the nation's largest power generation and retail electricity businesses.

A small fleet of all-electric vehicles fitted with UD's patented vehicle-to-grid technology is earning money from the electric power grid.

According to **DAVID WEIR**, director of OEIP, "The UD-NRG partnership has become part of a very effective network of research and development collaborations, involving a number of other commercial partners, working 'hand in glove' with the University faculty and student team, all focused on a milestone-driven playbook that has brought us to this significant stage in the project."

Partnerships and collaboration are a hallmark of the project. BMW AG provided the vehicles and sent a senior electric vehicle technician from Munich, Germany, to live in Delaware and support the project. Electric grid operator PJM progressively adapted its rules to allow energy storage technologies to participate in the market; automobile retrofitter AutoPort Inc. fitted the standard production vehicles with the grid integrating technology; and Milbank Manufacturing Company built the charging stations to the required specifications. CEOE's School of Marine Science and Policy helped advance necessary public policy changes and supported Kempton's research.

> "I look forward to sharing in Washington the innovative research and discovery being done at University of Delaware's STAR Campus."
>
> –-U.S. Sen. Chris Coons (Del.)

A technology milestone

As demands on the electricity system fluctuate, large generators ramp up and down quickly to adjust for the changes and to balance electricity supply and demand.

"We serve that same function," said Kempton. "It's an important service, this balancing service. It's not a new service, but we are doing it in a very different way. Our system responds faster, is less expensive to operate and it does not burn fuel or create pollution. The batteries are storage devices, so we can take off excess electricity and we can push back when there is not enough. We are providing a power balancing service rather than power generation."

Kempton and his team are refining and optimizing the technology, moving it toward commercialization. Looking to the future, he hopes to see at least 50 percent of electric vehicles capable of electric grid service and be contributing to a renewable, sustainable energy supply.

Adapted from an article by Laura Gleason
Photos by Evan Krape

Kitson delivers keynote at 2013 Research Day

FREDERICK KITSON, B1974, executive vice president and chief technology officer of DTS Inc., chronicled the industry's evolution from a focus on technical design of portable sound technology with the 1979 release of the Sony Walkman, to providing an immersive user experience with today's advances in 3D sound technology in his keynote address at the Department of Electrical and Computer Engineering's (ECE) 2013 Research Day.

He described how technological enhancements such as Blu-ray devices, smart TVs and 3D sound make the entertainment experience more lifelike without weighing users down with complicated back end details of how things work.

"The metaphor for this is an iceberg," said Kitson. "Part of the iceberg is below the water, and it's the part you don't typically see." The underlying technology, in his analogy, is like the hidden part of the iceberg, seamlessly stabilizing and enhancing the user experience while remaining unseen.

Kitson, a member of the ECE Advisory Council, was honored during the event with the department's Distinguished Achievement Award for his career accomplishments.

Three other alumni also received career achievement awards:

KAREN BLOCH, B1985, M1997, Ph.D.2004 – Outstanding Service Award
Strategic planning manager for DuPont's chief engineer and vice president; ECE Advisory Council member

THOMAS MCCORMICK, B1981 – Entrepreneurial Innovation Award
founder, president and CEO of American Electrical Inc.

QIAN XIE (CASEY), Ph.D.2001 – Young Alumni Achievement Award
Principal scientist for Broadcom's Wireless and Mobile Group

A student poster session showcasing student research rounded out ECE Research Day. The following doctoral students were honored for outstanding research:

ELKIN GARCIA, "Overcoming New Challenges in the Many — Core Era: From High Performance to Energy Efficiency"

ANAGHA KULKARNI, "Spin Control in Quantum Dot Molecule"

YIN ZHOU, "SHREC: 3D Shape Recognition via Dictionary Learning"

Article by Sarah E. Meadows | Photos by Ambre Alexander

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

Please plan to attend the next ECE Research Day, scheduled for March 5, 2014.

Annual event celebrates capstone course success

Students, their families, project sponsors, mentors and faculty members gathered in May for the annual senior capstone celebration breakfast and poster session. Department chair **KENNETH E. BARNER**, offered opening remarks, and project sponsors from JPMorgan Chase and SAIC were on hand to discuss the students' contributions toward the industry-based design team assignments. UD alumnus **RAY SOKOLA**, B1976, president of CellPort Systems of Boulder, Col., gave the keynote address.

Instructed by professor **CHASE COTTON**, Senior 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.

Mr. Terrance Bowman
JPMorgan Chase & Co.

Ms. Jennifer McDermott
JPMorgan Chase & Co.

Mr. John M. Ferriter
SAIC

Mr. Ray Sokola
President at CellPort Systems

Prof. Chase Cotton

JPMorgan Chase & Co.

SAIC
From Science to Solutions

STUDENTS

- Michael Lanci, Matthew Velazquez, and Curtis Wheeler
- Jeremy Benson, Aryeh Kuller, Andrew Mercante, Matt Michels, & Joe Spirk
- Chris Abrahamsen, Evan Fleischman, Stephen Gerson, Sean Kilgallon, and Lauren Saxton
- Zebang Du, Xiaoyue Liu, Buming Tan, Hongfeng Wang, and Tao Wu
- Jake Benedict, Antonio Grigoli, Joseph Mensah, Safwat Saad, and Danny Wang
- Frank Chou, Alexander Coleman, Sean Kelley, and Brittany Wagner
- Ryan Carroll, Chris Jackson, Kassem Nabha, David Roper, and Eric Yong
- Thomas Gray, William Griswold, Dan Murphy, Angela Pasquale, and Eric Venturino
- Ryan Hickey
- Vlad Anderson, Arun Das, Ivor Fazlic, Samuel Lubin, and Elizabeth Mashal
- Keith Elliott, Curtis Kisielius, Dave Koeplinger, Tom Potter, Nicole Wells, and Junpeng Zhu
- Matt Becker, Will Goswell, Jensine Hollister, Geoffrey Johnson, and Yizhu Wang
- Jing Ji, Lu Liu, and Yang Yu
- Geoffrey Alexander, Gunjan Majmudar, and Kimberly Smith
- Chris Kerwien, Brock Overmiller, and Tim Wen

Team places 9th worldwide in IEEE data fusion contest

Four doctoral students placed 9th worldwide in the IEEE Best Classification Challenge, a global competition focused on creating accurate large-scale data images. Selected from a pool of 50 global teams, the UD students were the only US team to rank in the competition's top 10.

