SENSING THE FUTURE $100M TRANSFORMATIVE INITIATIVE ECE MAKES A GLOBAL IMPACT BUILDING CRITICAL SPACES POWERFUL VIDEO PROCESSING UNDERSTANDING THE SPACE ABOVE 10 ANSWERS

RESONANCE

THE MAGAZINE OF ECE ILLINOIS

FALL 2013

JUST A DROP.

HOW ECE IS HELPING TO DRIVE BIO APPLICATIONS

ILLINOIS

TOP OF MIND

Later in this magazine you'll read about the $100 million commitment the College of Engineering at Illinois received early this year to launch the Grainger Engineering Breakthroughs Initiative. The incredible generosity of The Grainger Foundation of Lake Forest, Illinois, will help departments across the college—including ECE—through support of new professorships, student scholarships, and investment in our facilities.

At a time when support from the State of Illinois is at an all-time low, private support is extremely important to ensure we can continue to fulfill our land-grant mission. Student scholarships are one area of strong need. In 1990, the state provided $3.36 in funding per student tuition dollar. As of 2012, that number is down to 62 cents.

Early next year the College of Engineering will announce a massive scholarship fundraising initiative designed to ensure that great students still have access to a great education at Illinois. Through this initiative we'll ensure that students of all backgrounds will have a chance to get an ECE ILLINOIS education.

One example of the power of alumni and industry support is the new ECE building currently under construction on the engineering campus. By next fall, ECE will be moved into this state-of-the-art facility built around the needs of our students. Though fundraising is ongoing, when the building is complete exactly half of the $95 million project cost will have been supplied by alumni, industry, and other private donors. This building will impact our students and faculty in profound ways.

The funding landscape continues to change for colleges and universities, and Illinois is no exception. Gifts of all sizes will play an instrumental role in helping ECE maintain and grow its academic and research programs in the years ahead.

William H. Sanders
Interim Department Head
Donald Biggar Willett Professor of Engineering

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RESONANCE

Fall 2013

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CONTENTS

_FEATURES

_DEPARTMENTS

"I think that is a thing that Illinois should be very proud of. We make a global impact..."

Minh N. Do
Speaking about the Vietnam Education Foundation, page 16

CARE

CARE OPEN TO STUDENTS

On March 26, a new student service was officially launched by the College of Engineering: the Center for Academic Resources in Engineering (CARE). Located on the fourth floor in the Grainger Engineering Library, CARE offers resources and expertise that support students in achieving their academic and professional goals: free walk-in tutoring, workshops, peer advising, and review sessions for core classes (including ECE 110).

This facility provides ample space for collaborative and independent study, including group study rooms, dual-monitor computer workstations, and over one hundred study carrels. Caterpillar, Inc. provided CARE with furniture and equipment.

PURELY RESEARCH

Promoting Undergraduate Research in Engineering (PURE) pairs undergraduates with graduate student mentors for a semester-long research collaboration. Established as an ECE program in Fall 2007, PURE has since expanded to computer science, and Rockwell Collins has joined as a corporate sponsor, providing the student teams with funding for the past two school years.

CONGRESSIONAL VISITS DAY

In mid-March, four ECE students attended the annual Science, Engineering, and Technology Congressional Visits Day. The two-day event brought academic and industry leaders to Washington, DC, where they met with members of Congress and their representatives. For the students, this was an opportunity to discuss the importance of funding engineering research and education.

ECE graduate student Gloria See, who organized the student coalition, met with Illinois representatives, as did undergraduate Anthony Shvets. Undergraduates Alex Hsu and James Su met with representatives of California and Maryland, respectively.

BRONZE TABLET

Fifteen ECE students were named on the 2013 Bronze Tablet, the university's highest honor for graduating students: Muneeb Ahmed, Pourya Assem, Jerry Chang, Yujie Chen, Xiong Kai Benjamin Chng, Neil Christanto, Miguel Luigi De Dios, David Goldstein, Jeff Lale, Shiyang Liu, Matt Tischer, Eric Wei, Jeff Wheeler, Zhixing Xu, and Jerry Zhou.

UNIVERSITY HONORS

SEE MORE NEWS AT:
ECE.ILLINOIS.EDU

ALUMNI HONORS

In a ceremony held at the US Patent and Trademark Office in May, three ECE alumni joined the legendary echelon of innovators inducted into the National Inventors Hall of Fame: Donald Bitzer (BSEE '55, MSEE '56, PhD '60), Gene Slottow (PhD '64), and Robert Willson (PhD '66). They were recognized for the plasma display, which they invented in the mid-1960s while Bitzer and Slottow were Illinois faculty and Willson a graduate student.

Plasma displays are forerunners of the high-definition, flat-panel television screens ubiquitous today and are well known for their excellent contrast ratio, wide viewing angle, and rapid response time.

ILLINOIS MARATHON

A large number of ECE faculty and students participated in the fifth annual Christie Clinic Illinois Marathon. The course winds throughout Champaign and Urbana, and passes Everitt Lab early in the race. This year, over 20,000 athletes entered the races.

RECORD NUMBERS

A record number of ECE students were offered Graduate Research Fellowships from the National Science Foundation this year. Three are current graduate students: Nicole Bohannon, Choden Königsmark, and Josiah McClurg. The others—Genevieve LaBelle, Maryann Tung, and Eric Wei—completed their undergraduate degrees last spring.

CAREER AWARD

ECE Assistant Professor **Maxim Raginsky** recently received a CAREER Award from the National Science Foundation (NSF). This five-year grant will be used to develop an information-theoretic approach to machine learning problems, particularly those that involve multiple resource-constrained learning agents in a large network. These awards are given specifically to junior faculty members who demonstrate excellence in research and teaching.

UNIQUE EQUIPMENT

ECE ILLINOIS recently became the only engineering program in the country to possess a non-linear vector network analyzer (NLVNA). This state-of-the-art technology—capable of generating behavioral models of nonlinear devices—was first introduced by Agilent Technologies in 2008.

The acquisition was made possible through the support of ECE alumni at Agilent, along with funding from Illinois administration, Engineering at Illinois, the ECE Department, and the Ralph E. and Winifred T. Kuehn Endowment Fund.

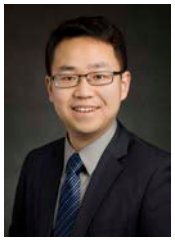
ECE grad students (left to right)
Dan Fisher, Tim Duly, and Tom Gehrels
with ECE Associate Professor Jonathan Makela

ECE grad students (left to right)
Surrounding ECE Professor Naresh Shanbhag:
Yingyan Lin, Sai Zhang, Tianqi Gao, and Min-sun Keel.

CHARTER FELLOW

Nick Holonyak Jr. was chosen as a charter fellow of the National Academy of Inventors. The inaugural class of fellows comprises 101 scientists and innovators from academic and nonprofit research institutions around the world, who collectively hold more than 3,200 patents with the US Patent and Trademark Office.

Holonyak, who famously invented the first visible-spectrum light-emitting diode (or LED), was honored for his many innovations, which resulted in 49 US patents.



NEW FACULTY

ECE Assistant Professor **Yihong Wu** joined the department this spring, following a postdoctoral fellowship with the statistics department at The Wharton School at the University of Pennsylvania. Wu's research combines information theory and statistics for applications including big data. Wu is based in the Coordinated Science Laboratory.

INVESTITURE

At an investiture ceremony held at the Beckman Institute on February 26, 2013, ECE Professors **David Nicol** and **Zhi-Pei Liang** were named Franklin W. Woeltge Professors in Electrical and Computer Engineering.

The Franklin W. Woeltge Professorships were established in 1998, thanks to an estate gift from alumnus Franklin Woeltge (BSEE '26).

FACULTY APPOINTMENTS

ECE Professor **Andreas C. Cangellaris**, who had served as department head since 2008, was chosen to be the next dean of the College of Engineering. In this new role, Cangellaris will be positioned to use his proven leadership and communication acumen, advancing the college's mission on campus and around the world.

Professor **William H. Sanders** has been named interim head of the ECE Department. Since 2008, Sanders has served as director of the Coordinated Science Laboratory, overseeing large expansions in that lab. His oversight will ensure a smooth transition for the department.

CS Professor **Klara Nahrstedt** has been appointed acting director of the Coordinated Science Laboratory. Nahrstedt is a leading researcher in multimedia systems, and has been a CS faculty member since 1995. In this new position, she will guarantee the continued success of this premier multidisciplinary research laboratory.

ECE and Bioengineering Professor **Rashid Bashir**, who has been the director of the Micro and Nanotechnology Laboratory (MNTL) since 2007, is now the head of the Department of Bioengineering. Professor **Brian Cunningham** has been named interim director of MNTL.

ECE Professor **Douglas L. Jones** has been appointed director of the Advanced Digital Sciences Center in Singapore. His leadership will ensure the ongoing excellence of the ADSC, as it continues to facilitate international research collaborations.

›PROFESSORS ›BRESLER ›CHEW ›CHOQUETTE ›DALLESASSE ›DO ›FENG ›LIBERZON ›LOUI ›LYDING ›MILENKOVIC ›MITRA ›OVERBYE ›PILAWA-PODGURSKI ›SINGER VASUDEVAN ›VISWANATH

›IN THE NEWS

YORAM BRESLER
Yoram Bresler was awarded the Innovation Transfer Award by the University of Illinois Office of Technology Management at the Champaign County Innovation Celebration.

