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"Flipping the Classroom" enables scholarly collaboration on new Instructional Model

Flipping the classroom, where students watch lecture videos and read testbooks and articles outside the classroom, allows dicussion and questioning during problem solving in class.

With the creation of a new Power Electronics curriculum by Department of Electrical and Computer Engineering (ECE) Prof. Ned Mohan and his colleagues Profs. Bill Robbins, Vern Albertson (retired), Bruce Wollenberg, Paul Imbertson, Tom Posbergh, and Sairaj Dhople, the need emerged for a new method of presenting the materials and testing the students' learning and retention of the complex concepts. Jia-Ling Lin, Ph.D., a research scientist for the STEM (Science, Technology, Engineering, and Mathematics) Education Center in the U of M College of Human Development and Education, and ECE instructor Prof. Paul Imbertson collaborated throughout three semesters over three years to develop a new instructional model to present the new curriculum effectively. Before they were done, Lin would conduct hours of research into education practicum and Imbertson would shape and reshape his teaching methods.

Throughout the three semesters,Lin and Imbertson conducted surveys and focus group meetings. In spring 2013 and 2014, they taped classroom discussions and prepared transcripts. Says Lin, "We knew our model was a success the day a student in class asked a question of a classmate, 'Why did you use this equation instead of that one?' Students had learned to think for themselves, to ask the deeper questions, and to demonstrate that they understood the material."

Jia-Ling Lin, Ph.D.

"No longer was the classroom one-sided with a leader providing information and the students parroting it back during testing," Lin says. "Dr. Mohan's new curriculum provided a new context and our new instructional model reinforced an active learning model."

Three years of instructional modeling

Tamara Moore, Ph.D., the former director of the STEM education Center, had worked with Mohan during the Power Electronics curriculum development process, and upon the project's completion, Moore asked Lin to assess the implementation of new inquiry-based STEM teaching practices designed to enhance learning in the new curriculum. "I observed that the classical education theory still would be incorporated but the method had to be modernized in some fashion," Lin says. "We would have to devise new ways of identifying students' mastery of the material."

Prof. Paul Imbertson

Imbertson was the instructor assigned to EE4701 Electric Drives, one of three core courses to the Power Electronics curriculum. Lin and Imbertson discussed the risks for the new curriculum, the ways new concepts could be provided, and the best use of the pre-recorded lectures and other materials provided by Prof. Mohan and his team. Imbertson says, "It's important that the students master new skills because engineers must talk to everyone, they must ask questions, they must learn from their peers, and they must work well in groups without a leader present. If choices are difficult in problem solving, they must be able to keep talking and asking great questions."

Lin conducted an extensive literature search of classroom practice models involving problem-centered learning. "I found developing new methods would require the classroom professor to make moment to moment decisions as he taught," she says. "The literature stressed that students must be engaged and that learning would include actual implementation of practice rather than passive listening. The instructor's role would change considerably; no longer would the instructor be the sole authority, rather, he would be a consultative partner with the students. "The notion of flipping classrooms, originating from Khan Academy, has extended into

Continued on page 2 - Flipping

Continued from page 1 - Flipping

the design of pedagogical support techniques, Lin says." The model that we created incorporated some techniques from inquiry-based math and science teaching in pre-college classrooms to foster active learning," Lin says.

Lin and Imbertson turned the short project into a scholarly and fruitful collaboration. Lin attended and critiqued all of the class meetings over a three-year period and Lin and Imbertson met an hour every week to fine-tune the method. "At the beginning of the semester, students had been boisterous and noisy," Lin says. "As the group problem presentation and evaluation sessions became more refined, the students became more engaged and focused. When Prof. Imbertson gave the important clarifying lectures, both long and short, students began to ask thoughtful questions and were eager to understand and learn more. One day, more than 20 students stayed an extra 40 minutes after class to continue the discussion. We knew then that the new method was working to build engagement."

At the end of each semester, students provided positive feedback about the new classroom method. One student reported that the best part of this class was that he learned how to ask questions. "We were delighted with that observation," Lin says. "Formulating and asking questions is one of the most important skills an engineer can have. It was Mother's Day week and this student's observation was a wonderful Mother's Day gift for me."

Lin and Imbertson "Four-Practice Model"

Practice One - Anticipating included creating problems for students to solve within the context of having listened to the lectures outside of class time. This technique often is referred to as "Flipping the Classroom" where lecture and reading occur outside the classroom and solving and discussion of problems occur in the classroom among one's classmates and with the instructor as a guide. During class time, the Electric Drives students worked in groups of three to five, discussing and helping each other with the problems presented.

Practice Two - Monitoring involved the instructor's active observation of the students' discussion during the group work. During this time, the instructor shared authority in the classroom with the students encouraging them to take the ownership of their learning. Imbertson walked around listening to the students, coaching as he went along, and noting the problematic areas where students were struggling.

Practice Three - Connecting and contrasting involved scaffolding inquiries, displaying the groups' work and sharing the students' responses with the whole class. During the classroom discussion, the instructor would either "connect" or "contrast" the students' views with the discipline. Through this process, Imbertson would reassure the students' authority of their answers, and hold them accountable by asking questions of how their work related to the context materials, and move the whole class forward.

Practice Four - Contextualized lecturing involved the instructor presenting a lecture based on the student's responses to the material. This involved "teaching in the moment" in response to the areas which seemed problematic to the students, or were in need of reinforcement. It helped students to understand what it means to be accountable for knowledge in the engineering discipline.

