SIGNALS

Department of Electrical and Computer Engineering
2012 Summer, Vol. XII, Issue 1

In this issue of Signals*, we are sharing stories of talented undergraduates who have had the opportunity to experience hands-on projects and production management opportunities that normally would be occurring during the graduate level curricula offered by most universities or at a job after graduation. The College of Science and Engineering designates a portion of funding to add enrichment activities for our University of Minnesota undergraduate students.*

ECE undergraduate student Taylor Trimble (left) and NTP² advisor Prof. Marvin Marshak stand before NTP²'s U of MN campus holiday-themed light show last December.

ECE sophomore Taylor Trimble learns technical aspects of engineering a holiday light show

One evening last fall, University of Minnesota Electrical Engineering undergraduate Taylor Trimble and some friends decided to check out the University's Nicholas Tesla Patent Producers (NTP²) student group. "We went for the free pizza, but stayed for the project brainstorming," Trimble says.

At the meeting, the NTP² group reported it had designated funds to work on a group project. Trimble suggested a holiday-themed light show, something he had wanted to do since high school. With the blessings of NTP² advisor Marvin Marshak, Professor and Director of Undergraduate Research, and Susan Kubitschek, College of Science and Engineering (CSE) Director of Student Programs, the group began the project two weeks later.

At the time, Trimble was entering his sophomore year in the five-year Masters in Electrical Engineering program. Working on a project that would provide creative, hands-on electrical engineering project management is a rarity for early undergraduates at some colleges. "It's all about demystifying the process," Trimble says. "Sometimes it's scary for students to say, 'I want to do this thing but I don't know how to do it yet.' Our generation been raised being told exactly how to do something before we do it. But, everyone here at the U of MN wants to help. They give you room for improving on designs and creative thinking."

Trimble and his fellow NTP² members also appreciated the value of their project work for future careers. "When you talk to prospective employers, they want you to tell them about your projects and how you made them work, not about what classes you took," he says.

Learning to meet challenges

From the beginning of the project, the group, made up of nearly 60 students from Departments of Electrical, Mechanical, and Aerospace Engineering, and the Department of Design, faced obstacles and learned to adapt. "We spent two months planning and six days in construction to produce the light show," Trimble says. "We worked right up until the show was to open."

Because open lab space is so tight on campus, the group had to make project components whenever and wherever they could; creative solutions were many.

"We decided to use a free software program but learned that it wasn't very adaptable," Trimble says. "We made do along with our free controller and a small circuit box that was connected to the lights. But, during every performance, the timing never quite synched as we wanted. This year, we're designing the software from scratch!"

After staying up for more than 72 hours working on the details, Trimble watched the first two minutes of the first show and then fell asleep.

Continued on page 2 - Trimble

In this issue

College of Science & Engineering
University of Minnesota

Continued from page 1 - Trimble

Nearly 3,000 people attended the light show on three separate weekends. The schedule included Thursdays, Fridays, and Saturdays with two shows each night. "Topper's Pizza, University Dining Services, and Raising Cane even donated food," Trimble says.

Putting learning and experience to work

During his freshman year, Trimble learned about planning a project and building circuit components. "But then I began working on this real project," he says. "I learned about additional equipment, like the linear regulator, and how to add more precision to the project. In the classroom, when you design a circuit on paper and get a circuit wrong, it's two points off. In the real world, that mistake could amount to an electrical fire."

"This year, we are making all our equipment—from the hardware to the software interface," says Trimble. "CSE has agreed to fund the show again for the 2012 holidays."

As the students who are preparing the music for the light display discussed their component needs, Trimble listened and took notes. Using that input, Trimble is building an LED timing control that will help synch the lights to the music. NTP² members are constructing and testing additional components including one they hope will encourage non-technical, light show attendees to help program one of the shows.

"When you're a student at the U of MN, you have unlimited opportunities," says Trimble. "I received the Ruth and Roger Nordby tech scholarship. I joined a group that allows me to use my education to further my learning and to prepare me for a career. There is incredible value in doing things yourself. Working on these projects, there's a chance for recognition, too. People on campus get to know you."