WENG CHO CHEW
Weng Cho Chew was elected to membership in the National Academy of Engineering.

KENT D. CHOQUETTE
Kent D. Choquette was named a fellow of the American Association for the Advancement of Science (AAAS).

JOHN DALLESASSE
John Dallesasse was elected a Fellow of the Optical Society (OSA).

MINH N. DO
Minh N. Do received a three-year grant from the National Science Foundation to advance the theory and practice of image and video processing with 3-D cameras.

MILTON FENG
Milton Feng has been awarded the 2013 R.W. Wood Prize by The Optical Society (OSA).

DANIEL M. LIBERZON
Daniel M. Liberzon was named an IEEE Fellow, the highest level of membership within IEEE.

MICHAEL C. LOUI
Michael C. Loui was presented the Campus Award for Excellence in Graduate Student Mentoring by the Graduate College at Illinois.

JOSEPH W. LYDING
Joseph W. Lyding received the 2013 Nanotechnology Recognition Award from the American Vacuum Society Nanometer-Scale Science and Technology Division.

OLGICA MILENKOVIC
Olgica Milenkovic was named a Willett Scholar and also received the 2013 Dean's Award for Excellence in Research.

SAYAN MITRA
Sayan Mitra received a one-year grant from Samsung's Global Research Outreach Program for his mobile-cloud debugging project.

THOMAS J. OVERBYE
Thomas J. Overbye was elected to membership in the National Academy of Engineering.

ROBERT PILAWA-PODGURSKI
Robert Pilawa-Podgurski received a one-year Google Faculty Research Award, for research pertaining to data center power delivery.

ANDREW SINGER
Andrew Singer was awarded the Entrepreneur Advocacy Award at the Champaign County Innovation Celebration.

SHOBHA VASUDEVAN
Shobha Vasudevan received the 2013 Outstanding New Faculty Award by the Association for Computing Machinery Special Interest Group on Design Automation.

PRAMOD VISWANATH
Pramod Viswanath was named an IEEE Fellow, the highest level of membership within IEEE.

JUST A DROP.

A MEASURED APPROACH.

HOW ECE IS HELPING TO DRIVE BIO APPLICATIONS

BY JOHN CAPAROON

IT WAS SUPPOSED TO BE A DAY-HIKE IN THE DESERT. A WRONG TURN AND NOW YOU'RE LOST IN SCORCHING HEAT. YOU STUMBLE ACROSS A WATER SOURCE, BUT IS IT SAFE? AS YOU WEIGH DEATH BY DEHYDRATION VERSUS POISONED WATER, YOU SUDDENLY REMEMBER—YOU SLIP A SMALL PLASTIC DEVICE FROM YOUR BACKPACK, ATTACH IT TO YOUR CELL PHONE, TAKE A QUICK MEASUREMENT—AND DRINK.

It's not science fiction. Life saving devices like the one above are fast becoming a focus in the field of bioengineering. As new biological research collides, overlaps, and sometimes even merges with modern engineering technologies, advances in areas like microelectronics and nanotechnology are making possible the development of new handheld laboratory and field instruments that will revolutionize the way we pursue health care, environmentalism, recreation, and more.

START SMALL

Historically speaking, there has always been a relationship between engineering and the life sciences. Medicine, pharmacology, and food science, just to name a few, have relied on engineering for the design and construction of boundless necessities—from laboratory equipment to prosthetic devices to the actual facilities that house hospitals, research laboratories, and processing plants.

Now, as these complex disciplines become even more nuanced and specialized—especially in the areas of micro and nano applications—the lines between engineering and biology are blurring. This growing trend, along with significant support from the recently announced Grainger Engineering Breakthroughs Initiative, has provided ECE with a unique opportunity: To advance biological research, in general, and bioengineering, specifically, within Engineering at Illinois, the University of Illinois and beyond.

"Bioengineering sits at the nexus of multiple disciplines. The departmental boundaries here are very porous, which is a good thing. I think that some of the most interesting things are happening at the intersection of these disciplines," said ECE and Bioengineering Professor Rashid Bashir, who was recently named head of the Department of Bioengineering (see page 12).

"The new research directions and multidisciplinary collaborations that the Grainger Initiative will foster across all engineering departments, the life sciences, and other parts of campus will not only strengthen bioengineering at Illinois, but will boost our leadership as educators and innovators."

In pursuit of new breakthroughs in bioengineering and big data, funds committed by The Grainger Foundation will be used to endow dozens of new professorships and chairs, recruit senior faculty to Illinois, provide undergraduate scholarships, and renovate Everitt Lab, which will become the new home for the Department of Bioengineering after ECE moves out. Monies supporting research at the college will not be limited to newly endowed positions, but will also be available to faculty working in these areas.

STEP IT UP

So what does the future look like? Bashir's optimism isn't without merit. Even without new funding, new labs, and new faculty, he's correct in his assertion that exciting developments are already underway at the crossroads of engineering and bio research, and several of them are rooted in the ECE Department. This is evident in projects like the one referenced in our imagined desert hiking scenario: MoboSens.

MOBOSENS

A mobile, smartphone-compatible sensor for detecting contaminants such as nitrates, arsenic, heavy metals, bacteria, and radiation in groundwater, tap water, or even properly prepared soil samples, MoboSens is being developed by ECE

Assistant Professor Logan Liu and a team of graduate and undergraduate researchers. The sensor differs from the disposable "yes or no" type kits currently available for hikers or remote field workers in that it is reusable, and provides detailed information about contamination levels—the same kind of information that has previously been available only through expensive and time consuming laboratory testing.

"This device can be applied in several areas of use," said Liu. "There are environmental groups like the Sierra Club and adventure-type groups who are concerned with water pollution and if the water is safe to drink. There are certain regions of the United States, like Illinois and California, which are very agricultural, that have high levels of nitrates, where it could be used to help track and reduce pollutants. Also for newly industrialized countries like China and India, where there are many poisons in the water, it would help raise awareness of the danger people are in from their environment."

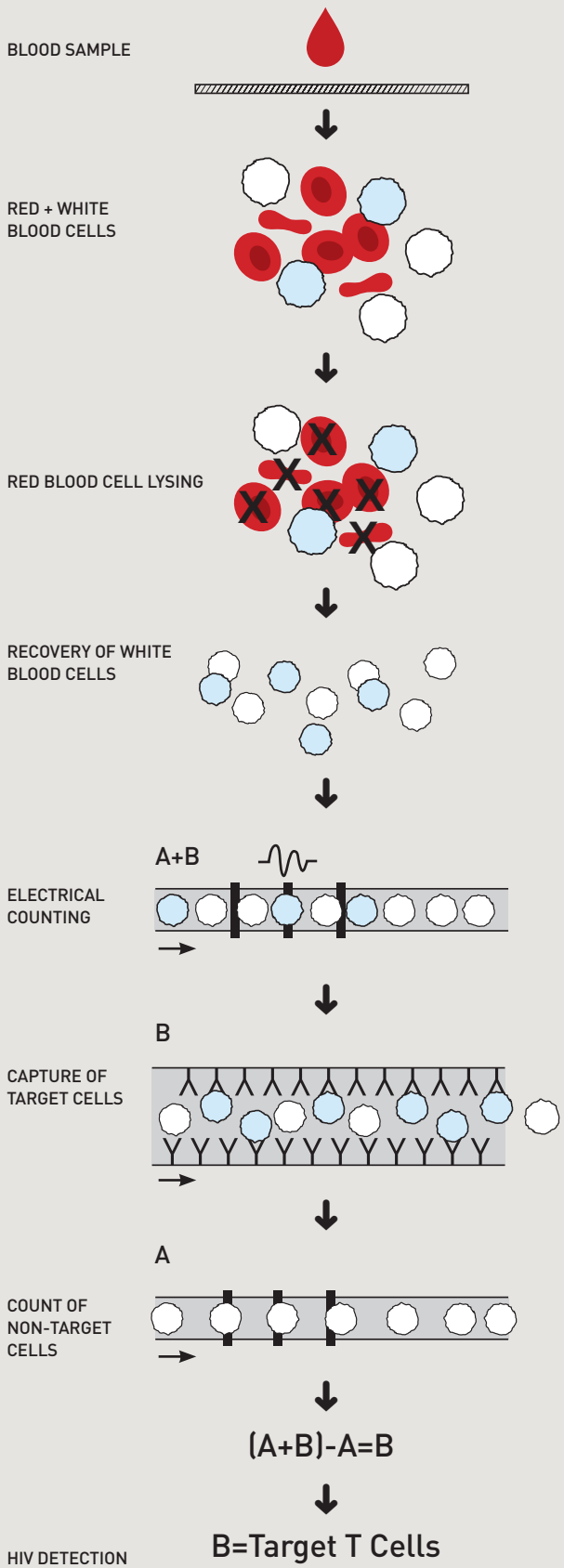
While the ability to test water quality on the go with laboratory-level precision is impressive enough, the ambition of the MoboSens project doesn't stop there. Liu and his team have an even larger goal, which is to empower aid workers, outdoor enthusiasts, environmentalists, and regular citizens by making the device available at a reasonable cost (below $50 per unit), and combining it with a free, cross-platform smartphone application. The application will allow users to upload test results to the cloud, and this "crowdsensed" data can then be combined with geospatial location for the purpose of tracking pollutants—helping to reduce the over three million deaths each year from water related diseases.

IPHONE BIOSENSOR

Another research project that is poised to have a huge impact in the fight against contamination and disease is the handheld biosensor developed by ECE Professor Brian Cunningham and his team of researchers.