Each team received three sets of geographical data for the University of Houston, including ground truth data, a hyperspectral image and a LiDAR (Light Detection and Ranging) derived digital surface model. The assignment was to create an algorithm and produce a useful navigational tool that differentiated campus locations— residential areas, parking lots, roads highways and grassy areas— by color.

Led by doctoral student **YIN ZHOU**, the UD team included **SHERIN MATHEWS**, **LUISA POLANIA** and **ANA RAMIREZ**. Working under the advisement of professors **GONZALO ARCE** and **KENNETH BARNER**, the team developed a novel discriminative dictionary-learning algorithm to fuse the data together.

Classification of high resolution satellite images is a challenging task since an image may contain almost a million pixels with tens or hundreds of feature dimensions, and takes a lot of time and money to complete. However, for this competition, both sets of multi-sensor data had a spatial resolution of 2.5 megapixels (1 million pixels for every 1 megapixel).

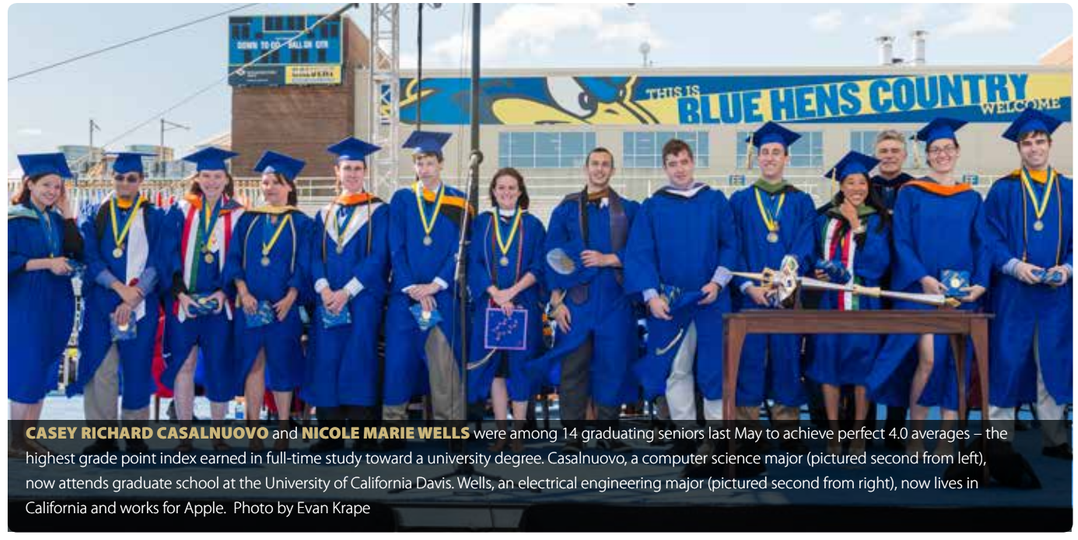
Due to the surplus of data, Zhou said the major challenge was creating and testing the algorithm within a relatively short time span. Another factor he said that had to be taken into consideration was evaluating the speed and complexity of the algorithm to determine its efficiency.

"The data set was large and required us to discover a way to speed up our algorithm to match the complexity of a real world database, such as a satellite or the space station that processes large quantities of data in real time," said Zhou.

In order to ensure the data was implemented correctly, he said a lot of the team's time was devoted to researching hyperspectral imaging and learning how to integrate it into the algorithm.

"Sensing technology is advancing rapidly," said Barner, ECE department chair. "In this hyperspectral example, 144 spectral bands were captured. Making sense of such high dimensional data is a critical challenge. The novel algorithms developed by the team demonstrates how meaningful conclusions can be extracted from a plethora of data."

Article by Collette L. O'Neal



CASEY RICHARD CASALNUOVO and **NICOLE MARIE WELLS** were among 14 graduating seniors last May to achieve perfect 4.0 averages – the highest grade point index earned in full-time study toward a university degree. Casalnuovo, a computer science major (pictured second from left), now attends graduate school at the University of California Davis. Wells, an electrical engineering major (pictured second from right), now lives in California and works for Apple. Photo by Evan Krape

UD's Clinton Global Initiative University participants include, (from left, seated) Marta Shakhazizian, Jacob Joseph, Daniel Reyes and Noel Shadowen, UD graduate student and student adviser to the program; and (from left, standing) N'Kosi Oates, Xiaowen (Sharon) Qui, James Leitner, Mike Wilson, Tim Fowles, who serves as faculty mentor, Erwing Fabian Cardozo and Sergio Pino.

Ideas into action

ECE students share "Farms of Hope" idea at Clinton Global Initiative meeting

ECE doctoral student **SERGIO PINO**, and fellow students **FABIAN CARDOZO** and **IRENE GUTIERREZ**, were among eight Blue Hens to represent University of Delaware at the Clinton Global Initiative University (CGI U) meeting this spring.

UD recently joined the network of more than 30 universities and colleges, founded by former President Bill Clinton, to engage the next generation of leaders on college campuses in solving world problems. The UD team joined more than 1,000 students from around the globe to discuss their "Commitment to Action" proposals and formulate concrete plans for implementation.

With seed funding from the University's Institute for Global Studies, the teammates — all from Bucaramanga (the "City of Parks") in Colombia — shared their idea to launch "Farms of Hope," an initiative to provide a sustainable restorative farming environment near their hometown in Colombia for people forced to abandon their countryside homes and livelihoods as a result of internal conflict. There are more than 26 million internally displaced persons in the world, with Colombia having among the highest numbers, at 3.9 million.

"We want to put into practice a sustainable model that will be economically supported by means of local farming and food processing activities, making it possible for displaced persons to pursue a self-sustainable life," said Pino.

"Farms of Hope represents a call of duty to provide help and share with others our abilities as persons and engineers," he said. "We believe we can help improve society by creating an out-of-the-box solution that involves the extraordinary capabilities of the faculty and students at UD and at the Industrial University of Santander in Colombia."

If successful, the Farms of Hope team envisions replicating the model to help displaced persons around the world.