Trimble attended a "Mentors in the Classroom" presentation on March 26 given by ECE Industrial Advisory Council member Riki Banerjee (Ph.D.'05), Medtronic Neuromodulation principal engineer. Trimble says, "Her words summed up my project experience when she said, 'Once you do a hands-on project, that information is yours. You grappled with the problem and now the information you learned is cemented in your brain.'"

Trimble explains the light show's circuit board

This circuit board takes a DMX512-A signal, a standard control signal for lighting applications, and uses it to dim our LED strings and turn them on and off. The circuit can be broken into sections, all of which are student designed. They include the power supply section, which provides 170VDC to each light string, 5V to the DMX transceiver module, and 3.3V to the microcontroller module; the transceiver module, which passes the DMX signal to the microcontroller with an optoisolator; and the microcontroller module, which processes the DMX signal and controls the PWM LED dimming chips.

Fun fact: All the lights in our show were LEDs, and that design decision was advantageous to us. LEDs aren't like incandescent lights, where you can vary the voltage and the brightness with increase or decrease linearly. Instead, LED intensity depends on the current flowing through them. We took advantage of LEDs' quick reaction time and the slow reaction time of the human eye. To dim the LEDs, we very rapidly turned them on and off; for 60 percent intensity, they were on for 60 percent of the time and off for 40 percent of the time. This all happened 96,000 times per second though, so to the human eye the switching wasn't perceptible.

Our power delivery system, which took the PWM signal from the LED chips, gave power to the LED strings via a high power MOSFET transistor, which was essentially acting like a digitally controlled on-off switch that could keep up with the PWM.

Watch the ECE Web site (www.ece.umn.edu) this fall semester for information about dates and times for the next CSE-sponsored music and light show.

Solar vehicle team readies for summer races

University of Minnesota Solar Vehicle Project members are putting finishing touches on their latest car, Centaurus III. The team leaves the beginning of July to participate in two events: the Formula Sun Grand Prix (FSGP) and the American Solar Challenge (ASC).

Held in Monticello, N.Y., FSGP is a three-day qualifying challenge where teams attempt to get as many laps in as possible in 24 hours of racing. Upon completion of this race, the team will transport Centaurus III by trailer to Rochester, N.Y., for the start of ASC.

ASC is a seven-day road race where about 17 teams will drive their cars from Rochester, N.Y., to the Minnesota State Capitol in St. Paul. This race ends on Saturday, July 21.

For more information about the race and the project, go to: www.umnsvp.org/ and also: americansolarchallenge.org

Keep an eye on the team's blog (www.umnsvp.org) for events where they will be showing off Centaurus III!

The U of MN Solar Vehicle Project team (above) includes student engineers from Electrical Engineering, Mechanical Engineering, Materials Science, and Aerospace Engineering. (Below) The Centaurus III is unveiled on the St. Paul Campus.

Senior Honors research opportunity leads Leandra Brickson to graduate school

Not really wanting to add more work to her senior year, Leandra Brickson (BEE '12) had mixed feelings about a Senior Honors Project that would last all year. "Looking back, this was the best experience I had while at school," Brickson says. "Working in the lab was exciting and fun, the graduate students were super helpful, and Prof. Beth Stadler, my project advisor, was open to what I wanted to choose for a project."

Brickson chose to research cobalt nanowires as polarizers. She explains that her project involved creating a structure that would make a suitable magnetic field, fabricating her own nano wires, and testing the effects that a rotating magnetic field would have on the nanowires in solution. "Polarizing of the nanowires caused a flashing light effect," she said as she showed a short video of the phenomena on her cell phone.

Making the magnetic field structure came easily. Fabricating the delicate nanowires was much more difficult. A porous wafer substance with a copper electrode is immersed in a solution containing cobalt ions as voltage is applied to the electrodes. Ions of cobalt begin to fill the pores of the wafer until they are full. Next the wafer is placed into an etching solution which eats away the wafer substance. "A Sonicator shakes what is left at high frequency to get the wires to fall off; that part was fun," she says. "What was not fun was when the pores of the wafer did not fill up to create good wires or when the etching process revealed that the wires were too short. The process is a bit fussy but I enjoyed it. When the nanowires are done you have them in a small glass container of clear liquid, usually some kind of alcohol like ethanol—you know they are there but you cannot see them."