Like the MoboSens device, Cunningham's biosensor leverages smartphone technology to deliver an extremely portable, sensitive, and inexpensive alternative to conventional laboratory testing. The finished product consists of an iPhone compatible cradle containing lenses, filters, and a photonic crystal. While the cradle holds the optical components—similar to those found in larger laboratory equipment—in line with the phone's camera, the crystal reflects narrowband light through both the component array and a prepared sample slide. A compatible iPhone application then uses the computing power provided by the phone to analyze variations in the wavelength of the reflected light, exposing the nature and concentration of blood, food or waterborne pathogens, toxins, proteins, and other molecules.
As with Liu's project, harnessing and combining the power of smartphone technology and advanced laboratory analysis also means almost instant availability of field data for doctors, researchers, and aid workers worldwide.

LAB-ON-CHIP



"BIOENGINEERING SITS AT THE NEXUS OF MULTIPLE DISCIPLINES. THE DEPARTMENTAL BOUNDARIES HERE ARE VERY POROUS, WHICH IS A GOOD THING. I THINK THAT SOME OF THE MOST INTERESTING THINGS ARE HAPPENING AT THE INTERSECTION OF THESE DISCIPLINES."
-RASHID BASHIR

"In our work with smartphone-based biosensors," said Cunningham, "we are considering applications in which performing biosensor tests at the 'point of use' rather than in a distant laboratory would be important because a result is needed immediately or a laboratory facility is not available. One such scenario is the development of tests for infectious disease in parts of the world that lack clinical diagnostic laboratories. The ability to perform a blood test near the patient, for the information to be processed and interpreted by a remote doctor and to prescribe treatment immediately would save lives of people who would otherwise not be tested at all. We are also thinking of applications in food safety, in which a smartphone based sensor could detect allergens in food, or the presence of other types of contamination. The ability of a cloud-based information system to collect data from many users can be used to do things like identify trends that span large geographic areas."

LAB-ON-CHIP

What's a laboratory without a hot plate, Bunsen burner, or other heat source?

A final example of the innovative work being done by ECE researchers in the bio space, "lab-on-chip" systems bring various laboratory functions down to size—settling components and samples onto the surface of microchips—and producing quick, complex, and accurate results at a fraction of the cost and footprint of their full-sized counterparts.

While lab-on-chip is not a new idea, Bashir's research has helped lead to new developments in this field, such as the inclusion of a heating element within this miniature laboratory context. The newfound ability to heat nanodroplets using silicon based devices means that biochemical reactions can now take place—and be thoroughly analyzed—in a laboratory that could easily be slipped into a large envelope. Further, using microfabrication techniques, lab-on-chip technology can be scaled down to "lab-on-transistor" technology, for use in point of care diagnostic products.

These are the kinds of products—incorporating lab-on-chip, microfluidics, and electrochemical sensing breakthroughs—that have launched two startup companies licensing Bashir's technologies: BioVitesse and Daktari Diagnostics. While the former venture focuses on fully automated and integrated in-process control monitoring systems to rapidly detect and monitor bacteria, the latter is pioneering handheld diagnostic devices similar to blood glucose meters—so that even in the most remote locations, doctors can effectively diagnose and prescribe treatment for diseases like HIV, which claims millions of victims every year.

FINISH BIG

While the words "baby steps" can't begin to describe the diminutive dimensions of the new frontiers in ECE-related bioengineering, "great strides" does no better job in explaining the expanse that these breakthroughs cover.

Widespread use of convenient, instantaneous sensing, testing, and sharing devices may not be a reality yet, but the work being done by Bashir, Liu, Cunningham and others within ECE, the Department of Bioengineering, the Micro and Nanotechnology Laboratory, and other departments and facilities within and outside of Engineering at Illinois, is demonstrating how the combination of engineering and bio-research will shape—and is already shaping—the future.

The science is real, the concepts are proven, the prototypes are functional—and in a matter of months many new, world changing, and lifesaving technologies will begin to make their way into the hands of doctors, scientists, adventurers, researchers, and others around the planet.

It just goes to show that what they say is true: Great things really do come in small packages.

RASHID BASHIR

WHERE THE RESEARCH MEETS THE ROAD

ECE'S IMPACT-FOCUSED BASHIR TO HEAD EXPANDING DEPARTMENT OF BIOENGINEERING

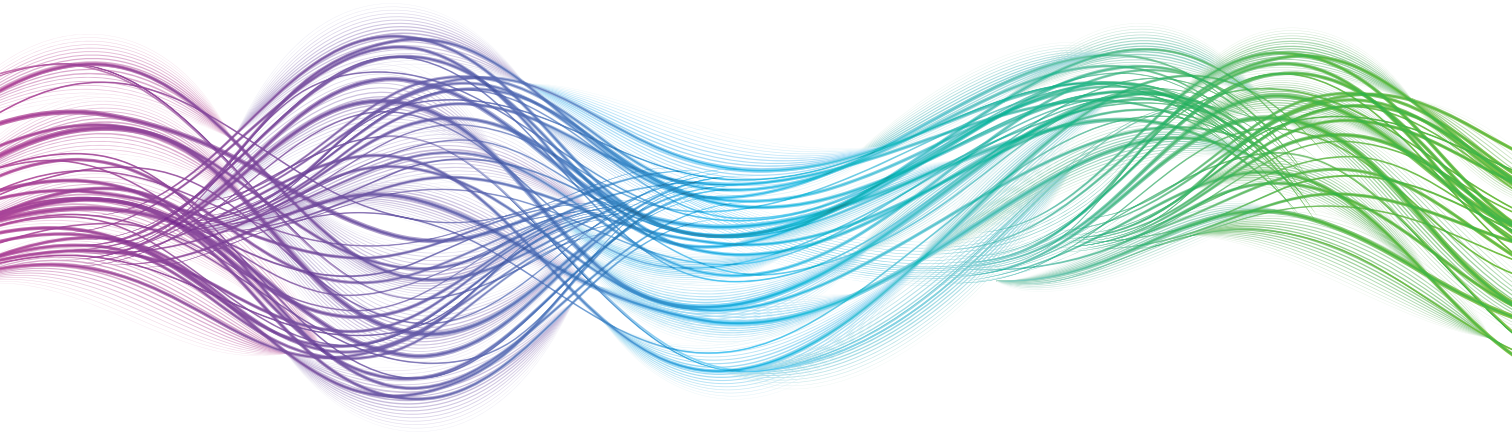
Even as a child growing up in Pakistan, Rashid Bashir knew that he wanted his future career to make an impact on the world. He was going to be an engineer and build things.

His future did not disappoint. He did become an engineer, and over the course of his career to this point he has had the opportunity to build many things that have made and are making a significant impact. Along the way, he has also managed to build a long list of professional and academic appointments—the most recent being head of the Department of Bioengineering at Illinois.

Bashir is the Abel Bliss professor of Electrical and Computer Engineering and Bioengineering, former director of the Micro and Nanotechnology Laboratory, and director of the Center for Nanoscale Science and Technology. He has authored or co-authored over 150 journal papers, over 200 conference papers and conference abstracts, over 120 invited talks, and has been granted 34 patents. He is a fellow of IEEE, AIMBE, AAAS, and APS.

His research interests include BioMEMS, lab-on-chip, nano-biotechnology, interfacing biology and engineering from molecular to tissue scale, and applications of semiconductor fabrication to biomedical engineering, all applied to solve biomedical problems. He is cofounder of Daktari Diagnostics, and a member of the technical advisory board.

His tenure as head of the Department of Bioengineering began on August 16. He will use his background as an electrical engineer and interest in biomedical applications—as well as the support provided by the Grainger Engineering Breakthroughs Initiative—to advance the role of bioengineering at Illinois.



$100M COMMITMENT LAUNCHES GRAINGER ENGINEERING BREAKTHROUGHS INITIATIVE

Early this year, the University of Illinois announced the establishment of the Grainger Engineering Breakthroughs Initiative, a $100 million investment in the future of Engineering at Illinois. Supported by a commitment from The Grainger Foundation, this initiative will focus on supporting research in the areas of big data and bioengineering, areas in which ECE has had a long history with promise of more to come.

The Grainger Engineering Breakthroughs Initiative will have a direct impact in four specific ways:

The initiative will provide source funds to endow 35 professorships and chairs. Twenty-six of these will focus specifically on the areas of big data and bioengineering, and many will go toward recruiting senior faculty to Illinois in these research areas.

Funds to support research in big data and bioengineering across the college will also be available. These funds are not tied to the endowed faculty positions, but will be available to any faculty member working in one or both of these areas.

Funding for undergraduate scholarships will be provided.

Once the new ECE building has been completed and ECE has moved to its new home, this initiative will provide funds that will go toward the renovation of Everitt Lab as the new home for the Department of Bioengineering as well as other research units.

The Grainger Engineering Breakthroughs Initiative promises to be transformative across the College of Engineering for many years to come.

POWERED PROSTHETIC DEVICES HELP AMPUTEES WALK NATURALLY

BY KATHRYN CARR, COORDINATED SCIENCE LABORATORY

According to the Amputee Coalition of America, there are approximately 1.7 million people in the United States living with limb loss and over one million lower-limb amputees. The number of lower-limb amputees is expected to double by 2050, especially due to the increasing prevalence of diabetes. Complications of diabetes can cause poor circulation and nerve damage, leading to amputation.