Learnings from the Research

- In a single model of problem-based learning classroom, some students did well, while others were stuck and were wasting time.
- A short discussion leading to a numerical solution doesn't mean that the students know the concepts. The longer the discussion lasts the more clearly one can ascertain if the students are engaging in true learning.
- Solving problems and knowing the solution is successful only if the students also understand the learning process.
- Instructors embraced this new model because it frees time to help students learn to learn.
- Students were more cooperative, more open to sharing and helping each other, and avoided the sometimes negative side of group dynamics with this instructional model.
- Using the new model requires the instructor to revise his problems and solutions as well as discussions on the spot – one needs to be able to shift focus during the class time. When the instructor observed students displaying difficulty with a concept, the instructor would shift to coaching and lecturing if necessary.
- Active learning is observed daily.
- Instructors model transparency and honesty through the use of inclusion techniques, i.e. "Let's find out together," rather than "I have all the answers, listen to me."
- Memorizing for the test and low excitement for learning in the classroom were eliminated.
- Learning becomes a positive activity, even when students were wrong about a problem. Reframing the content and trying again reinforces learning to learn.

Learning becomes a positive activity in the classroom as students reframe and discuss the content thereby reinforcing their learning.

New Faculty

Andrew Lamperski
Assistant Professor

Andrew Lamperski, Assistant Professor, joined the Department of Electrical and Computer Engineering fall semester 2014. He will be part of the Systems and Controls Research Group. Prior to joining the faculty, he was a postdoctoral scholar at the University of Cambridge, United Kingdom, with funding from the Whitaker International Program.

Lamperski received his Ph.D. in Control and Dynamical Systems in 2011 from California Institute of Technology, Pasadena, Calif. He received B.S. in Biomedical Engineering and Mathematics from The Johns Hopkins University, Baltimore, Maryland in 2004. From 2011 to 2012, he did postdoctoral work at Caltech and Johns Hopkins.

His research interests include control theory and experimental work on human movement and perception. On the theoretical side, he studies networked control and decentralized control. Most recently, he has been studying the effects of timing uncertainty in control systems. His experimental research uses a combination of robotics and virtual reality displays to test how people control their movements and sense the environment. At Cambridge, he studied how the dynamics of arm movements can influence the perception of time.

Tony Low
Assistant Professor

Tony Low joined the Department of Electrical and computer Engineering in the fall semester 2014 as an Assistant Professor. He obtained his doctoral degree from the National University of Singapore in 2008, and was a postdoctoral associate from 2008-2011 at Purdue University. From 2011-2014, he worked as a device theorist in various experimental groups at Columbia University, Yale University and IBM TJ Watson Research Center.

His research seeks to elucidate the physics and workings of nanoscale devices in a very diverse spectrum ranging from electronics, optoelectronics, photonics to plasmonics. In the past few years, Low has been interested in the class of atomically thin 2D materials, and has advanced the basic understanding of their electronic properties and their light-matter interactions in the terahertz, mid-infrared and visible spectrum. He develops models to understand physical phenomena, corroborates them with experiments, and explores their potential device applications.

Low has published more than 40 scientific papers in distinguished journals. He received the IBM Pat Goldberg Memorial Best Paper Award (2013), IBM Invention Award (2013), KITP Rice Family Fund Fellowship (2012), Singapore Millennium Fellowship Award (2007) and the IEEE Electron Device Society Fellowship (2005).

Cross-country solar car race finishes on U of MN campus; Centaurus III takes second place

The U of MN Solar Vehicle Project team driving Centaurus III finished second overall in the 2014 American Solar Challenge, an eight-day, 1,700-mile race that started in Austin, Tex., on July 21 and ended at the U of MN campus in Minneapolis, Minn.

The College of Science and Engineering student team finished with a total elapsed time of 45 hours, 19 minutes and 9 seconds over the eight days. First-place University of Michigan finished the race in 41 hours, 27 minutes and 29 seconds. Third place Iowa State University finished with a time of 50 hours, 18 minutes and 46 seconds.

The Centaurus III team was one of 24 teams from the United States, Canada, Puerto Rico and Iran competing in designing, building and driving a car completely powered by the sun. Only about 10 teams passed all of the requirements to compete in the cross-country race.

Centaurus III, originally built in 2012, included a newly revamped electrical system, improved aerodynamics, and new safety features.

Nearly 50 U of MN science and engineering students are members of the Solar Vehicle Project team and had a role in designing and building the car. About a dozen students participated in the cross-country race. Materials for Centaurus III were funded through cash and in-kind donations. In addition to support from the college, major sponsors include 3M, Altium, ANSYS, Cirrus Aircraft, Delta Airlines, IAR Systems, PAR Systems, PTC, Segger and SunPower.

Profs. Keshab Parhi and Chris Kim receive NSF/SRC STARSS research grant as part of $4 million, 10 University push to secure computer semiconductor circuitry, architecture, and systems

The National Science Foundation (NSF) and Semiconductor Research Corporation (SRC) provided nine research awards to 10 universities totaling nearly $4 million under a joint program focused on Secure, Trustworthy, Assured and Resilient Semiconductors and Systems (STARSS). Among them is the University of Minnesota with its "Design of secure and anti-counterfeit integrated circuits." U of M researchers Keshab Parhi (Principal Investigator) and Chris Kim (Co-Principal Investigator) will develop hierarchical approaches for authentication and obfuscation of chips.

In their abstract, Parhi and Kim write:
"Hardware security, whether for attack or defense, differs from software, network, and data security in that attackers may find ways to physically tamper with devices without leaving a trace, and mislead the user to believe that the hardware is authentic and trustworthy.