"You cannot see an individual nanowire, even under the microscope," she says. "As Prof. Stadler has described, 1,000 would fit across the diameter of a single human hair. When suspended in liquid and subjected to a magnetic field, nanowires begin to diffract and polarize light and they appear to blink and get brighter. This action is similar to a rotating mirror as a light is shined toward it; sometimes the light will be reflected towards you, sometimes it won't, so it looks like it is making light but it is actually just interfering with the light that's passing."

Brickson observed and hypothesized about the polarizing and diffraction effects. Applications for this research may someday bring about more efficient plasma screens that could be turned on and off and use less energy.

Research experience leads to graduate school

"Without this research, I would not have applied to graduate school," she says. "The graduate students in my group helped me realize that attending graduate school wasn't nerdy. You go because you're excited about EE, about studying and exploring. Prof. Stadler also played a big role in influencing my decision."

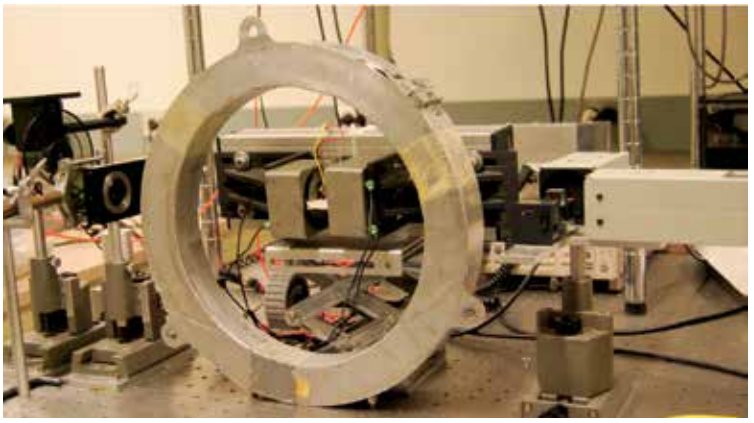
Leandra Brickson (BEE '12) demonstrates laser light directed through the small vial containing the nanowires that she fabricated.

Brickson rearranged her fall and spring schedules so she could do the research. She found herself spending more time at school and in the lab to work on her project. "I took part in the EE community, not just going home and studying for tests like I had the first two years," she said. "I also joined the IEEE Student Group, got to know the members, learned what they were doing, and helped organize events. I also helped tutor other students, and even helped with high school students' visits to the campus."

Brickson says she encourages all new students to get involved in student organizations in their major area. "It's a great way to get to know people in your area, get class recommendations, even work on projects together like the Solar Vehicle Project. It's more interesting when you are finding out why you are learning certain things when you do project work."

Brickson, a recipient of both the Bruce Nordby and Oscar Schott scholarships, says students should apply for scholarships online. "The U of MN makes it easy to apply. It's just one easy-to-complete form," she says.

Brickson, who graduated just this spring, will enter the North Carolina State University's doctoral program in the fall.



Brickson's final testing system with magnetic field.

ECE senior Ellyar Barazesh learns research and presentation skills during UROP project

Ellyar Barazesh (BEE '12)

Imagine you are an undergraduate EE student and have the opportunity to do a research project where you plan, conduct, and analyze a project, as well as build a prototype tool all with the prospect of vetting a new way to identify leukemia cells.

Last fall, EE senior Ellyar Barazesh (BEE '12) checked the online University of Minnesota Undergraduate Research Opportunities Program (UROP) site and found such a project.

"I liked that there would be freedom to do what I wanted on this project and I would work with a faculty mentor," says Barazesh. "I also learned that lack of structure can be frustrating and beneficial at the same time."

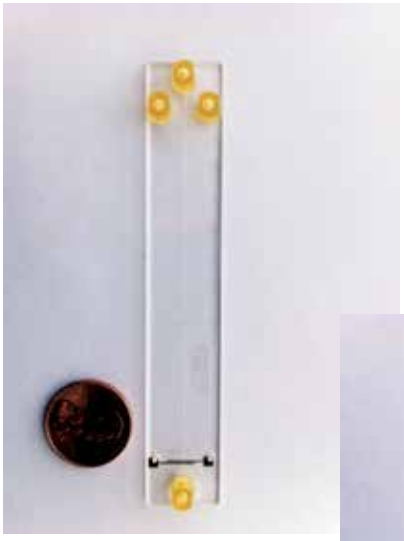
"Measuring electrical impedance of biological cells" is the title of Barazesh's project. Differing cell lines can be identified based on their impedance values, and healthy and diseased cells also can be differentiated. His mentors included ECE Emeritus Prof. James Holte and Dr. Simon Shelley, Director of Hematology/Oncology Research, Gunderson Lutheran Medical Foundation, LaCrosse, Wis. Barazesh was able to use the labs of Dr. Walter Low of the Department of Neuroscience and ECE's Prof. Steve Campbell.