Adapted from an article by Tracey Bryant | Photo by Doug Baker

Doctoral student partners with Naval Academy in Arctic training exercises

University of Delaware scientists braved freezing temperatures and high winds to study changes in Arctic sea ice. Their field site – a frozen expanse of the Arctic Ocean along the northernmost shoreline of Alaska.

Among them was electrical and computer engineering doctoral student **JESSE SAMLUK**, whose role was to explore methods to improve the accuracy of ice thickness measurements near deformed ice features where measurement errors are highest.

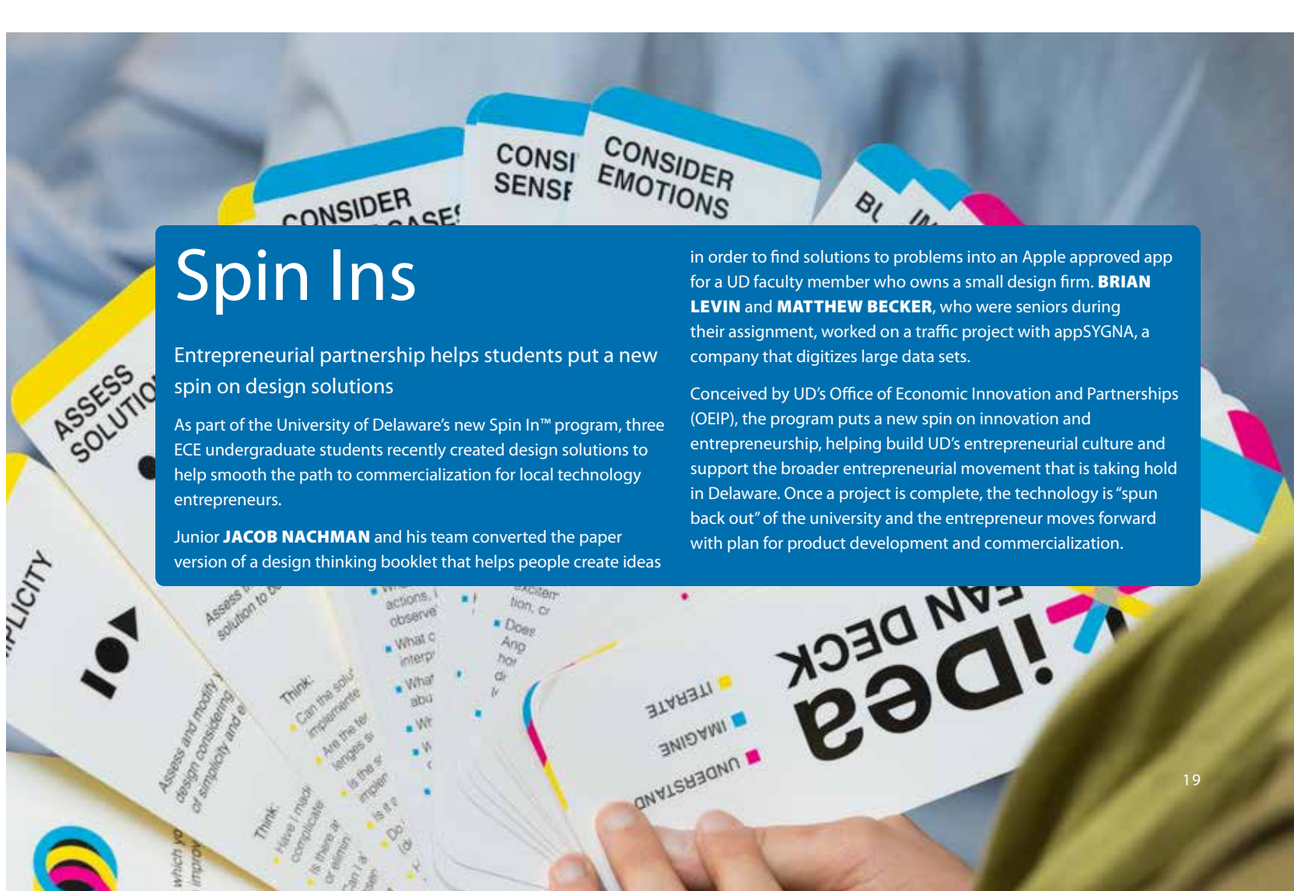
The 15-day program was led by the Naval Academy's Oceanography Department to expand its curriculum on polar regions, with the UD portion sponsored by the National Science Foundation under a grant led by **CATHLEEN GEIGER**, research associate professor of geography in the College of Earth, Ocean, and Environment. Geiger's UD team monitored sea ice changes using cutting-edge technology to quantify shifts in the dynamic environment, where seawater freezes in winter and melts in warmer months. They also trained undergraduates from the U.S. Naval Academy in 3-D mapping of ice contours and cross-referencing locations into geographic information systems.

"This project has increased our fundamental knowledge about how radar signals interact with the environment and enable more accurate predictions of ice thickness distribution as a global climate variable," said **JAMES KOLODZEY**, Charles Black Evans Professor of Electrical Engineering, who co-advises Samluk with Geiger.

Geiger said the field project prepares the next generation of leaders to understand future changes in the environment.

"Students will stand on a world of ice that is changing directly beneath their feet," she said. "Together with views of the Aurora Borealis, such an experience completely solidifies a person's understanding of Earth as a moving, changing planet."

Adapted from an article by Teresa Messmore and Karen Roberts



Spin Ins

Entrepreneurial partnership helps students put a new spin on design solutions

As part of the University of Delaware's new Spin In™ program, three ECE undergraduate students recently created design solutions to help smooth the path to commercialization for local technology entrepreneurs.

Junior **JACOB NACHMAN** and his team converted the paper version of a design thinking booklet that helps people create ideas in order to find solutions to problems into an Apple approved app for a UD faculty member who owns a small design firm. **BRIAN LEVIN** and **MATTHEW BECKER**, who were seniors during their assignment, worked on a traffic project with appSYGNA, a company that digitizes large data sets.

Conceived by UD's Office of Economic Innovation and Partnerships (OEIP), the program puts a new spin on innovation and entrepreneurship, helping build UD's entrepreneurial culture and support the broader entrepreneurial movement that is taking hold in Delaware. Once a project is complete, the technology is "spun back out" of the university and the entrepreneur moves forward with plan for product development and commercialization.