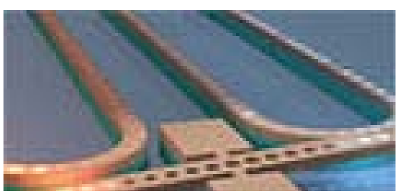
"Furthermore, the advent of new attack modes, illegal recycling, and hard-to-detect Trojans make hardware protection an increasingly challenging task. Design of secure hardware integrated circuits requires novel approaches for authentication that are ideally based on multiple layers of protection. This project develops a novel framework for embedding heterogeneity and hierarchy in security and obfuscation at multiple layers into the design of integrated circuits.
The project uses a combination of server-based global authentication combined with local authentication of components from third-party vendors reduces communication with the server, thus reducing the communication overhead as well as error in authentication. The investigators explore new approaches to increasing robustness of SRAM based physical unclonable functions (PUFs) by intentional voltage stress, and the trade-offs in hierarchies of authentication. The project investigates techniques for obfuscation based on modifications of finite state machine (FSM) state transition graphs, and obfuscation metrics that are developed and validated using data collected from test chips."

http://nsf.gov/news/news_summ.jsp?cntnid=132795&org=NSF&from=news
"Protecting our processors"

For a full report of the release go to:
https://www.src.org/newsroom/press-release/2014/646/
Also reported in http://www.eetimes.com/document.asp?doc_id=1324043&_mc=RSS_EET_EDT

Engineers show light can play seesaw at the nanoscale

U of MN electrical engineering researchers developed a nanoscale device that for the first time demonstrates mechanical transportation of light, called photon shuttling. The discovery could have major implications for creating faster and more efficient optical devices for computation and communication.



The research paper by Prof. Mo Li and his graduate student Huan Li was published online and in the October issue of *Nature Nanotechnology*.

The U of MN researchers developed a novel nanoscale device that can capture, measure, and transport fundamental particles of light, called photons. The tiny device is just .7 micrometers by 50 micrometer (about .00007 by .005 centimeters) and works almost like a seesaw. On each side of the "seesaw benches," researchers etched an array of holes, called photonic crystal cavities. These cavities capture photons that are streamed from a nearby source.

Even though the particles of light have no mass, the captured photons were able to play seesaw because they generated optical force. The researchers compared the optical forces generated by the photons captured in the cavities on the two sides of the seesaw by observing how the seesaw moved up and down. In this way, the researchers weighed the photons. Their device is sensitive enough to measure the force generated by a single photon, which corresponds to about one-third of a thousand-trillionth of a pound or one-seventh of a thousand-trillionth of a kilogram.

Li and his research team also used the seesaw to experimentally demonstrate for the first time the mechanical control of transporting light. "When we filled the cavity on the left side with photons and left the cavity on the right side empty, the force generated by the photons started to oscillate the seesaw. When the oscillation was strong enough, the photons could spill over along the beam from the filled cavity to the empty cavity during each cycle," Li said. "We call the phenomenon 'photon shuttling.'"

The stronger the oscillation, the more photons are shuttled to the other side. Currently, the team has been able to transport approximately 1,000 photons in a cycle. For comparison, a 10W light bulb emits 10^{20} photons every second. The team's ultimate goal is to transport only one photon in a cycle so that the quantum physics of light can be revealed and harnessed.

"The ability to mechanically control photon movement as opposed to controlling them with expensive and cumbersome optoelectronic devices could represent a significant advance in technology," said Huan Li, the lead author of the paper.

The research could be used to develop an extremely sensitive micromechanical way to measure acceleration of a car or a runner, or could be used as part of a gyroscope for navigation, Li said.

In the future, the researchers plan to build sophisticated photon shuttles with more traps on either side of the seesaw device that could shuttle photons over greater distances and at faster speeds. They expect that such devices could play a role in developing microelectronic circuits that would use light instead of electrons to carry data, which would make them faster and consume less power than traditional integrated circuits.

The team's research was funded by the Air Force Office of Scientific Research.

ECE student Scott Sievert ('15) applies adaptive sensing sampling to solve a practical problem

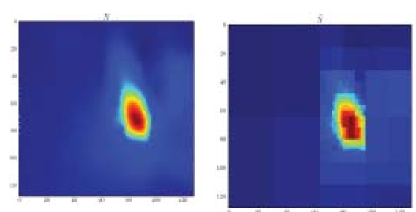
Scott Sievert

Prof. Jarvis Haupt

Problem/need, adverse cost, and available aptitude are all drivers for invention. Such were the drivers for a project Prof. Jarvis Haupt presented to ECE senior Scott Sievert ('15).

Last winter, Haupt was aware that heat was escaping from certain areas of his roof. These areas produced a process of icing and melting that created ice dams. Ice dams can cause roofs to leak. Haupt went on line to research heat-sensing cameras that would help him identify where the heat leaks were located. He found the costs of the cameras prohibitive (upwards of $4,000). So he proposed the problem to Sievert to see if Sievert could build a camera with a single, simple sensor and develop an accompanying algorithm that would be able to collect the thermal data while running on a small credit-card sized computer.

Sievert's choice was an infrared sensor that would detect heat waves through infrared radiation. "In the real-world, there are many areas that are the same color," Sievert says. "In essence, these areas of the image are "boring." Taking more samples does not present more detail. Instead, the edges between these areas contain the most detail. What we are trying to devise is a strategy for collecting more samples near edges (where they are more informative), and collecting fewer samples in the constant areas."



The object on the left is the true image and the image on the right is the approximation after sampling at roughly 8.8%.