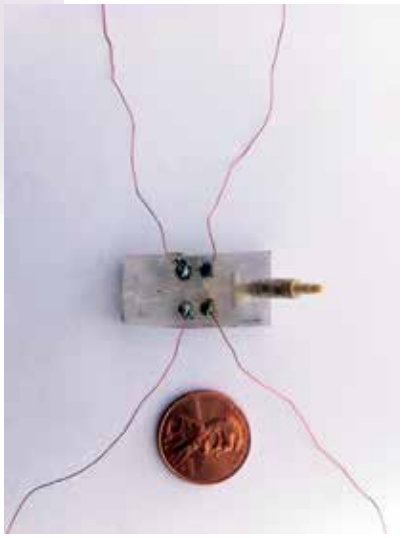
Steps in research

Locating a microfluidic device needed for the experiment was first on Barazesh's list—it was more difficult than he thought. After talking with members of the nanofabrication lab, it was decided that the best option (based on time and budget) was to purchase a device rather than ordering a custom-made one. The only manufacturer was in Germany. After a successful grant approval from the Department of Electrical and Computer Engineering Hartig Fund and working with a contact in California, Barazesh purchased the device and the project was on track.

In discussion with Prof. Holte, Barazesh also decided to design and build an alternative—a prototype microfluidic device that would be considerably cheaper than the equipment from Germany. He would then test it against the German-manufactured device during his research project.

Using Shrinky Dinks polystyrene plastic sheets—a basic crafting material that shrinks when heated in an oven—he pre-cut the sheets and bound them between glass slides, then inserted electrodes into the device that made contact with the channel. In similar research, University of California, Irvine, Prof. Michelle Khine applied Shrinky Dinks to create tiny structures for the application of microfluidics to topics such as stem cell research.





(Above) Commercial microfluidic device and (right) Shrinky Dink hand-made microfluidic device. Barazesh's research involved using a professionally-made microfluidic device and building a less expensive testing model with the goal of using both for detecting impedance values of healthy and diseased cells.

Working with biological material presents its own challenges—the cell material must be alive when tested. Dr. Shelley grew the OCI-AML3 cell line test material in his Gunderson lab. Barazesh had to coordinate the transport of cells from LaCrosse, and the preparation for and the timing of testing. It was necessary to prepare the biological material by placing it in a centrifuge prior to testing. Barazesh worked with Dr. Low and used the centrifuge in the Department of Neuroscience.

The final step would involve presenting his findings at the UROP National Conference held in Ogden, Utah, at the end of March.

"The conference was a really interesting experience for me," says Barazesh. "I talked with people who had background in my area and they provided me with interesting points, questions, and suggestions for further work. Some people had no idea what I was working on, so I had to explain it in terms that they would understand. And then there were those questions 'What does this do?'" Barazesh learned on the spot how to give key talking points.

"Basically, I said that I am studying these cells to learn as much as I can about them, with the goal of eventually killing the leukemia cells," Barazesh says. "Knowing the impedance values of cells is a tool researchers can use to find weaknesses in cell vitality."

As to creating a microfluidic device that can be fabricated more cheaply and rapidly than the commercially-produced device, Barazesh says his device did not work as well as hoped, but that it does have the potential with further refinements to give the results they are seeking. "It's a balance of fabrication techniques. Inserting the electrodes with precision into the device was the most difficult process. Its future would be in providing measurement estimates on the same day—a quick assessment that would help define what type of measurement would be needed in the more precise tests to follow."

Where are they now?

MyRain LLC successfully completes initial round of angel investment

Former 2010 Acara Challenge students to launch social venture in India

Sri Lathan Ganti (MSEE '11), cofounder and COO of MyRain LLC

A University of Minnesota student project aimed at boosting local economies in India has acquired funding to launch a for-profit social venture that will offer efficient drip irrigation systems to rural farmers in developing countries.