ECE PhD student Navid Aghasadeghi (MSEE '10) recognized this problem and is putting his control theory knowledge to use to help advance prosthetic limbs, specifically for lower-limb amputees. In February, he received a $42,232 grant from the National Institutes of Health to pursue this research. Assistant professor of Aerospace Engineering Tim Bretl, who is based in the Coordinated Science Laboratory at Illinois, and Northwestern University associate professor of Biomedical Engineering and Physical Medicine and Rehabilitation Eric Perreault are advising Aghasadeghi in this research.

"I see health problems as one of the biggest challenges that the world faces," Aghasadeghi said. "I thought that the knowledge that I had from control theory should be applicable to some of these problems. I wanted to see a complete loop in developing the theory and then testing the theory in application to see if the whole system could work."

Previously, prosthetic devices were passive, meaning that they behaved like a spring system that didn't provide power to the individual, but technology has advanced so that there are many powered devices currently available. Powered devices include a motor at the two degrees of freedom – the ankle and knee.

"With passive devices, it has been shown that amputees spend more energy over a gait cycle and that the gait is not natural," Aghasadeghi said. "With powered devices, if we can provide the right control to the device, we should be able to provide natural locomotion to the amputee."

The challenge comes with learning how to control these devices and how to provide power to them. Currently, when fitting an amputee with a prosthetic device, a clinician is required to select between a myriad of parameters that match that specific amputee. Aghasadeghi is working to automate this process by using locomotion trajectories from unimpaired individuals and the physical characteristics of the amputee, such as height and weight, to customize controller parameters for the devices.

"Every amputee has to go into a clinic where the clinician chooses the parameters," Aghasadeghi said. "They would walk with the device, try out the gait and tweak the parameters. We're trying to customize the controller parameters for the amputees, so clinicians don't have to spend hours figuring out what the parameters should be. They can just use our algorithm."

Aghasadeghi is working with the Rehabilitation Institute of Chicago (RIC), which is closely associated with Northwestern University in Chicago, to develop his idea. He spent two summers at RIC and continues to make trips to the institute for various experiments.

He began by observing how unimpaired humans walk and attempted to replicate that using a prosthetic device. He is working on a theory called inverse optimal control, which hypothesizes that human motor control (moving an arm or leg, etc.) can be modeled as being optimal with respect to a performance criterion. With this theory, Aghasadeghi determines the performance criteria of an unimpaired human walking and uses those criteria to derive controllers for prosthetic devices.

Currently, testing of Aghasadeghi's algorithm has been done on two non-amputee subjects walking on flat ground.

"Feedback has been positive, in regards to how comfortable the subject was, if the subject's gait was natural and symmetrical and that the subject didn't need to use an overhead harness for support," Aghasadeghi said.

Aghasadeghi has plans to try the algorithm on amputees in the future, as well as extending it to different locomotion modes, such as walking up stairs or down ramps.

"It's been both fulfilling and challenging to work with experts in the field of rehabilitation," Aghasadeghi said. "I try to understand the challenges clinicians face and use my theoretical knowledge to develop a precise mathematical representation of the problem they are facing. With this approach, I hope to help improve clinical practice and address challenges in the medical field."

VIETNAM EDUCATION FOUNDATION CELEBRATES TEN YEARS

BY JONATHAN DAMERY

MORE THAN A GENERATION OF AMERICAN STUDENTS HAVE GROWN UP AND GRADUATED FROM UNIVERSITIES SINCE THE VIETNAM WAR ERA.

During that period—particularly the past two decades—Vietnamese products have become common in American retail, travel between the countries is easy, and as a result, the significance of an initiative like the Vietnam Education Foundation (VEF), an educational exchange program between that country and the US, which is celebrating its tenth anniversary this year, can be underappreciated.

But for ECE Associate Professor Minh N. Do, who grew up in postwar Vietnam, the significance of the VEF has not been lost: a sign of the restored relationship between the two countries and a formative experience for the students who participate. "It is beyond my dreams," he said. "Any [Vietnamese] family you talk to, education for their children is the highest priority, and for young people, having a chance to go abroad and learn from the very best is the dream."

The fellowship program, which was established in 2003, is designed to support Vietnamese graduate students in science and engineering programs in the US. The National Academy of Engineering assembled a team of five US professors to participate in student interviews in 2004, and because Do is originally from

Vietnam, he was invited to join, along with ECE Professor Richard Blahut, then department head, who ensured Illinois's active participation.

That summer, Do and Blahut spent several days in Hanoi and Ho Chi Minh City interviewing prospective students. "I made sure to keep my Illinois hat on and encouraged future VEF fellows to come to Illinois," Blahut said. Over the ensuing decade, 54 have pursued graduate studies at Illinois, 16 in the ECE Department. Nationwide, over 400 students have studied at various research universities, and by the numbers, Illinois has been the top destination.

One of the first ECE students to participate in the program was Loan Vo (PhD '12). After graduation, the fellows are expected to return to Vietnam to build upon the research infrastructure in that country, but Vo, like many other fellows, has maintained close ties with colleagues at Illinois. She accepted a faculty position at the International University in Ho Chi Minh City in 2011, and for the past two summers, she has returned to Illinois to continue a research collaboration with Arthur Kramer, the director of the Beckman Institute.

"The people are the most important thing," Vo said recently, on campus at Illinois. "In Vietnam, I couldn't find anyone who is doing the type of research that I'm doing—the same or very near to it. It is really hard if you don't have colleagues to discuss with." She also indicated the significance of the labs and equipment here. At the same time, she is building a research team of her own at the International University and currently has eleven students and research assistants working in her lab. These are students who will look to Illinois for future guidance and education.

"I think that is a thing that Illinois should be very proud of. We make a global impact," Do said. "My wish is that, in the next fifty years, we would have a very large network of Illinois alumni, from our department, in Vietnam. And they would all be in key positions, leading Vietnam to a knowledge-based economy."

Another ECE alumnus, Ha Nguyen (PhD '07), returned to Vietnam after a three-year stint as a senior research engineer at Sony, in San Jose, and founded Techburg JSC, a company specializing in embedded software development. Located in Hanoi, the company has around 25 employees and is expanding steadily, recruiting additional software and programming engineers. "We continue to have discussions and exchange ideas and so forth," said Do, who was Nguyen's research advisor at Illinois.

After ten years, the impact of Illinois's participation in the VEF program is already palpable. "There is a good pipe established between the Vietnamese universities and the ECE Department at Illinois," said Blahut.

Even when the program culminates in 2018, as it is scheduled to do, this relationship will almost certainly continue. "The first generation of students, they come to [Illinois]; they become successful; and they will share their experience back to the next generation of students," Do said. "That, I think, would be a fantastic outcome for our department as well as Vietnam."

"THE FIRST GENERATION OF STUDENTS, THEY COME TO [ILLINOIS]; THEY BECOME SUCCESSFUL; AND THEY WILL SHARE THEIR EXPERIENCE BACK TO THE NEXT GENERATION OF STUDENTS."

SOLAR PLAYGROUND:

A NEW 60 PANEL ARRAY ON SOUTH CAMPUS WILL ALLOW FACULTY AND STUDENTS TO GET HANDS-ON EXPERIENCE WORKING WITH CUTTING-EDGE SOLAR TECHNOLOGY.

ECE ILLINOIS
Department of Electrical and Computer Engineering

PHOTO BY KATHRYN CARR

STUDENTS

"IT'S TRYING TO PROVIDE THE LAST-MILE SERVICE TO THE STUDENTS: YOU KNOW, THE LAST MILE BETWEEN LEARNING AND EXPERIENCE, LEARNING AND THE JOB."
-SANJAY SRIVASTAVA

SPACES THAT BRIDGE GENERATIONS

BY JONATHAN DAMERY

A reality at any university, even where world-changing research is being conducted, is that everything revolves around students and their success. After spending hours in cleanroom suits or after typing endless lecture notes, the students must be equipped with the skills and knowledge to drive future innovations. If not, all would be in vain. That is why, at times when previous graduates circle back to share their success and ensure the same for present and future generations, a healthy program is unmistakable.

The ECE Department is a case in point. Throughout the new building campaign, even before ground was broken, alumni began to make contributions, supporting not just the building, but also the students who will use the classrooms, laboratories, and collaborative spaces for years to come. In recognition of that support, several student spaces, to date, have been named in honor of alumni who have made substantial contributions. We will highlight three of them.

Inside the Wright Street entrance, on the west side of the building, students will find the Frank and Irene Low Classroom Wing, where lectures and conferences will be held in two 113-seat classrooms. The wing is named in honor of Frank Low (BSEE '34) and his wife, Irene. In 2001, the Lows designated a $7 million estate gift to ECE with the intent of supporting a new building for the department, knowing that a large-scale investment like this building campaign would be a key to the department's long-term success.

Frank spent the bulk of his career at General Electric as an engineer in the Hotpoint Appliance Division. He held 34 patents, mainly for electrical components of washing machines and dishwashers. Irene dedicated her career to education, including as a teacher at the Illinois School for the Deaf and Blind.

On the second floor of the building, students will enter the Nearing Family Classroom, prepared to learn about p-n semiconductor structure, perhaps, or algorithm optimization. This 45-seat classroom is named in honor of Fred Nearing (BSEE '43), who has given $500,000 for the building campaign.