"Then we built it," he says. "It was not that easy. This was a multi-step Adaptive Sensing Problem where we would be learning from the data collected in previous sampling steps. The algorithm created would have refinement steps that would essentially drive the next sampling steps and would compute a number of these 'scans.'"

"I first tried to use a closed form solution, a solution cleanly defined by mathematics that does not require computation," he says. "In essence, I was trying to develop the theory behind reconstructing an image from random point samples from scratch. But that was far beyond my current level of education.

"After some brainstorming, I decided to use a theory that already implemented a similar image reconstruction. Our algorithm forms several approximations and then samples the "interesting" or edge-filled parts of the image. This algorithm was efficient and effective after taking roughly 8.8 percent of the total image and, with hardware, producing an image in 6 minutes rather than the 20 to 30 minutes a simpler system based on exhaustive sampling would require."

After simulating this computation on a laptop, the next step was to bring this to a small credit-card sized mobile computer. At first Sievert used an Arduino with servo motors, but the Arduino wasn't powerful enough to do all the calculations required and the motors weren't precise enough. Instead, he used a Raspberry Pi computer that had more powerful computation capabilities and coupled it with precision stepper motors. "The interface step is always a problem," he says. "The most challenging part is always the interface between the computer and hardware. Analogously, while skiing, it's pretty safe to assume the boots and skis are working properly. The real difficulty is the interface between the boots and the skis."

Sievert is also a U of MN Ski Team member.

"I found that this process required me to use the C language for low level hardware interaction – I refer to it as "bit-flipping language," he says. "One has to take a close look to see where just one bit might need to be changed and then the whole process works. It's slow, time consuming work. Luckily, the Raspberry Pi runs Python (very similar to MATLAB) meaning the algorithm didn't have to be ported to C, which would have been a pain and a half."

As expected from academic work, this device is only a rough prototype. The motors are large and the wiring system is delicate. It is not a polished product. However, Haupt and Sievert have demonstrated that this computation can be done practically on a mobile scale. Sievert and Haupt are planning to submit their research to the upcoming Computational Photography and Intelligent Cameras Workshop at the University of California Los Angeles.

Sievert is fired up about more study and wants to get his Ph.D. "Right now I want to understand the math. It's the key to solving these kinds of problems. As a freshman I wrote long messy solutions and assumed that my later career would involve that. When I took Circuits II as a sophomore I was amazed at how elegant the math was behind these still closed form solutions. In the past six months, I have learned that every problem does not have a closed form solution. These are complicated computations that must be done on the computer. Supercomputers exist for a reason and the mathematical concepts behind their algorithms are deep and elegant. I've found that this math fascinates me."

Public voted online for winners of global competition to develop next-generation medical sensors

University of Minnesota team wins $120,000 in the Nokia Sensing XCHALLENGE

A University of Minnesota-based team has been selected as one of five distinguished award winners and recipient of $120,000 in the Nokia Sensing XCHALLENGE, a global competition to develop breakthrough medical sensing technologies that will ultimately enable faster diagnoses and easier personal health monitoring.

The Golden Gopher Magnetic Biosensing Team has developed a handheld device, named "z-Lab," that can detect a number of infections and health indicators with a single drop of blood or urine.

The z-Lab device is designed to detect various diseases using disease indicators, or "biomarkers," found in bodily fluids at the earliest stages of the disease often when symptoms are not even present. A single drop of blood or urine is placed on a small biochip (~10 millimeters by 10 millimeters) and results of up to 10 health indicators are displayed within 15 minutes on a smartphone, tablet or other mobile device. The sensor can also be used for monitoring other factors that can impact one's health, such as the mercury concentration in water.

"The high sensitivity of this device allows it to detect various ailments—from cancer to infections to heart disease—faster, easier and earlier than ever before," said Golden Gopher Magnetic Biosensing team leader Jian-Ping Wang, an electrical and computer engineering professor at the University of Minnesota's College of Science and Engineering. "We see this as a prevention-based device that will ultimately save lives."

Prof. Jian-Ping Wang

The Golden Gopher Magnetic Biosensing Team includes professors and engineers from the University of Minnesota, doctors from the Mayo Clinic, and several corporate partners including Zepto Life Technology, Universal Magnetic Systems, R&D Systems, Vates, and Jim Sawyer Professional Audio Service.

The z-Lab device can detect a number of infections and health indicators with a single drop of blood or urine.

For the XPrize, the University of Minnesota-led team was matched up against groups from the United States, France, Switzerland, and United Kingdom, all competing for a piece of the $2.25 million in prize money, as well as the growth and entrepreneurial resources offered by this prestigious prize. This is the second of two consecutive, separate competitions in the Nokia Sensing XCHALLENGE.

For more information about the Nokia Sensing XCHALLENGE, visit: http://sensing.xprize.org/.

About XPRIZE

Founded in 1995, XPRIZE is the leading organization solving the world's Grand Challenges by creating and managing large-scale, high-profile, incentivized prizes in five areas: Learning; Exploration; Energy & Environment; Global Development; and Life Sciences. Active prizes include the $30M Google Lunar XPRIZE, the $15M Global Learning XPRIZE, the $10M Qualcomm Tricorder XPRIZE, the $2.25M Nokia Sensing XCHALLENGE and the $2M Wendy Schmidt Ocean Health XPRIZE. For more information, visit www.xprize.org.

Two officials from the Nokia XCHALLNGE flank Todd Klein (center left) and Prof. Jian-Ping Wang (center right) as the Golden Gopher Team is honored with a $120,000 check as one of five distruinguished award winners.