MyRain LLC began as the brainstorm of a team of 2010 Acara Challenge participants. The Acara course and competition sponsored by the University of Minnesota Institute on the Environment helps budding social entrepreneurs develop plans for businesses that make a positive change in the world. After completing the Acara competition, the project leaders incorporated their business and refined plans to the point where they could solicit funding from investors.

Having successfully completed the first of an anticipated two rounds of soliciting funds from angel investors, MyRain co-founder and CEO Steele Lorenz went to India June 1 to launch the program.

"I am pleased to announce that the capital raised from our initial angel investment round is sufficient to fund MyRain's first year of operations in the Tamil Nadu region of southern India," said Lorenz, who gave up a job in Minnesota to pursue the launch.

"In many parts of rural India, small-plot farmers rely on flood irrigation, an approach that stunts crops and washes away valuable soil nutrients," said **Sri Latha Ganti** (MSEE '11) (Keshab Parhi, advisor) co-founder & COO of MyRain. "By implementing drip irrigation, rural farmers can increase water and fertilizer efficiency by 20 to 50 percent and increase yields by 30 to 100 percent. MyRain also will stimulate local job creation by hiring salespeople from villages and training them to sell, construct, and use drip irrigation systems."

According to Fred Rose, co-director of Acara and a member of MyRain's advisory board, drip irrigation technology, despite its advantages, has been applied to only five percent of arable land in India. MyRain seeks to increase that number while creating sustainable economic development in the communities it serves.

MyRain's strategic partners include Acara and the Covenant Centre for Development.

The University of Minnesota's Institute on the Environment seeks lasting solutions to Earth's biggest challenges through research, partnerships and leadership development.

For more information, go to: environment.umn.edu.

To learn more:
Acara, go to: acara.environment.umn.edu
MyRain, go to: myrainindia.com

ECE Professors and graduate students recognized for patents and licenses achieved in 2011-12

On March 8 at the annual University Innovations Celebration, Vice President for Research Timothy Mulcahy celebrated 134 inventors, representing 13 colleges, who have earned 65 patents and 74 licenses.

The road from research to commercialization can be a long one and obtaining a patent on intellectual property is a key milestone. The Department of Electrical and Computer Engineering awardees honored for patents were:

- Gaurav Aggarwal (MSEE '05) (Ned Mohan, advisor)
- Prof. Philip Cohen
- Prof. Georgios Ginnakis
- Prof. Anand Gopinath
- Prof. Heiko Jacobs
- Prof. Ned Mohan
- Prof. Joseph Talghader (multiple patents)
- Satish Thuta (Ph.D. '07) (Ned Mohan, advisor)
- Yuyan Wang (Ph.D. '07) (Joseph Talghader, advisor)

Licensing technology to an existing company or forming a startup ensures it will reach those who need it most, while potentially generating royalties. Among the Department of Electrical and Computer Engineering honorees for licenses were:

- John Ballard (Ph.D. '12) (Emad Ebbini, advisor)
- Andrew Casper (multiple licenses) (MSEE '11) (Emad Ebbini, advisor)
- Prof. Emad Ebbini (multiple licenses)
- Dalong Liu (multiple licenses) (Ph.D. Biomedical Engineering) (Emad Ebbini, advisor)
- Yayun Wang (MSEE '06, Ph.D. '10) (Emad Ebbini, advisor)

ECE News

Students

Binh Lieu

Ph.D. student Binh Lieu (Mihailo Jovanovic, advisor) received a fellowship from the European Collaborative Dissemination of Aeronautical Research and Applications (E-CAero) initiative to attend the E-CAero Spring School on Fast Methods in Scientific Computing in Montestigliano, Italy (Mar. 26 – Apr. 2, 2012). Twelve doctoral students from around the world were selected on a competitive basis by a panel of experts involving the organizers and the keynote speaker, Prof. Gunnar Martinsson of the University of Colorado at Boulder.