After graduating from the university, Nearing spent the majority of his career in electronic sales. In 1949, he became a commissioned sales representative for Hewlett-Packard, then a ten-year-old company with 200 employees (over 300,000 are employed today), and he later became their Midwestern sales manager. In 1971, he helped launch an independent sales company, Electronic Instruments Associates, which was later renamed Electronic Equipment, Inc.

"I've been lucky in my work career," Nearing said, "and I found the harder I worked, the luckier I got." Supporting the ECE building was a means of sharing his good fortune with students and faculty.

Around the corner from the Nearing Family Classroom, students will walk across the second floor balcony, overlooking the main lobby, and will find the Srivastava Senior Design Lab.

The laboratory is named in honor of Sanjay Srivastava (MSEE '87), who has supported the building project, and the senior-design space in particular, with a gift of $1 million.

Srivastava is chairman of SKS Capital, an investment group based in Los Altos Hills, California, which supports early stage ventures in storage, semiconductors, and education, and he is also the chairman and CEO of Vocareum, a new endeavor aimed at providing online resources to engineers transitioning into the workforce from school or from other careers.

As a graduate student at Illinois, the collaborative workspaces available to him had a profound impact. "I discovered on my own pace what I really enjoyed doing, and having access to that space was critical," he said. His support of the senior design laboratory was thus motivated by its experiential emphasis. "It's trying to provide the last-mile service to the students: you know, the last mile between learning and experience, learning and the job."

These named student spaces, in other words, are reminders of previous graduates who have ensured future successes: for students and for the department as a whole. The building, overall, will include 18 classrooms and 21 instructional labs, and it is in those settings that students will prepare to become the leaders of tomorrow.

WHILE BUILDING CONSTRUCTION IS IN FULL SWING AND ON TRACK FOR COMPLETION IN JULY, DONOR SUPPORT IS STILL NEEDED. CORPORATE AND PRIVATE DONORS MAY FUND AND NAME PROMINENT AND HIGHLY VISIBLE SPACES WITHIN THE BUILDING.

LOG ON FOR MORE INFORMATION ON THESE OPPORTUNITIES OR TO MAKE A GIFT OF ANY AMOUNT.

ECE.ILLINOIS.EDU/BUILDINGCAMPAIGN

OTHER KEY, STUDENT-CENTRIC SPACES IN THE BUILDING WILL INCLUDE:

ECE 110 LAB: A space through which all freshmen will pass, the ECE 110 Lab will be both a state-of-the-art environment for students and a showcase space for the department. Visitors to the building will immediately notice the lab, located off the main lobby.

STUDENT ORGANIZATIONS SPACE: A prominently located, first-floor gathering space will energize ECE's already flourishing student groups. The student organization space will be equipped for meeting and collaboration, and next door, a café will provide an informal location for additional brainstorming.

STUDENT LOUNGES: Graduate and undergraduate student lounges will be located on the third floor of the building, providing spaces for lunch breaks, between-class reading, and relaxation. The lounges will overlook the north quad and main entrance.

OPEN PROJECTS LAB: Stocked with equipment, the Open Project Lab will be a flexible space for students working on non-class projects, like designing parts for the student racing teams. Within close proximity of faculty offices, this lab will provide space for dynamic exploration.

"I HAVE HAD GIRAFFES LOOKING OVER MY SHOULDER WHILE PROGRAMMING A CONTROL BOX IN THE MIDDLE OF A SAVANNAH."
—MARK ANDERSEN

BY JOHN CAPAROON

Mark Andersen (BSEE '87) is manager of the Show Systems Design team in the Scientific Systems division at Walt Disney Parks & Resorts, providing design, development, fabrication, installation, and ongoing systems support for Walt Disney Creative Entertainment, Disney Cruise Line, and Walt Disney Imagineering.

From Officer Friendly to Mickey Mouse—Mark Andersen's engineering career has always been about character.

"The summer in between my junior and senior years [at Illinois], my family and I took a vacation to Walt Disney World. While we were [there] we went on a ride at Epcot, and on the wall at the exit was a quote from Walt Disney, 'If you can dream it, you can do it.' I read that quote and told my parents it was always my dream to come work for Disney, and one day that's what I was going to do," he said.

He was right about that dream. And for the last 27 years, Andersen has been helping to make other people's Disney dreams come true.

From an early age he knew engineering was in his future. "When I was in high school I remember my dad bringing home an HP computer over Christmas break," he said. "The tutorial was 'hosted' by a character called 'Officer Friendly.' I spent most of my break going through it. I always did well in math and science, so when I graduated, engineering seemed like the natural choice for college."

After two years of community college, Andersen enrolled in Engineering at Illinois. His primary focus was digital design, and many of his electives were programming classes.

Anderson said about Illinois, "I'm very grateful. I look back at my time fondly, and I'm proud to say that I'm a graduate from one of the top ranked engineering colleges in the country. I definitely feel that my education prepared me to excel in my career, and I have very fond memories of all of the friends I made and the extracurricular activities I was involved with."

It was also while at Illinois that Andersen began his lifelong career at Disney. During that same family vacation, he got a

"I'M VERY GRATEFUL. I LOOK BACK AT MY TIME FONDLY, AND I'M PROUD TO SAY THAT I'M A GRADUATE FROM ONE OF THE TOP RANKED ENGINEERING COLLEGES IN THE COUNTRY. I DEFINITELY FEEL THAT MY EDUCATION PREPARED ME TO EXCEL IN MY CAREER."
-MARK ANDERSEN

behind-the-scenes look at the central computer room controlling all of Epcot. "The light bulb turned on," he said. "They need engineers to design and program these systems!" Amazingly, he landed an interview while on vacation, leading to a co-op position in Disney's Engineering division the following summer.

"I still remember my first day on the job. My office was located at Epcot and we got a call that Universe of Energy was having problems. As I stepped through the door [of the attraction] I was suddenly surrounded by animatronic dinosaurs – I had been transported instantly into prehistoric times. My summer was filled with adventures like that."

After returning to Illinois for his final semester, Andersen was offered a position with another company – but Disney's magic intervened again. "Before I had a chance to reply to the offer," he said, "my dorm phone rang and it was Disney calling to offer me a full-time job. I accepted, and began my full-time career as an electrical engineer."

'Full time' hardly describes the extent of Andersen's experience and achievement over the course of the next 27 years. In his time at Disney he has played numerous roles, from troubleshooting to design, development, installation, support, system controls, and animatronics for parks and systems around the world. He was lead show controls software engineer for many attractions, lead software engineer during the installation of the Walt Disney World Mark VI monorails, and part of the project management team that installed a huge outdoor LED video display on board Disney Cruise Line. As a program engineer, his portfolio includes Disney's Hollywood Studios, water parks, Downtown Disney, ESPN Wide World of Sports Complex, textile services, and Walt Disney Transportation – and he currently manages a multidisciplinary team of mechanical, electrical, and software and control systems engineers.

In addition to his management position, Andersen is the Design & Engineering spokesperson for Disney's Professional Intern program. "Being able to teach and mentor is one of my passions. There were engineers and leaders that invested in me and helped me throughout my career. I want to be able to do the same."

When asked how he feels about the relationship between his famous workplace and his chosen profession, he spoke with passion:

"Am I an engineer that works at Disney or a Disney Engineer? Without question, I am a Disney Engineer."

There are many reasons behind Anderson's loyalty and sense of identity as a Disney Engineer, one of which is the variety of work environments he has been able to experience.

"I have had giraffes looking over my shoulder while programming a control box in the middle of a savannah. I have been inside an Asian tiger habitat troubleshooting a system that separated hungry tigers from getting to their food. I have stood underneath a cruise ship while it was in dry dock. I have programmed aliens and a giant yeti and systems that teach dolphins to communicate with humans. Every day is something different. It is that variety and uniqueness that makes this job so much fun."

What would he do if he wasn't working for Disney? Anderson can't imagine any other job providing the fulfillment he receives by being a part of the Walt Disney Company.

"What we do is in no way a typical job. I absolutely love what I do. I love the people I work with," he said. "And, if I ever start feeling differently all I have to do is take a walk out into the park and watch the look on the faces of our guests to remind myself that I and my team had a part in making them smile and creating that magical experience for them. We engineer systems that play a part in bringing a creative vision to life, telling stories and creating magical moments that people from around the world come and experience. I can honestly say that in my 27 plus years with Disney, I have never looked for another job. I am truly blessed."

And if that isn't proof that dreams really do come true—we don't know what is.

FIELD REPORT LOOKS AT ECE ALUMNI AND THEIR WORK, SEEKING TO EXPLORE AND ILLUMINATE THE MANY FACETS OF TODAY'S ENGINEERING WORKPLACE, AND THE PART THAT ENGINEERS PLAY IN A VARIETY OF POSITIONS ACROSS MULTIPLE FIELDS.

IF YOU WOULD LIKE TO BE CONSIDERED FOR **FIELD REPORT**, PLEASE SEND AN EMAIL TO: ECE@ILLINOIS.EDU

ILLINOIS LAB TACKLES DIGITAL IMAGERY

BY STEPHANIE HENRY

ADVANCES IN DIGITAL IMAGERY MADE BY ECE RESEARCHERS IN SINGAPORE MAY SOON MAKE A DIFFERENCE IN THE FIELD. THE ILLINI FOOTBALL FIELD, THAT IS.

Researchers at the Advanced Digital Sciences Center (ADSC), a collaboration between the University of Illinois and the Singaporean government, have partnered with the men's football program, and other sports teams, to see if their advances in video tracking when applied to sports analytics can help teams improve game play by studying the enhanced playback video taken during games.