Enhancing the ECE Undergraduate Experience

By Prof. James Leger, Director of Undergraduate Studies

Prof. Gerald Sobelman (near center in cap and striped shirt) and students from the recent Australian Global Seminar.

This fall, the College of Science and Engineering welcomed more than 1,100 new freshmen. By all measures, this is the best prepared and highest achieving class that has enrolled in our college. The college has recently introduced an introductory course designed to give each entering student a small sample of research and discovery through experiential learning. This year, the Department of Electrical and Computer Engineering was chosen to develop the central theme of the course based on the optical sciences and optical instrumentation. Groups consisting of five students each have been busy constructing optical instruments and experiments. Each of the highly diverse set of projects is serving to challenge our students' design, observational, and teamwork skills. The course will culminate in an exposition in Coffman Union on Nov. 25, 11 a.m. -1 p.m., where approximately 220 teams will be on hand to show off their projects and their presentation skills.

The ECE Department continues to attract both entering freshmen as well as a sizable number of transfer and international students. Of the 425 students that make up our current undergraduate class, approximately 25 percent hail from abroad. The representation from overseas enhances the richness of the ECE experience, and exposes our domestic students to different cultures, traditions, and approaches to engineering. To supplement these experiences, several of our students have chosen to spend a portion of their time studying abroad either by participating in a global seminar or by enrolling in a foreign institution. Our most recent global seminar to Australia was conducted by Prof. Gerald Sobelmen pictured above with seminar students. During the course of 20 days, Sobelman and 17 students traveled to three major cities in Australia, visiting both universities and industries. The trip explored nanotechnology and biotechnology related to the design of integrated circuits and systems, and culminated in the chance to attend the IEEE International Symposium on Circuits and Systems in Melbourne.

The department has continued to encourage our students to spend full semesters at a foreign university as well. Recent study abroad locations have included Singapore, Hong Kong, Norway, Ireland, and New Zealand. Students who take advantage of this educational opportunity invariably report that it profoundly changes their world outlook. Emily Mattison, who currently is studying at the Hong Kong University of Science and Technology, writes in her learning-abroad blog: "Last fall I was questioning whether engineering was the right fit for me. I wanted to do something to change peoples' lives, but trying to program in assembly language, for example, just didn't seem like it could help anyone, ever." But then one of her engineering professors explained his definition of engineering: "Engineering is the purposeful application of science. And 'purposeful' means making peoples' lives better." This simple framing of the profession completely transformed Emily's outlook. She now reports that she is considering doing research in engineering. She writes, "In research, I would be on the 'front-lines' of helping humanity. Cool!"

Emily Mattison with a collection of U of MN materials (left) and in a lab "bunny suit"(right) looking forward to a engineering career of research "being on the front lines of helping humanity."

When Emily returns home, she will find an ECE department that has taken a more active role in encouraging undergraduate student participation in research. Along with a strong senior honors research program, the department provides opportunities to students at all levels to join a research group through the University Research Opportunities Program (UROP). Most recently, 23 of our students were given the chance to perform cutting-edge research with an ECE faculty member. ECE senior John Bartoletta summarized his experience this way: "Through my UROP experience I have been able to work alongside faculty who are experts in their fields of research and learn the importance of teamwork in engineering to produce successful outcomes." Such experiences are one of the truly priceless benefits of a vibrant research university.

To enhance the quality of our classroom and laboratory instruction, the ECE department has recently introduced specialized classes in pedagogical techniques for our teaching assistants (TAs). Although all our lectures and discussion currently are taught by ECE faculty, much of our laboratory instruction is carried out by TAs. This year, the Center for Teaching and Learning has been helping these TAs hone their teaching skills by holding group clinics and performing one-on-one classroom observations. Feedback from the TAs regarding the training has been positive, and we expect that this program should benefit both our undergraduate and graduate students.

Finally, through the generosity of many former alumni and several companies, the department has been able to support our highest achieving students through a variety of scholarships. Last year, 38 students were awarded more than $142,000 in scholarships, with award amounts ranging from $500 to $11,000 per student.

As we look to the future, the ECE department plans to enhance our instructional laboratory course offerings by adding a staff position in laboratory development. Constantly improving instruction together with an ever-increasing range of global learning and research opportunities make it a great time to be an undergraduate in ECE at the University of Minnesota.

News Briefs

Students

ECE senior Tien Do received the Minnesota High Tech Association Award. He is pursuing his bachelor's degree in Electrical Engineering.

ECE students **Karel Kalthoff** (CS&E) (black and white scarf, left), **Emily Mattison** (Electrical Engineering) (in yellow), and Tari Jung (Electrical Engineering)(not pictured) delivered three days of instruction to 60 area students at the UMN Southwest Research and Outreach Center in Lamberton, Minn. The event—"Where can Science take you?"— was presented July 29-31. ECE department staff member Dan Dobrick prepared materials and activities for the event.

Ph.D. student Patrick Quarterman received the Best Contributed Poster Award featuring his research effort to develop future heat-assisted magnetic recording media beyond 5 Terabit per square inch at the 25th Annual Magnetic Recording Conference (TMRC 2014) in Berkeley, Calif. His poster title was "Effects of embedded hark mask patterning process on FePt HAMR media with ultra-small grain size." (Prof. Jian-Ping Wang, advisor)

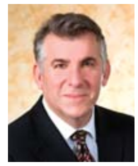
Graduate student Mustafijur Rahman received the Best in Session Award at TECHCON 2014 in Analog/RF Circuit Design for his paper "An Ultra-Low Power Multiband WBAN Transmitter Using a Novel ILO Based Modulator" authored by Mustafijur and his advisor, Prof. Ramesh Harjani. TECHCON 2014 is conducted by Semiconductor Research Corporation (SRC) and was held Sept. 8-9 in Austin, Texas.