Geoffrey Johnson, Achiever of the Year

GEOFFREY JOHNSON, a computer engineering major who graduated in May, was selected as the Achiever of the Year for Delaware by the Mid-Eastern Association of Education Opportunity Program Personnel.

Cheryl Davis-Robinson, director of the Student Support Services Program, who nominated Johnson, said he impressed her with "his eagerness to learn and his desire to be someone who would make a difference for other people." She also acknowledged his gift to motivate others by speaking to high school students in the region.

UD's Student Support Services Program enriches students' experiences academically, culturally and socially by strengthening relationships, providing staff and peer mentoring and providing unique experiences and leadership opportunities to promote academic success and degree attainment.

Johnson, a Student Support Services Program participant throughout his academic career, has been active in the National Society of Black Engineers, Resources to Insure Successful Engineers (RISE) and the Institute of Electrical and Electronics Engineers. He also did volunteer work with the Yeardon Athletics Association basketball league and with the 69th Street Wildcats football program, both in Philadelphia.

International classroom

Sixteen visiting scholars from universities in Colombia, Venezuela and Bolivia conducted research with University of Delaware faculty during summer 2012 as part of the College of Engineering Summer Research Program. The students were hosted by faculty members in the departments of Civil and Environmental Engineering, Computer and Information Sciences, Electrical and Computer Engineering and Mechanical Engineering. The initiative is part of a vibrant UD partnership established in 2008 with a consortium of Colombian universities to attract top doctoral students to UD. Since the program's inception, close to 30 doctoral students have enrolled in UD's graduate program in engineering.

"Expanding our world view is a critical component to solving global problems," said **BABATUNDE A. OGUNNAIKE**, dean of the College of Engineering. "Initiatives like the summer research program with Colombian universities allow UD faculty and students to establish global relationships that will help us make progress on these important problems."

Association of Old Crows awards merit scholarships

Undergraduates **CURTIS KISIELIUS**, **DAVID KOEPLINGER** and **NICOLE WELLS**, were each awarded $1,000 merit scholarships from the Association of Electronic Warfare and Information Operations, Aberdeen Proving Ground, Susquehanna Chapter.

Colloquially known as the "Association of Old Crows," the association established the scholarship to encourage and assist the study of science, engineering and technology at local colleges. Scholarships are awarded based on academic merit, character and leadership.

Kisielius, a computer engineering major, maintains a 3.9 GPA and is a member of Tau Beta Pi Engineering Honor Society and Eta Kappa Nu Electrical and Computer Engineering Honor Society. He has been on the Dean's List all semesters and received UD's General Honors Award, the Roscoe M. Lewis, Jr. '50 Endowed Scholarship, the AmeriCorps Education Award and the University of Delaware Merit Scholarship. He participates in the Linux Users Group, is a founding member of the Robotics Club and is an undergraduate research assistant in mathematics. Kisielius' educational objectives are to focus on building general knowledge of mathematics, computer hardware and computer software.

With a 3.97 GPA, Koeplinger, an electrical engineering major, is a member of both Eta Kappa Nu and Tau Beta Pi. Additionally, he has received many awards including the Roscoe M. Lewis, Jr. '50 Endowed Scholarship, the Lillian Sincoskie Scholarship and UD's General Honors Award. A well-rounded student, he has been on the Dean's List five consecutive semesters while participating in the UD Marching Band, Pep Band, Philosophy Club and Linux Users Group. He is a research assistant with the UD Undergraduate Research Program and the CVORG Research group. He plans to attend graduate school and is interested in designing and programming digital data and image processing systems.

Wells' 4.0 GPA has earned her a spot on the Dean's List every semester while at UD. An electrical engineering major, she is a member of Eta Kappa Nu and Tau Beta Pi, and has received many special honors and scholarships. She participates in the Robotics Club, Linux Users Group and varsity Lacrosse, and also volunteers for Heartland Hospice, Food Bank of Delaware and Faithful Friends Animal Shelter. As an undergraduate researcher for the CVORG research group, Wells works on projects involving electric car charging and imaging through turbulence. She is considering graduate programs in robotics or artificial intelligence.

A special thank you to Mr. Giorgio Bertoli, president of the Association of Old Crows, for making this scholarship opportunity possible for our students.

Article and photo by Debbie Nelson

Code for Good

University of Delaware students swept winning honors at JPMorgan Chase's Delaware Code for Good Challenge, a codefest where teams of students worked for 14 continuous hours to create a wide range of innovative applications and technical tools.

First place went to electrical engineering major **MCKEIGHRY TIERNEY** and teammates **MICHAEL BALLES**, a mechanical engineering student; Lingbin Cai from University of Pennsylvania and Karthik Nadimpalli from Rochester Institute of Technology.

Tierney's team designed a mobile app for United Way of Delaware, allowing the nonprofit to streamline its 2,000 services and deliver related information via smartphone over the weekend and in times of emergency. Designed for an Android phone, the app allows users to search for agencies using a keyword, find emergency numbers other than 911, "like" United Way on Facebook and learn more about the organization in general.

The UD students worked on the back-end of the app to create a parser/search program in Java to categorize the database and facilitate searching by keyword, while Cai and Nadimpalli created the front-end interface design and hotline one-touch call buttons and integrated the search function into the app.

"I really enjoy coding, but as an electrical engineering major my courses are getting more specialized so I thought this would be a fun opportunity to code and perhaps brush up on programming language," said Tierney. "I ended up coding on the Java platform and I am grateful to **JAMES ATLAS** who taught me to code in the CISC181 course!"

Tierney also said it was a great experience to be paired with students from other universities.

"We were able to design and create a working Android app in 14 hours despite never having met, seen the challenge or known each other's coding experience beforehand," Tierney said.

A UD team also placed second at the event. In fact, UD generated the most participants for the event with 17 out of 42 top technology students from 15 area universities.

Adapted from an article by Kathryn Meier

Honors & Awards

TEACHING ASSISTANTS HONORED

Each semester, (ECE) recognizes teaching assistants selected by the ECE Graduate Committee based on student evaluations.