Sudhir Kudva

Ph.D. students Sudhir Kudva (Ramesh Harjani, advisor); Hui Zhao (Jian-Ping Wang, advisor); John Backes (Marc Riedel, advisor); Peng Li (David Lilja, advisor); and Chuan Zhang (Keshab Parhi, advisor) were named as recipients of the University of Minnesota Doctoral Dissertation Fellowship (DDF). The financial award is provided for final-year Ph.D. candidates to complete their dissertations within the upcoming academic year by devoting full time to the research and writing of the dissertations.

Hui Zhao

John Backes

Peng Li

Chuan Zhang

Faculty

Prof. Massoud Amin was named among the "100 People you must know in Smart Grid in 2012" by *GreenTechMedia*.

Prof. Steve Campbell received the College of Science and Engineering George W. Taylor Award for Distinguished Service for 2012. This award recognized Campbell's extensive contributions to the college and the university as the Director of the Nanofabrication Center (NFC) and the Center for Nanostructured Applications (CNA).

Prof. Chris Kim was named a 2012 Council of Graduate Students (COGS) Outstanding Faculty Award recipient. The COGS Outstanding Faculty Award was established in 2010. Students nominate, review, and select the faculty awardees.

Prof. Ned Mohan was selected for the IEEE Power and Energy Society Ramakumar Family Renewable Energy Excellence Award. This award recognizes outstanding contributions in the field of developing, utilizing, and integrating renewable energy resources in the national and global energy scenarios. Given once a year, the award will be presented to Prof. Mohan at the IEEE-PES General Meeting in San Diego.

Prof. Keshab Parhi received the IEEE Circuits and Systems Charles A. Desoer Technical Achievement Award for his exceptional technical contributions. Contributions are documented by publications (including but not limited to patents) and based on originality and continuity of effort.

Prof. Guillermo Sapiro's research into early detection of autism spectrum disorder (ASD) using Microsoft's gaming and CoPro sensors combined with computer vision algorithms was reported in the article "Watch over me" in *New Scientist*, May 5, 2012. The project collaborators include Profs. N. Papanikolopoulos, V. Morellas, A. Esler, and a team of graduate students Jordan Hashemi, Thiago Spina, and Mariano Tepper.

Prof. Jian-Ping Wang was selected as a University of Minnesota Distinguished McKnight Professor for his work in magnetic materials and spintronic devices for Information Storage and Computing and Molecular Diagnostics. Wang is an international leader in magnetic recording materials and spintronic devices. His inventions are used in the production of hard disk drives. He discovered the origin of giant saturation magnetization in the iron nitride compound. He also pioneered the interdisciplinary research of high-moment magnetic nanoparticles and spintronic nanosensors for the early detection of disease.

Correction: In the previous issue, Dr. Arun Majumdar's affiliation was incorrectly identified. Dr. Majumdar is the Director of the Advanced Research Projects Agency (ARPA-E).

New Staff

U of MN undergraduate student Lucas Geissler joined the staff as Computer Support Staff. He is pursuing scientific and technical communications and computer science (dual degree).

Faith Goenner joined the staff as Director of Financial Operations. During her 17 years at the University, she has held financial positions at Schulze Diabetes Institute, Northrop Auditorium, Sponsored Projects Administration, and within the Academic Health Center.

Jennifer LaFrance joined the staff as Accountant, Sponsored Projects. Jennifer's previous position was with Sponsored Financial Reporting, Controllers Office. She also has worked with Best Buy, Green Tree Servicing LLC, and U.S. Bank.

Jerian Lind joined the staff as Accountant, Sponsored Projects. Jerian previously worked in U of MN Medical School Pediatrics. She also worked as Accounting Grants Manager for the U of MN Medical School Pediatrics Department.

Laura Olevitch joined the staff as Research Administrator. Her previous position was with the Minnesota Population Center, the University's interdisciplinary cooperative for demographic research.

Rachel Rud joined the staff as Grants Assistant. Rachel's previous position was with U of MN Parking and Transportation.

Dr. Otto Schmitt named to Institute for Engineering in Medicine (IEM) Academy of Medical Device Innovators

Former ECE Professor Otto Schmitt was inducted into the inaugural class of IEM Academy of Medical Device Innovators. Schmitt, a pioneer in biomimetics, worked at the University of Minnesota founding the University's Biophysics program. Among his many patents, the Schmitt Trigger, an electronic circuit converting analog signals to digital that is used today in virtually every computer and electronic device, is his best known innovation.