Ph.D. candidate Tingting Xu won First Prize in 2014 IEM Student Poster Contest in Neuroengineering Category. Her poster is titled "Classification of Borderline Personality Disorder based on Spectral Power of Resting-State fMRI". She is advised by Prof. Keshab Parhi and mentored by Dr. Kathryn Cullen of Psychiatry Department.

Ph.D. candidate Armin Zare was selected as a finalist in the Student Best Paper Award at American Control Conference in Portland, Ore., June 4-6. (Prof. Mihailo Jovanovic, advisor)

Ph.D. student Hui Zhao received an Honorable Mention in the 2014 Best Dissertation Awards at the University of Minnesota. (Prof. Jian-Ping Wang, advisor)

Faculty



Prof. Massoud Amin provided an article for *National Geographic* about the 11th anniversary of the August 14, 2003 blackout.

Prof. Vladimir Cherkassky spoke at Royal Holloway, University of London on May 26. His title was "From Big Data to Little Knowledge." He also provided an invited speech at the Medtronic-sponsored "Big Data & Advanced Analytics Symposium," Sept. 23-24 in Minneapolis. His title was "Reliable Prediction of Epileptic Seizures from EEG Signal."

U of M blog "Inquiry" included comments from MnDRIVE Team members Prof. Peter Seiler (Aerospace Engineering and Mechanics) and **Asst. Prof. Sairaj Dhople** (Electrical and Computer Engineering).Dhople, the group's solar expert, is researching small-scale energy distributions systems that may someday replace the existing large-scale power stations. For more, go to http://wp.me/p4wAsQ-oW

Prof. Rhonda Franklin received the Sara Evans Faculty Woman Scholar/Leader Award. It recognizes women faculty at the University of Minnesota-Twin Cities who have achieved significant national and international accomplishments and honors and who contribute as leaders on campus. Only two awards are given each year: one in science and engineering, and one in humanities.

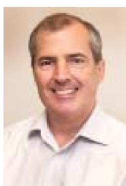
Prof. Tryphon Georgiou organized a New Directions Short Course on "Topics in Control Theory" at the Institute for Mathematics and Its Applications. This intensive three-week course was held at the University May 27 - June 13, 2014, and offered an opportunity for mathematicians, physicist, and engineers to branch into new research directions. The course provided an excellent lead-in for the 2015-2016 program year on "Control Theory and its Applications."

Prof. Georgios Giannakis received the 2015 IEEE Fourier Technical Field Award (TFA) for his contributions to the theory and practice of statistical signal processing and its applications to wireless communications. The TFA award was established in 2013 and Prof. Giannakis is its first recipient.

Prof. Mihailo Jovanovic received a Transdisciplinary Faculty Fellowship from the U of M Informatics Institute. Six U of MN faculty from across two campuses and representing eight different departments and institutes were awarded fellowships. The support provided to Prof. Jovanovic also will benefit the College of Science and Engineering's MnDRIVE Initiative on Robotics, Sensors, and Advanced Manufacturing.

Prof. Chris Kim has received a funding award for MnDRIVE Transdisciplinary Research. His project —"Design and Manufacture of Wearable, Printed, and Flexible Electronics for Treating Neurological Disorders"—was selected from among 61 proposals. (See additional accomplishment with Prof. Keshab Parhi).

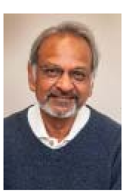
Prof. Mo Li and graduate student Huan Li's research paper has been published online and in the October issue of *Nature Nanotechnology*. The paper reports that the team has demonstrated "photon shuttling" the ability to mechanically transport photons. For more, go to http://www.nature.com/nnano/journal/vaop/ncurrent/full/nnano.2014.200.html
http://discover.umn.edu/news/science-technology/engineers-show-light-can-play-seesaw-nanoscale



Profs. Steve Koester and Mo Li (above) are members of a multi-university collaborative that won a $3 million grant from the Air Force Office of Scientific Research, as a part of the agency's highly competitive Basic Research Initiative program. Their team is led by University of Washington and includes Stanford University, Yale University, and Carnegie Mellon University. The title of the Li's and Koester's study is "2D Heterostructures for Integrated Nano-Optoelectronics." The period of the project is three years.

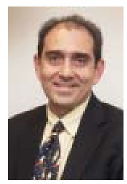
Prof. Zhi-Quan (Tom) Luo was elected to the Royal Society of Canada, the highest honor for a scholar or artist in Canada.

Prof. Tom Misa, Director of the Charles Babbage Institute, University of Minnesota, will oversee two history research grants. An Alfred P. Sloan grant will fund research into the historic era of women's surge into the computer profession. A Los Alamos National Laboratories' grant will fund research into the history of its prolific lab.



Prof. Ned Mohan was invited to be a part of University of Minnesota President Kaler's delegation during the president's trip to Norway to visit the Universities of Oslo, Trondheim, and Agder this past summer. Mohan's newest book—*Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB/Simulink(R)*—has just been published, and his book *Power Electronics - A First Course* has been translated into Kazakh.