The gridiron is just one application of the center's work. Tracking a suspect on a security camera video or improving traffic flow in a busy subway station are others.

Since its inception in 2009, when Illinois was given the unique opportunity to lead a Singapore-based research center, the ADSC has become what the center's newest director calls a remarkable research lab.

"When we started, the space we are in was just an empty space with a bunch of desks. We've built up from nothing into a world-class lab at this point, in just four years," said the center's director, ECE Professor Douglas Jones.

The center's research is focused in two main areas: interactive digital media (IDM) and the smart grid. IDM projects have included work on enhanced computer vision, information gathering, depth imaging, and video tracking. Smart grid work has focused on information gathering and monitoring, as well as control and security of smart grids.

Jones, who has been on the ADSC faculty since 2010, assumed his position as director on July 1. He said a key part of his role is facilitating the collaboration between Illinois and some of the world's best researchers in Singapore, which he described as a very complementary relationship.

"We are an Illinois research lab with 12-14 faculty coming over twice a year, a few weeks at a time, to provide intellectual leadership for projects. Singapore is interested in the intellectual capital of U of I. That's what is unique about our particular arrangement. U of I faculty are seriously engaged with the center, not just lending our name to an organization," Jones said.

ADSC was established in 2009 and funded through a grant from Singapore's Agency for Science, Technology and Research (A*STAR), a national research lab. The ADSC lab is located in the Fusionopolis research facility in Singapore. Jones said unlike government-based research centers in the United States, A*STAR is not a defense lab, but an industry development lab. If Singapore can attract companies with its forward-thinking research climate and a growing talent pool of engineers, the city can offer a competitive place for large companies to base their operations, he explained.

While economic strategy may come into play for Singapore in funding Illinois researchers, what does the Illinois research center gain from being based in Singapore?

Aside from the funding for the research Illinois is able to conduct through the center, Jones said Singapore offers the perfect setting for testing some of the research, especially in the area of the smart grid, which could not easily be done in Champaign-Urbana. Singapore offers size, growth, and fewer regulatory inconsistencies to contend with, he said.

"WE HAVE SEVERAL PROJECTS INVOLVING VIDEO PROCESSING AND IN MANY WAYS WE ARE A LEADING LAB IN TERMS OF LOOKING AT THIS. IT IS VERY POWERFUL."

—DOUGLAS JONES

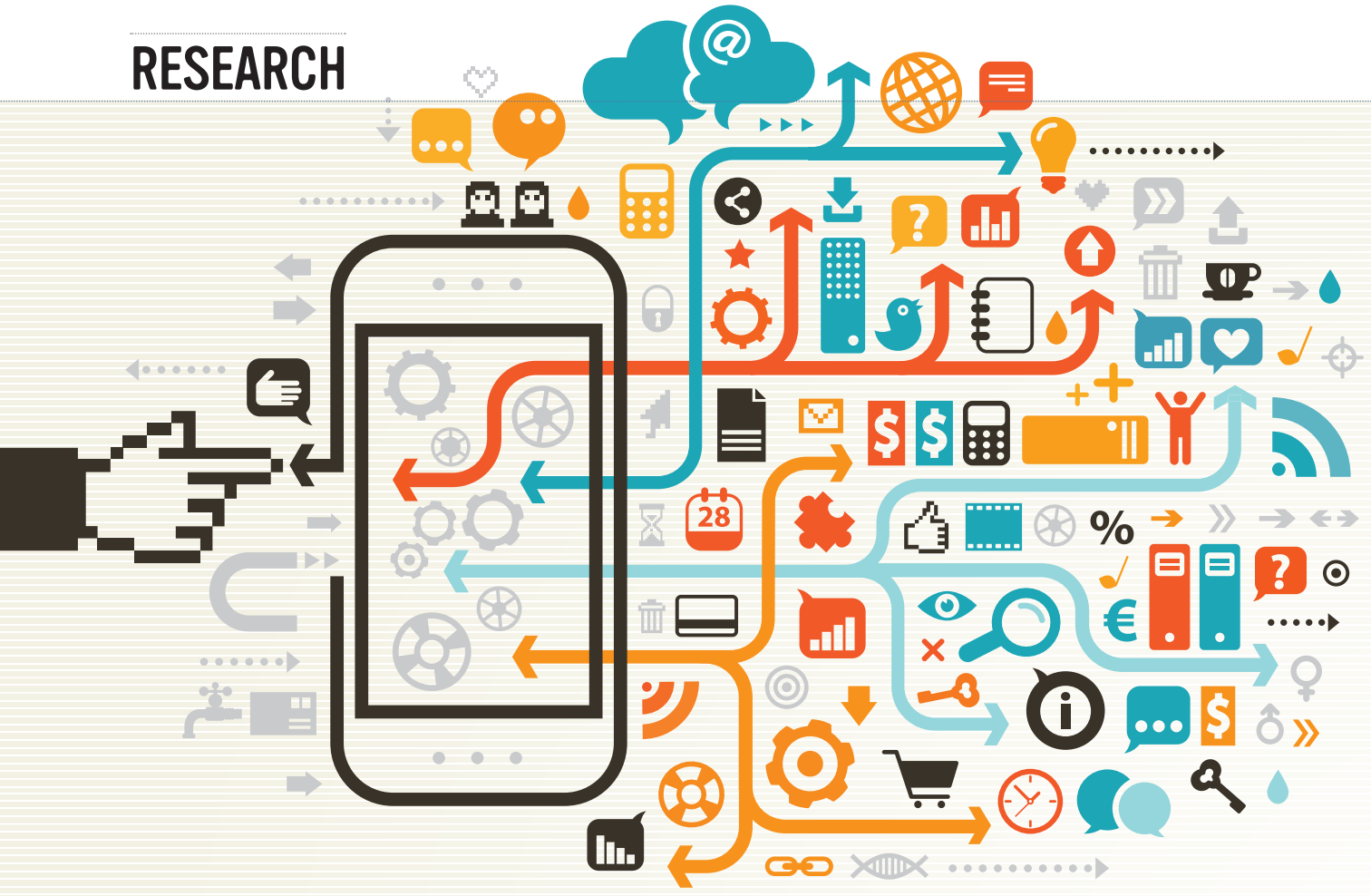
"This city is growing like crazy. By the end of this year more than half of the people in the world will be living in cities (as opposed to outlying areas). U of I is based in a relatively small city, so if we want to do research relevant to Chicago or to the urbanization of the world we need to have a presence in a city of that scale. This is the place to be."

Out of the two major themes of the center—IDM and smart grid—Jones said he sees one of the center's first and largest projects, the human sixth sense project, now moving on to the next phase. As devices are able to collect data, such as video, audio, and location information, Jones said researchers are looking at ways to use all that information for an immediate effect. "We want to give ourselves another sense of what's going on around us in this information-rich world, and take advantage of the ability to collect and use this information," he explained.

Another is what Jones describes as an attempt at a new mode of visual communication. Research in the use of 3-D and other recent advanced cameras, particularly in the area of video cutout, could help to improve the quality of virtual meetings, for example, through improved real-time recognition of people and other entities in a scene and of actions and activities taking place in that scene, using such cameras.

"We want to focus strongly on how we take advantage of this new ability of measuring, and enhance what we can do with video," Jones said. "We have several projects involving video processing and in many ways we are a leading lab in terms of looking at this. It is very powerful."

Original funding allowed for $10 million per year for 5 years. Jones said a sixth-year, no-cost extension was granted, and the two partners are negotiating a further extension of the funding and program.



THE SMALLEST PIECE OF THE PUZZLE

BY STEPHANIE HENRY

With the demand for electronic devices such as cellphones and tablets to offer more functionality, decrease in size and cost, and operate with more energy efficiency, the engineers behind the design of these devices face a number of critical challenges.

One of the biggest problems is found in the smallest piece of the design puzzle—the need for the small transistor switches in these devices to do more, with less power, and to take up less space, a process which outdates itself nearly every 18 months and asks even more of these small, intricate switches.

An ECE Illinois faculty-led research center launched earlier this year is tackling some of the most critical, long-term problems facing the semiconductor industry, focusing on computing systems on nanoscale fabrics. The new Systems On Nanoscale Information fabriCs (SONIC) Center—part of the $194 million Semiconductor Technology Advanced Research network (STARnet) initiative—has set out to design more robust, energy efficient, and functionally dense scaling in devices, as well as intelligent computing platforms to address some of these coming issues.

The researchers are envisioning a transformation of computing from low-level data processing into higher-level information processing, inspired by principles found in communication and biological systems. By processing information as opposed to data, the team hopes to point the way to the design of intelligent, reason-based, decision-making computing platforms.

"All of the STARnet centers, including SONIC, are looking at facets of the larger problem of how we make chips that use less power, are more robust, and that we can pack more functionality into a smaller area," said SONIC director and ECE Professor Naresh Shanbhag.

"SONIC is taking on a particular slice of this problem, and a very unique slice," he said.

The multi-university SONIC Center, with Illinois at the lead, was launched after the core research team was awarded $30 million in funding last October. With STARnet funding provided by the Department of Defense and the Semiconductor Research Corporation (SRC), Shanbhag and the rest of the

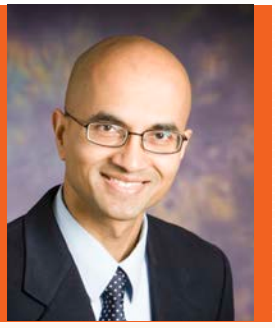
SONIC researchers are charged with looking ahead, 15 years down the road, at the issues the industry will face.