IEM Academy of Medical Device Innovators was established in 2012 through the University of Minnesota's Medical School and College of Science and Engineering to honor and to promote researchers who have had great impact on patient's lives through their work while at the University. The 2012 inaugural academy class also includes Dr. Kurt Amplaz, Dr. Perry L. Blackshear, Jr., Dr. Robert Kaster, Dr. C. Walton Lillehei, Dr. Owen Wangensteen, and Dr. Warren Warwick.

Alumni

Dr. Ranjan Gupta (Ph.D. '10) (Ned Mohan, advisor) of GE Global Research is leading a nearly $4.5M ARPA-E project titled "Resilient Multi-Terminal HVDC Networks with High-Voltage High-Frequency Electronics." Gupta joined GE Global Research in Niskayna, N.Y., upon graduation.

Dr. Alejandro Ribeiro (MSEE '05, Ph.D. '07) (Giorgios Giannakis, advisor) was awarded the S. Reid Warren, Jr., Award, which is presented annually by the University of Pennsylvania Engineering undergraduate student body and the Engineering Alumni Society in recognition of outstanding service in stimulating and guiding the intellectual and professional development of undergraduate students. Ribeiro is assistant professor in the Department of Electrical and Systems Engineering.

Rusch and Erickson honored at 2012 ECE Open House Luncheon

On May 1, Department of Electrical and Computer Engineering Department Head David Lilja presented ECE's Distinguished Alumni Award and Appreciation Award honoring two graduates of the department at the 2012 ECE Open House Luncheon.

Dr. Tom Rusch (Ph.D. '73)

Dr. Tom Rusch (BEE '68, MSEE '70, Ph.D. '73) (William Peria, advisor) received the the 2012 ECE Distinguished Alumi Award in recognition of his many career accomplishments including founding Creekside Technologies in 1994 and co-founding Xoft where he was involved in developing Xoft's miniature x-ray source technology and introducing the treatment capability called eletronic brachytherapy. In addition, during his career he has worked with 3M and Los Alamos National Lab. Rusch also has an MS in Managment of Technology from the University, which he received in 1973.

Grant Erickson (MSEE '98)

Grant Erickson (MSEE '98) (Matthew O'Keefe, advisor) received the 2012 ECE Appreciation Award for his active role in University Affairs through his work as both treasurer and president of the San Francisco Bay Area Chapter of the University of Minnesota Alumni Association (UMAA). In 2003, Erickson received UMAA's Rising Star award and in 2012, he and the rest of the San Francisco Bay Area Chapter culminated a 14-year vision and six years of development in establishing the University's first completely grass roots-funded UMAA chapter scholarship fund.

Erickson currently is principal engineer (and core member) of the startup Nest Labs, Inc. in Palo Alto, Calif. where he helped create the energy-saving Nest Learning Thermostat. Erickson also founded Nuovations, an engineering design consultancy firm.

Department of Electrical and Computer Engineering
University of Minnesota
200 Union Street SE, 4-174 Keller Hall
Minneapolis, MN 55455

Nonprofit Org.
U.S. Postage
PAID
Twin Cities, MN
Permit No. 90155

CYBER SECURITY SUMMIT 2012

October 9-10, Minneapolis Minnesota

"It's clear this cyber threat is one of the most serious economic and national security challenges we face as a nation. In short, America's economic prosperity in the 21st century will depend on cyber security." -Barack Obama

Cyber security breaches have a profound impact on all areas of society. Join the discussion at the 2012 Cyber Security Summit.

For two days, leaders from all areas of business and government meet to identify cyber threat issues and their countermeasures. Visit the exhibit hall, participate in discussions, hear key cyber security leaders during this two-day conference.

To register, go to: http://cybersecuritysummit.org/

Published by the University of Minnesota's Department of Electrical and Computer Engineering

David J. Lilja
Department Head

Paula J. Beck
Editor

To be added or removed from our distribution list, contact: Paula Beck, editor, at pjbeck@umn.edu, or 612-624-2284.

This publication is available in alternative formats upon request. Direct your request to Disability Services at 612-626-1333 or ds@umn.edu.

The University of Minnesota is an equal opportunity educator and employer. Printed on recycled and recyclable paper with at least 10 percent post-consumer material.