FURKAN CAYCI
Excellence in Teaching and Spring 2013 Best TA

"In engineering, I believe one of the main problems that students are facing is to actually relate the course material to real-world applications. I like to present the questions that make them realize that connection and lead them into finding answers."
--Furkan Cayci, Excellence in Teaching Award recipient

JOSH MARKS
Spring 2013 Outstanding TA

RYAN VAN ANTWERP
Fall 2012 Best TA

ANUPAMA PUTHUR VENKATARAMAN
Fall 2012 Outstanding TA

University Graduate Awards

Three electrical and computer engineering doctoral students were recognized by the Office of Graduate and Professional Education.

Nuha Ahmed, doctoral student under the direction of Steven Hegedus, an associate professor in ECE and affiliated with the Institute of Energy Conversion, received the Graduate Scholars Award for the second year in a row.

Xin Ma, who studies under assistant professor Sylvain Cloutier, received the University Dissertations Fellow Award for her research on ultra-low-cost, nanoscale light-emitting devices.

Luisa Polania, who studies under professor Kenneth Barner, earned the University Graduate Fellow Award for her work in signal and image processing.

Dissertation/ Thesis Titles *Fall 2012 – Summer 2013*

Ph.D. Dissertation

Information Graphic Classification, Decomposition and Alternative Representation
JINGLUN GAO
Advisor – Kenneth E. Barner

Chip-Scale Optical Interconnects
TIAN GU
Advisor – Michael W. Haney

Toward A Realistic Virtual Surgical Simulation Environment: Real-Time Deformation, Haptic Feedback and Visualization Algorithms
RUI HU
Advisor – Kenneth E. Barner

Interference Management and Energy-Efficient Transmission in Wireless Communication Systems
CHENZI JIANG
Advisor – Leonard J. Cimini

Exploiting Prior Knowledge in Information Processing
KEJING LIU
Advisor – Javier Garcia-Frias

Performance of Flooding in Proactive Routing Protocols for Ad Hoc Networks
CARLOS RODRIGO APONTE
Advisor – Stephan K. Bohacek

Numerical Time-Domain Electromagnetics Based on Finite-Difference and Convolution
YUANQU LIN
Advisor – Daniel S. Weile

Artificial Impedance Ground Planes for Low Profile Antenna Applications
IAN MCMICHAEL
Advisor – Mark S. Mirotznik

III-V/SIGE Tandem Solar Cells on Si Substrates
KENNETH SCHMIEDER
Advisor – Robert L. Opila

Using the Presence of Anti-Reverse-Engineering Artifacts to Detect Malware
RYAN VAN ANTWERP
Advisor – Chase J. Cotton

Nano-Scale Engineering of Lead Chalcogenide Nanocrystal for Opto-Electronic Applications
FAN XU
Advisor – Sylvain Cloutier

Spatial Diversity in Multiple Antennas Transmission Systems
TIANYI XU
Advisor – Xiaoming Xia

Coded Aperture Optimization in Compressive Spectral Imaging
HENRY ARGUELLO
Advisor – Gonzalo R. Arce

Growth of Silicon-Germanium-Tin Alloys and Fabrication of Magnetic Tunnel Junction Biosensors
NUPUR BHARGAVA
Advisor – James Kolodzey

Infrared and Terahertz Emitters Based on Group IV Semiconductors
JAY PRAKASH GUPTA
Advisor – James Kolodzey

Concurrency and Synchronization in the Modern Many-Core Era: Challenges and Opportunities
JUERGEN RIBUTZKA
Advisor – Guang R. Gao

A Study of the Feasibility and Performance of an Active/Passive Imager Using Silicon Focal Plane Arrays and Incoherent Continuous Wave Laser Diodes
RICHARD VOLLMERHAUSEN
Advisor – Mark S. Mirotznik

Result Diversification Through Subtopic Modeling
WEI ZHENG
Advisor – Hui Fang

Master Thesis

HIV Model Parameter Estimates From Interruption Trial Data
RUTAO LUO
Advisor – Ryan M. Zurakowski

Flow Measurement Via Novel Fiber Bragg Grating Optical Sensor
MATTHEW SOMERVILLE
Advisor – Mark S. Mirotznik

Tapestry: Weaving Execution and Synchronization Models
JOSHUA LANWEHR
Advisor – Guang R. Gao

A Hybrid GPU/CPU FFT Library for Large FFT Problems
SHUO CHEN
Advisor – Xiaoming Li

Current Requirements Engineering Tools and iMuse
KWANG CHOI
Advisor – Kristina Winbladh

Lapped-Windowed Reconstructions in Compressive Spectral Imaging
CLAUDIA CORREA-PUGLIESE
Advisor – Gonzalo R. Arce

A Wide-Band Narrow-Line RF Source Utilizing A Heterogeneous Silicon Photonic Platform
GARRETT EJZAK
Advisor – Dennis W. Prather

Hardware Acceleration of Lucky Region Fusion Algorithm for Imaging
WILLIAM MAIGNAN
Advisor – Fouad E. Kiamilev

Massively Parallel Breadth First Search Using a Tree-Structured Memory Model
THOMAS ST. JOHN
Advisor – Guang R. Gao

Motor Load Detection for Voltage Transient Based Non-Intrusive Load Monitoring
PAUL DEL MAR
Advisor – Keith W. Goossen

MS with Non-Thesis Graduates

OSAHON ERIBO JR.
DANIEL I. LEWIS
OBINNA ANYANWU
YUVRAJ KHADKE
SHANNON KUNG
SAMUEL SCHLACHTER
XIAOHANG GUO

Interested in hearing more? Contact Ken Barner at **barner@udel.edu**

Chengmo Yang to develop resiliency solutions with prestigious NSF CAREER award

Chengmo Yang has earned a National Science Foundation CAREER Award to study fault rates and boot reliability in computer systems

CHENGMO YANG, assistant professor of electrical and computer engineering, recently received a prestigious five-year, $449,541 Faculty Early Career Development Award from the National Science Foundation (NSF) to develop resiliency solutions that can help computer systems overcome progressively diverse types of hardware failures.

Funded through the Division of Computer and Network Systems, the new funding will enable Yang to design and evaluate new architectural and system level solutions to boost resiliency in computer systems and to develop new algorithms aimed at simultaneously optimizing a computer's performance, energy and reliability.