"This program is meant to keep the United States competitive in semiconductor technology, and to educate a new generation of engineers," Shanbhag explained.

Shanbhag, who coincidentally, was invested as the Jack S. Kilby Professor of Electrical and Computer Engineering on the same day he received the news that he and his fellow researchers were awarded the $30 million for the SONIC Center last fall, said that STARnet is part of the newest phase of the Focus Center Research Program (FCRP), which began in the late 1990s. At that time, there was only one FCRP center based at the University of California, Berkeley, but this grew to six centers over the years.

"In one sense SONIC coming to U of I holds a special significance. This program is the first time that we at U of I are leading a STARnet/FCRP center," he said. "There were a number of U of I faculty already participating in the FCRP centers, and it was broadly acknowledged that we were one of the leading contributors to the success of the FCRP research program."

"SONIC continues to build on a long history of circuits and computing research at Illinois," said William Sanders, interim head of ECE. "The transistor, integrated circuit, LED, flat-panel panel display, and the first online-learning system (PLATO), were all invented by ECE faculty or alumni. SONIC researchers are very well positioned to continue that legacy of excellence," he said.



SONIC

Naresh Shanbhag
SONIC director and ECE professor

While many of the participating ECE faculty are based in the Coordinated Science Laboratory, Shanbhag noted that faculty from several laboratories and departments across the college are key members of SONIC. Along with Illinois faculty, SONIC is comprised of 23 faculty investigators from seven participating universities, including Carnegie Mellon University; Princeton University; Stanford University; University of California, Berkeley; University of California, San Diego; University of California, Santa Barbara; and University of Michigan.

Many of SONIC's principal investigators are either current ECE faculty or have strong links to ECE Illinois. Along with Shanbhag, the team includes Andrew Singer, associate director for SONIC; Rakesh Kumar; Pavan Hanumolu; and Eric Pop, formerly of ECE. Upamanyu Madhow (UCSB) and Todd Coleman (UCSD) are also former ECE Illinois faculty. David Blaauw (Michigan) is an Illinois computer science alumnus. John A. Rogers from Materials Science and Engineering and Rob Rutenbar from Computer Science are other Illinois members of the SONIC team.

Together, these researchers recognized a mismatch in how far nanoscale technology has come and how computing methods have failed to meet those advances. "The technology that goes into building those chips has evolved over time, but the very foundations of computing have not changed. What SONIC is doing is questioning this very basis of computing. There must be a foundation for computing better suited for nanoscale technologies that exhibit native intelligence, i.e., computers that can infer context and meaning, achieve cognition and adaptability, by observing and processing locally-sensed data," Shanbhag said.

"When you use voice recognition software on the cell phone today, you need a remote, supercomputer-like setting to process the data and thereby provide an intelligent interface to the user. In SONIC, we are emphasizing a world in which our personal computing devices exhibit native intelligence without relying on a remote platform, and are able to create an intelligent personal cyberspace around the user," he said.

Looking at other disciplines, SONIC researchers believe the area of communications and neuroscience has much to teach about computing on nanoscale devices. "Communications provides a huge body of knowledge that teaches how to communicate with energy efficiency across a noisy communication channel, with the foundations of that technology established in 1948 by Claude Shannon. Shannon's work never really impacted computing, but it revolutionized communications. It is why smart phones and the internet exist in the first place.

"We believe that these new foundations will reduce energy, enhance robustness, and thereby bring intelligence from the data center onto our personal devices. That's what SONIC is about," Shanbhag said.

Visit SONIC's website at www.sonic-center.org to learn more about the team and research.

ASSAYING THE IONOSPHERE

BY JONATHAN DAMERY

Early last May, a team of researchers shot two sounding rockets from an atoll in the South Pacific. The rockets ascended into the ionosphere, one to 120 miles above ground level and the other to 220. During the ascent, sensors were deployed, readings were telemetered, and then, within nine minutes, each of the rockets fell safely into the ocean waters below. A balmy evening at ground level, with a light breeze blowing through the palm trees, in the ionosphere a storm was brewing, and the project aimed to unlock the secret of monitoring—even forecasting—this atmospheric weather.

That evening, ECE Professor Erhan Kudeki, the primary investigator on the NASA-funded Equatorial Vortex Experiment (EVEX), was stationed on the island of Roi-Namur, in the Kwajalein Atoll of the Marshall Islands. This was the site of the launch, and it was also where IRIS, a radar that he developed with ECE Professor Steven Franke, was monitoring the ionospheric weather. (IRIS is short for Illinois Radar Interferometer System.) A second radar, ALTAIR, was making simultaneous observations. With two rockets in the air and two radars on the ground, the team could gather data on the whole ionospheric system, enabling scientific investigations of the relationships between the winds and ion concentrations in separate layers of the ionosphere.

During the daytime, the ionosphere—the atmospheric layer beginning at about 35 miles above ground—tends toward quiescence. Satellite signals, such as those used for global positioning systems, pass unimpeded through the electrons and ions that compose the upper atmosphere, but a few hours after sunset, intense storms may erupt at altitudes between 120 and 240 miles, in the so-called F-region of the ionosphere. At those times, satellite signals are disrupted and can exhibit rapid fluctuations in amplitude. Dropouts in communication links result, and the locations derived from global positioning systems may become largely inaccurate.

"There is a lot of interest in trying to understand when this happens," Kudeki said. "It doesn't happen every sunset. Some days it happens. Some days it doesn't happen. But even more profound, as we are finding out, it always happens somewhere."

By launching two rockets into separate layers of the ionosphere, and timing the launches 90 seconds apart so that each rocket reached its apogee at the same moment, the researchers were testing whether turbulence in the lower E-region of the ionosphere (up to 60 miles above ground) could portend the larger storm formations in the F-region several hours later.

The rockets were equipped with sensors capable of taking electric field and electron density measurements, and as the rockets attained their maximum altitude, chemical trails were released, which emitted bright white or red glows, visible to researchers at ground level. The red was a trail of lithium, released by the upper rocket, and the lower rocket released the white: trimethyl aluminum, or TMA. The TMA turns into naturally occurring atmospheric compounds when exposed to air—aluminum oxide, carbon dioxide, and water vapor—and by tracking the movement of these clouds from disparate observation stations, the researchers were able to calculate the speed and direction of winds in the ionosphere.

These ionospheric winds are comprised of uncharged particles, and they are believed to play an important role in establishing the requisite conditions for ionospheric turbulence. The only effective way of determining their movement, however, because they are uncharged, is with the TMA and lithium streams. "Winds have nothing to do with the electric fields, because...winds are driven by thermal differential effects and so forth, just like the winds near the surface," Kudeki said.

Meanwhile, the two radars were used to monitor ionospheric turbulence. Almost two months prior to the launch, Kudeki and graduate student Pablo Reyes flew to Roi-Namur and unpacked and installed IRIS, which had been shipped from Urbana. Two collaborators from Penn State joined, including ECE alumnus Julio Urbina (MSEE '96, PhD '02). IRIS was designed specifically for the EVEX project and consists of long dipole

The ALTAIR radar

(Left to right) Erhan Kudeki, Pablo Reyes, and other members of the EVEX team standing with one of two sounding rockets

strings that are run parallel to the ground in two arrays, each 50 meters long. (Old television "bunny ears" are very simple dipole antennae.) It covers approximately the same area as an American football field.

Throughout the weeks leading up to the launch, IRIS monitored the daily ionospheric weather patterns before and after sunset, in both the E and F regions. With these patterns established, the researchers were able to time the launch according to the requisite low-altitude turbulence that was thought to presage the development of a strong storm in the upper regions of the ionosphere. The readings are shown in color on computer software designed for the radar, and resemble the weather map that might show an approaching thunderstorm on the evening news.

The ALTAIR radar, which was also used during the launch, is permanently located on Roi-Namur. Originally designed in the 1960s for tracking missiles, the radar is now used almost exclusively for tracking satellites and other space objects. "We find ourselves very lucky to be able to use ALTAIR [for research]," Kudeki said. At 150-feet in diameter, the dish towers above the surrounding palm trees, and its resolution of the weather patterns is unparalleled.

The researchers continued to collect IRIS data for another week after the launch, establishing context for what was observed during the nine minutes of airtime. "We were there with the IRIS system for two months, and we took data day after day after day," Kudeki said. "What we observed was very consistent with the theory that we were trying to verify. We did not find any disagreement. There was no contradiction on any of the days."

In fact, the experiment confirmed the correlation between the turbulence in the lower E-region and the subsequent storms in the F-region. Accordingly, systems like IRIS could be used to detect the lower turbulence and provide a one-to-two hour advance warning of severe formations to come. This forecast will be especially important as aircraft depend increasingly upon satellites for autonomous navigation—even at critical landing moments, where precise locations are imperative—and as driverless cars may someday zip along our roadways.

Yet, another aspect of this experiment is purely scientific: understanding the dynamics of the ionosphere. "You sometimes just do science for the sake of itself…but that invariably becomes very useful in generating very practical things down the way," said Kudeki. "You don't even necessarily know what it's going to be, but the more you know, the more opportunities arise."

The EVEX team, which includes researchers from Clemson University and the NASA Goddard Space Flight Center in addition to Illinois and Penn State, plans to build on this research with a repeat trip to Roi-Namur in the next several years: another launch, another tropical evening, and an even greater understanding of the space overhead.