Prof. Keshab Parhi and Chris Kim received a National Science Foundation (NSF) and Semiconductor Research Corporation (SRC) grant as part of a $4 million effort with nine other universities to focus research on Security, Trustworthy, Assured, and Resilient Semiconductors and Systems (STARSS). Parhi (PI) and Kim (co-PI) will focus their efforts on "Design of secure and anti-counterfeit integrated circuits" to develop hierarchical approaches for authentication and obfuscation of chips. In addition, a paper—"DREAM: Diabetic Retinopathy Analysis using Machine Learning"— by Parhi, his former Ph.D. student Sohini Roychowdhury, and Dr. Dara Koozekanani of Ophthalmology was featured on the cover of the Sept. 2014 issue of the IEEE *Journal of Biomedical and Health Informatics*.



Prof. Nikos Sidiropoulos, along with Prof. George Karypis (Computer Science & Engineering) have received a $1.2 million grant for research about learning and education data analytics. This is the second NSF BIG DATA award the team has received. The project title is "Learning Data Analytics: Providing Actionable Insights to Increase College Student Success." In addition, Sidiropoulos provided two plenary speeches: "Tensor Decomposition Theory and Algorithms in the Era of Big Data,'' Inaugural plenary lecture at EUSIPCO, Sept. 2, 2014, Lisbon, Portugal; and "Frugal Sensing and Estimation over Wireless Networks," plenary lecture at ISWCS, Aug. 28, Barcelona, Spain.

Prof. Beth Stadler was invited to speak at the IEEE International Magnetics Conference 2014 in Dresden, Germany, on "Magnetic Sensor Arrays for One-Pass Two-Dimensional Magnetic Records." On her return trip, Stadler visited the CERN Particle Accelerator in Switzerland. Her U of MN research group is synthesizing optical modulators that may be included in the next round of sub-atomic collisions to begin in 2015. (Collaboration with ECE Prof. Anand Gopinath and Physics Prof. Roger Rusack.)

Prof. Joseph Talghader presented an invited talk in Changchun, China, on the "Ultimate Thermal Performance of Micromechanical Devices," at the International Conference on Micro/Nano Optical Engineering in July, 2014. In addition, Prof. Talghader was invited to become a topical editor for the Nature Publish Group's new journal *Light: Science and Applications*.

News Briefs - continued

Prof. Randall Victora gave the opening address at the Franklin Award Symposium for Electrical Engineering on April 24, 2014, in Philadelphia. His speech was "Fighting Physics: The Transition from Longitudinal to Perpendicular Magnetic Recording."

Prof. Jian-Ping Wang was named one of the *Minneapolis-St. Paul Business Journal* 2014 Titans of Technology honorees. Wang was recognized as one of three Technology Inventors for his creation of breakthrough ideas, processes and products. Wang is responsible for 39 invention disclosures filed at the U and three issued patents and 22 more patents that are pending or being drafted. Wang's research includes a collection of ground breaking discoveries focused on the theme of advanced magnetic materials. His research group was the first in the world to demonstrate a sensing system that detects low concentrations of cancer marker proteins using human serum and urine samples. This discovery fueled the formation of Zepto Life Technology, a St. Paul-based startup that develops equipment to provide fast, low-cost disease detection accessible even in parts of the world where resources are limited. For more go to: http://z.umn.edu/detectdisease

Staff

Amy Grove joined the staff on Oct. 29. Most recently, she worked at General Mills as an Associate Human Resources manager. She has a Masters in Human Resources and Industrial Relations from the University of Minnesota. She has served as a teacher in the Teach for America program and as a web administrator for a publishing company.

Sylvia Hill, a student worker for ECE for three years, joined the staff this past summer as receptionist for C-SPIN. Sylvia graduated from the U of MN in spring 2014 with a B.A. in English/ Theater Arts.

Laurel Katsch joined the staff this past summer as the principal office and administrative specialist. Laurel graduated from the U of MN in spring 2014 with a major in Landscape Design and a minor in Architecture.

Jennifer Peterson joined the staff this past summer as department accountant. She previously worked in Finance for the College of Design. She has been with the University for 13 years and received her B.S. in Child Psychology from the U.

Thomas Schenk joined the staff this past spring as research coordinator. Previously, he served as the grants coordinator of the College of Design. He has been with the University for 16 years and received his B.A. from the U. He received his MBA from the University of St. Thomas.

Roopa Sukumara-Berzins joined the staff in spring 2014 as undergraduate student advisor. Previously, she served as an advisor for the College of Liberal Arts. She has been with the U for eight years and received her Ph.D. from the University of Minnesota.

Alumni

ECE alumnus Bodhisatwa Sadhu's (Ph.D.'12) paper—"A linearized, low-phase-noise VCO-based 25-GHz PLL with automatic biasing"—was cited as the most downloaded paper in IEEE's Journal of Solid-State Circuits in 2013. (2,810 times in 2013 and 3,173 to date.) The paper was written during Sadhu's research work at the U of M in collaboration with IBM. Currently, Sadhu is employed with IBM T.J. Watson Research Lab. (Prof. Ramesh Harjani, former advisor)

ECE alumnus Ted Brekken (Ph.D.'05) received the Oregon State University College of Engineering's Loyd Carter Award, their annual teaching award. The honor is voted on and bestowed by the students of the College of Engineering. Brekken says, "Last year was my first year of going 'all-in' on the flipped classes, I think that is a strong endorsement of your (Prof. Ned Mohan's) videos, materials, and curriculum!" (Prof. Ned Mohan, former advisor)

Senior Design Show
Tuesday, Dec. 9, 2014

2:00 - 4:30 p.m.
Coffman Union
Great Hall

Senior Design is a four-credit, semester-long course for students in their senior year, with the objective of providing students with a real-world, team-based design experience through which they develop an appreciation of design methodology and team dynamics, along with refining their oral and written communications skills.