According to Yang, there are three types of hardware faults that typically occur in computers: permanent (where a device breaks or can no longer be programmed); transient (which are random faults or errors); or intermittent (problems related to execution conditions like voltage and temperature).

"Future computer systems are expected to experience continuous faults, across all levels from hardware to software applications, raising critical concerns about the impact of intermittent faults that occur frequently and irregularly over nanosecond to second timescales," she said.

Previous approaches to address these problems have included adding system redundancies, such as having the computer perform a computation twice and comparing results to ensure accuracy.

"Doing the computation twice means double the energy expenditure," said Yang, who instead proposes adapting the execution conditions to improve efficiency while also controlling costs.

Her approach includes creating a feedback loop within the system to improve the devices' reliability over time through adaptive "work-arounds" for three tightly connected components:

- **Detection** and **check pointing** – enabling computers to repeatedly adjust approaches to tasks based on a system's reliability;
- **Error recovery** – enabling computers to re-execute commands following failures in a way that minimizes chance of further problems; and
- **Resource management** – enabling systems to monitor application and hardware reliability and quickly adapt scheduling decisions as needed.

By setting up systems that assign the most critical and vulnerable tasks to the computer's most reliable cores, Yang believes she can help create computer systems that can quickly recover from unplanned or intermittent problems.

"Our approach reduces the need for devices and interconnects to be 100 percent correct in order to work, which will dramatically reduce associated manufacturing, verification and testing costs," she said.

Yang credits her NSF award selection in part to supportive colleagues such as **GUANG GAO**, Distinguished Professor of Electrical and Computer Engineering, and her department chair, **KENNETH BARNER**.

"Professors Gao and Barner, and others within the department, really take junior faculty under their wing and support them," she said. "My successful proposal is one example of this."

Article by Karen B. Roberts | Photo by Ambre Alexander

Early career funding: Fang, Singh win UDRF grants, Powe award

Two ECE assistant professors have received early career funding to further their work on pressing life and health sciences issues through grants from the University of Delaware Research Foundation (UDRF).

HUI FANG is pioneering the use of smartphones to monitor risk factors and symptoms of depression. The research will develop data collection and fusion techniques to monitor a wide range of mental health factors over four domains, including lifestyle, emotion and emotion regulation, beliefs and interpersonal functioning. Fang's mentors are ECE associate professor **STEPHAN BOHACEK**, and Adele Hayes, professor of psychology.

ABHYDAI SINGH will use his UDRF grant to devise mathematical techniques to read protein variability across cells, which can lead individual cells to different fates, with the ultimate goal of reverse-engineering certain interactions between gene and proteins.

Singh also was recently selected by the Oak Ridge Associated Universities consortium for the Ralph E. Powe Junior Faculty Enhancement Award to model how cells make decisions at the molecular level, work that could help scientists comprehend how specific disease processes occur, particularly HIV and other stem cell disorders.

He plans to use several nodes on UD's Mills cluster, a 5,000-processor, high performance computing cluster designed for advanced research, to run highly technical simulations of how biochemical processes work and to predict how variations in protein levels arise in otherwise identical cells.

One of 30 winners selected nationwide, Singh said he is already developing relationships with collaborators at University of Pennsylvania Medical School and Johns Hopkins Medical School to test models in the future.

Congratulations to ECE assistant professor **HUI FANG**, who was honored with the College of Engineering's 2013 Excellence in Teaching Award at the May Convocation ceremony based on student and recent graduate nominations. Fang joined UD in 2008 after earning her bachelor's degree in computer science from Tsinghua University in China and her master's and doctorate degrees in computer science from the University of Illinois at Urbana-Champaign. Her research interests include text information management, text mining and bioinformatics.

Farber and Mills honored as internet pioneers

DAVID FARBER, professor and Distinguished Policy Fellow of Electrical and Computer Engineering, was inducted into the Internet Hall of Fame in Berlin, Germany, earlier this year. The distinction publicly recognizes a select group of leaders and luminaries who have made significant contributions to the development and advancement of the global Internet.

Farber helped develop CSNET, a network that linked computer science departments at academic institutions across the country and provided a bridge from the Department of Defense's ARPANET to the modern Internet.

Known by many as the "grandfather of the Internet," Farber was instrumental in helping to create the major American research networks CSNET, NSFNet and NREN. He is also noted for his involvement in designing the SNOBOL programming languages and the first electrical switching system.

ECE professor emeritus **DAVID L. MILLS** was honored with the 2013 IEEE Internet Award for significant leadership and sustained contributions in the research, development, standardization and deployment of quality time synchronization capabilities for the Internet.

Mills played an essential role in developing the internetwork gateways and protocols that provide the backbone to today's Internet. He actively participated in the evolution of Internet protocol (IP), transmission control protocol (TCP), file transfer protocol (FTP), simple mail transfer protocol (SMTP), Telnet and other protocols on which modern researchers rely.

In particular, his Network Time Protocol (NTP) -- which enables precise time synchronization -- was essential to the early development of the ARPANet, which led to the modern Internet. The protocol makes possible such online activities as aviation traffic control and monitoring, radio and TV programming launch and control, multimedia synchronization for real-time teleconferencing and traffic engineering.

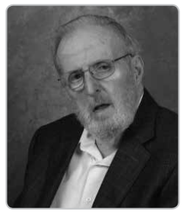
Mills' endowment of a career development chair for a female faculty member at UD in 2012 demonstrated his continuing leadership, this time to improve the climate for women in engineering.

Adapted from articles by Collette O'Neal, Richard Gordon and Neil Thomas
Mills photos by Kathy F. Atkinson and Richard Gordon

IN MEMORIAM

JOHN J. (JACK) KRAMER, professor emeritus of electrical and computer engineering, died Feb. 15, 2013 at the age of 81. He joined the University of Delaware faculty in 1965, after a successful career with Westinghouse Research Laboratories. His research in magnetic materials and crystal growth led to more than 50 scientific publications during his tenure. An avid researcher and teacher, he taught a wide variety of courses in electrical and mechanical engineering. Additionally, he was an industry consultant for companies such as DuPont, Martin-Marietta, Astro Power and Hercules. He retired from UD in 1995.