In Memoriam - Faculty

Former Department of Electrical and Computer Engineering Head Prof. Emeritus Robert Collins dies

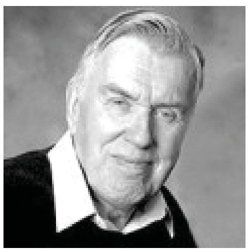
Prof. Emeritus Robert Collins

Prof. Emeritus Robert Collins, Department of Electrical and Computer Engineering Head (1964-69 and 1984-90), passed away in July, 2014. Memorial services were held in Washington, D.C., with burial in Pennsylvania.

Prof. Collins was Department Head during the groundbreaking and building of Keller Hall, the current site of the Department of Electrical and Computer Engineering (ECE). Collins participated in the ground breaking on Oct. 1, 1985; the building was completed in 1988. Collins held tenure with the department from 1963-1993.

During the 1980s, he and other department heads were responsible for hiring new faculty in the emerging fields of signal processing, communications, VLSI, computer systems, microelectronics and controls. While Collins was department head, ECE enrollments reached 1,300 students, a near historic high. Collins was a member of the Quantum Electronic and Optics Group in the 1970s researching particle sizing, semiconductor annealing with electron and laser beams, and laser interaction with solids. In the 1980s, Prof. Collins was a member of the Devices Research Group whose research included ultrasonic wave devices and microscopy; high speed, microwave and millimeter-wave devices and integrated circuits; three-dimensional integrated circuits; thin-film amorphous devices; complementary heterojunction insulated gate FETs; optoelectronic devices and circuits; silicon heterojunction devices; physics of heterojunctions; magnetic thin film devices; super lattice and quantum-well structures and devices, among others.

Developer of ARC Safety Device for High-Voltage Systems and Computer-Aided Recording System for Wiring Diagrams, Former Prof. Robert P. Featherstone dies



Former Prof. Robert P. Featherstone

Robert P. Featherstone, 93, of Minneapolis, Minn. died in August 2014 and was buried at Fort Snelling National Cemetery. He was an electrical engineer who worked at Twin Cities Central Engineering (currently United Technologies, Corp.), at the CERN Lab in Geneva, Switzerland, at FERMI Lab in Batavia, Ill., and at the University of Minnesota as Physics Professor and Center Engineering Professor. After retiring from his academic teaching career, he volunteered as a Department of Electrical and Computer Engineering Industrial Advisory Board member. Featherstone served during World War II in the Army Signal Corps, achieved the rank of Captain, and received the Bronze Star.

Featherstone was responsible for the “ARC Safety Device for High Voltage” patent. Featherstone wrote, “...[My invention] protects the system during the interval that it requires the circuit breaker to operate and trips open the AC input and after its first operation due to a fault occurring in the output of the rectifier, it then resumes its protective control over the rectifier to guard it against subsequent occurring faults without the necessity of resetting the circuit by an operator.”

Featherstone also developed a computer-aided recording system for wiring diagrams that would log all changes. He wrote, “Most particle accelerators have extensive networks of control wiring. The usual stream of minor modifications requires hundreds of control wires to be added, deleted, or changed in function every few months....We have devised improved computer-aided techniques for organizing information ....The computer-aided system has been in use for nearly two years at the University of Minnesota proton linear accelerator, which has a control wiring network containing about 10,000 wires. A complete set of record books can be worked out in about 18 minutes on a Control Data 1604 computer. Trouble-shooting, identification of wiring errors, and design of system additions all have benefited from the speed, convenience, and accuracy of the computer-aided system.”

While at CERN in 1968, he researched and published “The injection electrostatic deflector (vertical) for the CERN PS booster” (Accelerators and Storage Rings); “Computer routines useful in step-by-step calculations of LINAC R-F system operation; “The injection electrostatic deflector (vertical) for the CERN PS booster;” and “Computer routines useful in step-by-step calculations of LINAC R-F system operation.” In addition, Featherstone conducted extensive research while at FERMI Lab in 1969 on the LINAC system and published numerous papers about it including “Notes on the component identification problem,” “Coaxial transmission line for the NAL 200-MeV LINAC,” “Phase measurements on the ZGS 50 MeV LINAC,” and “Notes on the LINAC System Timing Problem.”

In Memoriam - Alumni

Dr. Morris F. Collen, pioneer in computerized medicine, dies

Dr. Morris Collen (EE'35, M.D.'38) died in September, 2014, at his home in Walnut Creek, Calif. Dr. Collen was an original founder of the Kaiser Medical Group, now Kaiser Permanente Medical Group. He worked part time at the Kaiser Division of Research until his death.

In 1935, after graduating with a Bachelor of Electronic Engineering from the University of Minnesota, he went on to study medicine at the University and graduated in 1938. He did his residency at USC/Los Angeles County General Hospital and in 1942 he met Dr. Sidney Garfield. Drs. Garfield and Collen worked together to provide care for the Henry J. Kaiser shipyard workers of Richmond. In 1948, along with five other physicians, Garfield and Collen founded the Kaiser medical group. Dr. Collen served as chief of medical services from 1942-1952 at Kaiser's Oakland Hospital and as medical director until 1953. He then became the physician-in-chief at Kaiser's San Francisco Hospital until 1961.

Dr. Collen pioneered the use of computers to improve medical care and published a book in 1995 titled "A History of Medical Informatics in the United States, 1950-1990." Prior to his death he had just completed an updated version of the book to include the additional history of medical informatics from 1990 to 2010. Kaiser Permanente plans to publish the book next year.

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

David J. Lilja — **Department Head**

Paula J. Beck — **Editor**