He is survived by his wife of 56 years, Mary Lou Kramer; three sons and seven grandchildren. Memorial contributions may be made to the Michael J. Fox Foundation at www.michaeljfox.org.



PETER J. WARTER JR., professor emeritus of electrical and computer engineering, died Feb. 3, 2013 at the age of 80. He joined University of Delaware as chairman of the Department of Electrical and Computer Engineering in 1975, following 10 years as vice president of Xerox, where he was instrumental in the development of color xerography. As ECE chair, he strengthened the department's focus on faculty recruitment and was imperative in renovating Evans Hall to include state-of-the-art research and teaching facilities. Prior to his retirement in 1994, he taught and mentored doctoral students and maintained a consulting relationship with industry, including Xerox and IBM.

Dr. Warter was predeceased by his wife of 55 years, Jane. Memorial contributions may be made to the Peter J. Warter Scholarship Fund, in care of the Development and Alumni Relations Office, 83 East Main St., Newark, DE 19716.

Keith Bentley named to Alumni Wall of Fame

KEITH BENTLEY, B1980, was one of 10 University of Delaware alumni inducted into the 2013 Alumni Wall of Fame during Alumni Weekend festivities in June.

UD President Patrick Harker called the Wall of Fame, established in 1984, an honor reserved for "our most esteemed alumni" who are the "trailblazers in their fields and whose lives and success and service are a source of inspiration."

Bentley earned bachelor's and master's degrees in electrical engineering from UD and University of Florida, respectively. A member of Tau Beta Pi and Eta Kappa Nu national honor societies, he joined the DuPont Company after graduation, where he created software for the engineering department. He negotiated ownership of this software from DuPont in 1984 and commercialized it through Bentley Systems, which he cofounded with his brother Barry Bentley, B1978, who earned his degree in chemical engineering and is also a 2013 Alumni Wall of Fame honoree.

Bentley Systems is a global leader providing comprehensive architecture and engineering software solutions for sustaining infrastructure. With development, sales and other departments in 45 countries, it is one of the world's largest privately held software companies, with more than 3,000 employees worldwide, more than $500 million in annual revenues and, since 2001, more than $1 billion invested in research, development and acquisitions.

Keith Bentley was president and CEO of Bentley Systems until 2000, when he became chief technology officer. He is a member of the company's board of directors and its executive committee, remains active as the firm's principal software architect, and is the author of numerous software patents. He is a sponsor of UD's Engineers Without Borders program.

"When I learned the electrical engineering department had their own computer in Evans Hall that I could actually touch and take apart, I was hooked," Bentley said of his undergraduate experience. "Computers and software have been my life's work ever since. They say in business the only sustainable competitive advantage is the ability to learn faster than your competition. I credit my time at UD as the catalyst to my becoming a lifelong learner."

Adapted from an article by Ann Manser | Photo by Kathy F. Atkinson

Mapp-Rivera earns Presidential Citation

Electrical engineering alumna **TAESHA L. MAPP-RIVERA** (B1994, M2000), corporate strategy and planning manager for DuPont (Wilmington, Del.), received the University of Delaware's 2012 Presidential Citation during Homecoming festivities last October.

As manager of DuPont's Global Trade Secret Risk Management Network, which is responsible for cultivating a disciplined knowledge management culture and robust technology infrastructure, Mapp-Rivera represents DuPont at campus job fairs and career informational sessions held by UD's Career Services Department.

A student mentor, she has been a featured presenter for UD's Resources to Insure Successful Engineers (RISE), a program she participated in as an undergraduate student that prepares students to meet the technological and industrial challenges of the engineering world. A long-time financial supporter of the University's Initiative Fund, Mapp-Rivera recently provided a leadership gift to the Black Alumni Organization's Scholarship Campaign.

ALUMNI SPOTLIGHT

Frederick L. Kitson, B1974

FREDERICK KITSON'S company, DTS Inc. — a premier audio solutions provider for high-definition entertainment experiences — is helping to establish a multimedia signal processing laboratory in the department through generous annual donations to electrical and computer engineering.

Kitson, executive vice president and chief technology officer since 2010, oversees research, development and engineering functions at DTS. Under his leadership, the company is expanding innovation efforts and building business in emerging areas of the consumer electronics market, including network connected devices, mobile and set-top boxes.

He was honored earlier this year with the department's 2013 Distinguished Career Award.

"UD gave me a foundation in engineering, math and science – the bedrock of my career. Part-time work with DuPont offered practical experience and led me to electrical and computer engineering. I entered UD with a Getty Oil Award for "Excellence in Science," and left with a great engineering degree, selfconfidence and a strong interest in football after four years as a 'Fighting Blue Hen!" Kitson said of his time in Newark.

Before joining DTS, he was vice president of Motorola's Applied Research and Technology Center, where he led the development of innovations such as high quality mobile video encoding and media for mobile devices that can adapt to different devices and listening environments. He previously spent more than a decade with Hewlett-Packard's global research and development labs developing encoding, decoding and compression methods for mobile media.

Kitson served as an adjunct faculty member at Georgia Institute of Technology, where he was inducted into the Academy of Distinguished Engineering Alumni in 2001. He was the 1991-1992 Clyde Chair visiting associate professor in University of Utah's Computer Science Department and has taught at University of California-Berkeley and Colorado State University.

He currently serves on the engineering advisory boards of the Georgia Institute of Technology, Carnegie Mellon University and UD's ECE Advisory Council. He has served on multiple boards at University of California-San Diego, USC Marshall School of Business, University of Southern California and UCLA.

Kitson earned bachelors and masters degrees in electrical engineering from UD and Georgia Institute of Technology, respectively; a doctoral degree in electrical and computer engineering from University of Colorado; and completed an executive program at the Graduate School of Business at Stanford University. Widely published and a frequent keynote speaker, he holds six patents.

- Adapted from an article by Kathryn Meier | Photo by Duane Perry

ECE alumni speak at Horn program entrepreneurial series

Social network Nfoshare founder and electrical engineering alum **NIKHIL PAUL**, B2009, and B & W Tek, Inc., CEO **SEAN WANG**, Ph.D.1992, returned to campus in February to share their entrepreneurial successes as part of a Free Lunch Friday entrepreneurship speaker series sponsored by UD's Horn Program in Entrepreneurship.

Paul's presentation, "Be Prepared to Grind: It takes Hard Work!" explored the founding of his social network, Nfoshare, which connects, tracks and motivates science, technology, engineering and mathematics (STEM) students to help increase student retention.

No stranger to hard work himself, while majoring in electrical engineering at UD, Paul founded the Red Cross Club and the national award-winning dance team, UD Kamaal. He has served as a board member of the American Red Cross of Delmarva since 2005 and was previously an engineer at Pepco Holdings. He is also the recipient of the Governor's Youth Volunteer Award and the Delaware Student Entrepreneur of the Year Award.

Wang shared "My Story as an Entrepreneur," talking about his leading photonics company that produces analytical instrumentation, medical systems and lasers. Wang is also a co-founder and chairman of the board at Newark, Del.-based Litecure, a leading medical device manufacturing company offering advanced laser technology to the health care industry.

Since 1990, Wang has founded more than 10 high-tech companies. He holds 25 patents with more than 30 pending applications in the areas of optical instruments, lasers, spectroscopic sensors and medical devices. He serves on the advisory councils for UD's College of Engineering, Independence School of Delaware and the Chinese Entrepreneur Association.

Nikhil Paul

Memories for sale

Get a breadboard; help give new lab equipment

Remember your first digital logic course, all the hours you spent wiring breadboards? Now is your chance to acquire a memory of those wonderful days while helping support today's electrical and computer engineering students. For a donation of $250 or more, you can get a breadboard of your own. Proceeds will be used to purchase new lab equipment for the next generation of ECE students.

Please contact us at info@ece.udel.edu

Alumni fund fellowships to honor former faculty

Two Electrical and Computer Engineering (ECE) alumni recently established fellowships honoring former faculty mentors they credit with significantly impacting their education and careers.

SEAN WANG, Ph.D.1992, endowed the Charles S. Ih Fellowship for first-year ECE graduate students specializing in photonics and related fields. The gift honors the retired electrical engineering professor, who taught at UD from 1975 to 2008, for his dedication to students, research and the university.

ROBERT L. PRITCHETT, B1961, established a graduate fellowship in honor of former faculty member, the late **DAVID ROBINSON**, B1954, M1960, Ph.D.1964. Robinson, who died in 2010, was the first Blue Hen to earn a doctoral degree in electrical engineering. He retired professor emeritus from the University in 1996 and received the College of Engineering's Outstanding Alumni Award in 1997.

Fellow alumni are encouraged to join Wang and Pritchett in contributing to one or both of these funds honoring Ih and Robinson's careers. Visit www.udel/edu/makeagift and designate electrical and computer engineering and the selected fellowship as the recipient in the comment box. Or, if you wish to discuss establishing a fund in honor of an ECE faculty member who played a meaningful role in your time at UD, contact Michele Quinn, associate director of development, at (302) 831-0840 or mlquinn@udel.edu.

ECE Advisory Council

Idea exchange offers valuable insight to department leaders

Distinguished alumni and friends representing a cross-section of the electrical and computer engineering industry generously lend their expertise and provide valuable guidance to department leaders through their service on the ECE Advisory Council. The council's 16 members convene annually on campus to learn more about UD's program and offer counsel on proposed initiatives.

The 2012 ECE Advisory Council meeting, held Oct 18-20, coincided with Homecoming weekend. The council will next meet on campus March 4-5, 2014, coinciding with ECE Research Day.

ADVISORY COUNCIL MEMBERS

- **Ms. Janine Barbacane, B2001**
  Account Executive
  Oracle
- **Dr. Fil Bartoli**
  Professor and Chair, Electrical & Computer Engineering
  Lehigh University
- **Mr. Tyler Barton, B2006**
  Computer Engineer
  U.S. Army CERDEC
- **Dr. Karen Bloch, B1985, M1997, Ph.D.2004**
  Engineering Manager
  DuPont Company
- **Professor Edward Coyle, B1978**
  Electrical & Computer Engineering
  Georgia Institute of Technology
- **Dr. John Ferriter**
  Senior Vice President, Strategic Program Development
  SAIC
- **Dr. William Gardner, B1989**
  Technical/Patent Consultant
- **Dr. Daniel Grim, B1970, M1972, Ph.D.1976**
  Chief Technology Officer IT
  University of Delaware
- **Dr. Frederick Kitson, B1974**
  Executive Vice President & Chief Technology Officer
  DTS, Inc.
- **Mr. Michael Lombardi**
  Deputy Director
  Intelligence & Information Warfare Directorate
  U.S. Army CERDEC
- **Dr. Kristofer Roe, B1995, M1997, Ph.D.2001, Advisory Council Chair**
  Director, R&D Imaging
  Smiths Detection
- **Mr. Ray Sokola, B1976**
  President
  Cellport Systems
- **Dr. Edward Szurkowski, B1976, M1978, Ph.D. 1982**
  Founder/Managing Partner
  Blue Mill Group
- **Dr. Douglas Tipton**
  Chair, IEEE Delaware Bay Section
  IEEE MidAtlantic
- **Dr. Sean Wang, Ph.D.1992**
  Founder & Managing Director
  B&W Tek, Inc.
- **Dr. Wayne Westerman, Ph.D.1999**
  Senior Engineer
  Apple

MARK YOUR CALENDAR FOR 2014

ECE Research Day

March 5, 2014 with keynote address by distinguished lecturer and UD Alumni Wall of Fame recipient **David Welch**, B1981, co-founder and president of Infinera Corp.

Electrical & Computer Engineering
140 Evans Hall
Newark, DE 19716-3130

UD ECE Advances in Rankings

The University of Delaware Electrical & Computer Engineering department's strong performance has yielded an 18 place improvement in the latest US News & World Report departmental rankings, which caps a 22 place improvement in just the past three years.

Looking for an old friend? Want to share your latest news? Searching for information on upcoming alumni events such as Homecoming? Now you can do it all in one place, ***UDconnection.com***. UD and the UD Alumni Association (UDAA) have collaborated to bring alumni a vibrant online community—so register and get active! The online community allows you to search the alumni directory, post class notes, update your contact information, and see if there are any upcoming alumni events in your area. You can also take advantage of networking opportunities and volunteer opportunities to get involved with your alma mater! Visit ***www.UDconnection.com*** today!