PHD GRADUATES

The following 41 students completed work on their PhD degrees in December 2012 and May 2013. ECE ILLINOIS congratulates each of them for this incredible accomplishment.

GRADUATED DECEMBER 2012

Student *Company + Title*	Adviser	Thesis Title
Vineet Abhishek *Adchemy : Research Scientist*	Hajek, Bruce	Revenue Considerations in Market Design
Mert Bay *MarketShare : Scientist, Simulation/Optimization*	Beauchamp, James	Methods for Multiple Pitch Tracking and Instrument Separation from Monaural Polyphonic Recordings
Vikram Chaudhery *Krayons Marketing Pvt. Ltd : Co-Founder and Director*	Cunningham, Brian	Next Generation Instrumentation for Photonic Crystal Biosensors: A Passage to Early Detection of Cancer
Joon Hyung Chung *Qualcomm : Senior Power Integrity Engineer*	Cangellaris, Andreas	Efficient and Physically Consistent Electromagnetic Macromodeling of High-Speed Interconnects Exhibiting Geometric Uncertainties
Michael Daly *SPAWAR : Engineer*	Bernhard, Jennifer	Physical Layer Encryption Using Fixed and Reconfigurable Antennas
Sairaj Dhople *University of Minnesota : Assistant Professor*	Dominguez-Garcia, Alejandro	Renewable Electric Power Systems Energy Yield and Performance Estimation
Sudipta Dutta *University of Illinois : Postdoctoral Research Associate*	Overbye, Thomas	Data Mining and Graph Theory Focused Solutions to Smart Grid Challenges
Douglas Eskins *Nuclear Regulatory Commission : Digital Instrumentation and Controls Engineer*	Sanders, William	Modeling Human Decision Points in Complex Systems
Reza Farivar *University of Illinois : Postdoctoral Research Associate*	Campbell, Roy	Adaptation of the Mapreduce Programming Framework to Compute-Intensive Data-Analytics Kernels
Adam Faust *Intel Corporation : Analog/Mixed-Signal Circuit Designer*	Rosenbaum, Elyse	Analog and Mixed-Signal Circuitry for System-Assisted High-Speed I/O Links
Benedikt Graf *NinePoint Medical : Systems Engineer*	Boppart, Stephen	Multimodal Intravital Imaging of Tissue Structure and Cell Dynamics in Skin Using Integrated Optical Coherence and Multiphoton Microscopy
Dayu Huang *GE Global Research : Engineer*	Meyn, Sean	Hypothesis Testing and Learning with Small Samples
Sreeram Kannan *University of California at Berkely : Postdoctoral Research Associate*	Viswanath, Pramod	Layering Principles for Wireless Networks
Albert Liao *MIT : Postdoctoral Associate*	Pop, Eric	Probing the Upper Limits of Current Flow in One-Dimensional Carbon Conductors
Qiang Ma *Synopsys : Senior R&D Engineer*	Wong, Martin	Routing Algorithms for Electronic Design Automation
Myra Nam *MIT Lincoln Laboratory : Technical Staff*	Ahuja, Narendra	Automated Image Sharpening Via Supervised Learning with Human Preferences
Matias Negrete-Pincetic *Pontificia Universidad Católica de Chile : Profesor Asistente*	Meyn, Sean	Intelligence by Design in an Entropic Power Grid
Alexandros Papakonstantinou *NVIDIA : GPU Architect*	Chen, Deming	High-Level Automation of Custom Hardware Design for High-Performance Computing
Shen-Fu Tsai *Microsoft : Software Development Engineer*	Huang, Thomas	Toward Ontological Visual Understanding

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Student *Company + Title*	Adviser	Thesis Title
Ryan Dowdy *Northrop Grumman : Electronics Engineer*	Li, Xiuling	Planar GaAs Nanowire Arrays for Nanoelectronics: Controlled Growth, Doping, Characterization, and Devices
David Estrada *Boise State University : Assistant Professor*	Pop, Eric	Reliability, Power Dissipation, Sensing, and Thermal Transport in Carbon Nanomaterials And Devices
Chun Ge *HGST : Research Staff Member*	Cunningham, Brian	External Cavity Laser Label-Free Biosensor
Benjamin Griffin *University of Illinois : Postdoctoral Research Associate*	Goddard, Lynford	Design and Characterization of Semiconductor Laser Structures for Hydrogen Sensing Applications
Farzad Hassanzadeh *California Institute of Technology : Postdoctoral Scholar*	Milenkovic, Olgica	Distances on Rankings: From Social Choice to Flash Memories
Kevin He *Intel Corporation : PTD Module Engineer*	Lyding, Joseph	Characterization of Graphene-Substrate Interactions Using Scanning Tunneling Microscopy
Brian Johnson *National Renewable Energy Laboratory : Solar Energy Researcher*	Krein, Philip	Control, Analysis, and Design of Distributed Inverter Systems
Daniel Johnson *NVIDIA : Research Scientist*	Patel, Sanjay	Multithreaded Architectures for Manycore Throughput Processors
Young Mo Kang *Samsung Electronics : Senior Engineer*	Goddard, Lynford	Inline Microring Reflector for Photonic Applications
Soomin Lee *University of Illinois : Postdoctoral Research Associate*	Nedich, Angelia	Optimization Over Networks: Efficient Algorithms and Analysis
Zhen Li *Google : Software Engineer*	Huang, Thomas	Generative and Discriminative Models for Person Verification and Efficient Search
Liang Pang *Lam Research : Process Engineer*	Kim, Kyekyoon	Development of High-Performance Gan-Based Power Transistors
Xianbiao Shu *Qualcomm : Senior System Engineer*	Ahuja, Narendra	Advanced Imaging Via Multiplexed Sensing and Compressive Sensing
John Stratton *MulticoreWare, Inc. : Senior Architect*	Hwu, Wen-Mei	Performance Portability of Parallel Kernels on Shared-Memory Systems
I-Jui Sung *MulticoreWare, Inc. : Solution Architect*	Hwu, Wen-Mei	Data Layout Transformation through In-Place Transposition
Meng Peun Tan *Intel Corporation : Module & Integration Yield Engineer*	Choquette, Kent	Modulation Approaches of Vertical-Cavity Surface-Emitting Lasers with Mode Control
Usman Tariq *University of Illinois : Research Assistant*	Huang, Thomas	Image-Based Facial Expression Recognition
Carlo Van Niekerk *Sonos, Inc. : Senior Antenna Engineer*	Bernhard, Jennifer	Analysis and Design of Compact Low Profile Antennas for Fixed Volume Applications
Gui Wang *EDF Trading : Nodal Power Trader*	Meyn, Sean	Design and Operation of Electricity Markets: Dynamics, Uncertainty, Pricing and Competition
Hsin-Yu Wu *University of Illinois : Graduate Research Assistant*	Cunningham, Brian	Study and Development of Plasmonic Biosensors for Biomedical Applications
Jingjin Yu *National University of Singapore : Research Fellow*	Liberzon, Daniel	Combinatorial Structures and Filter Design in Information Spaces
Zihan Zhou *MIT CSAIL : Research Associate*	Ma, Yi	Exploring Structural Regularities for Robust 3D Reconstruction of Urban Scenes

TEN ANSWERS

Elaine Chapin (MSEE '92, PhD '96) is Radar Systems Integration and Test Engineer at NASA's Jet Propulsion Laboratory, Pasadena, CA. Chapin's work has focused on radar interferometry, ionospheric impacts on low frequency radar, and SAR calibration. She was the integration and test lead for the radar used to land NASA's Curiosity rover on Mars.

ELAINE CHAPIN

ELAINE CHAPIN WITH CURIOSITY

FAVORITE ECE CLASS?
I enjoyed ECE 358 "Wave Propagation" taught by K. C. Yeh. It was the first of many classes I took on that subject and the first to mention the ionosphere.

HOW WOULD YOUR CLASSMATES REMEMBER YOU?
As the girl who organized the water slide trips. Several summers I rented the water slide in Champaign for an evening and would split the cost with whichever friends and friends of friends showed up. Lots of ECE graduate students would show up.

WHAT WAS THE HAPPIEST MOMENT?
The day that we delivered the landing radar for the Curiosity rover to be integrated to the Mars Science Laboratory spacecraft. Because of difficulties scheduling an x-ray of the radar's connectors, delivery day also happened to fall on my birthday.

WHAT CHORE DO YOU ABSOLUTELY HATE DOING?
The chore that I always push off on Mike Fitzsimmons (BSEE '83, MSEE '85) is catching rattlesnakes in the garage. Because our black cat, Dark Matter, will attack any snake he finds, Mike catches them, and then animal control relocates them.

WHAT FRIGHTENS YOU?
Snakes. Especially rattlesnakes. The bear eating our garbage, the bobcats in our back yard, the tarantula climbing our window, the scorpion in the sink, etc., were all less frightening visitors to our home. Yes, our home is really only 11 miles from Los Angeles.

WHERE WOULD YOU LIKE TO VISIT?
The Southwest, including the Grand Canyon, Bryce, and Zion National Parks.

GLASS HALF-EMPTY OR HALF-FULL?
I am the smiling, cheerful, enthusiastic, optimistic, half-full type.

ARE YOU A MORNING OR NIGHT PERSON?
Definitely morning. I still remember how awful I felt watching the foggy sunrises after midnight-to-dawn shifts at the Jicamarca Radio Observatory on data collection trips during graduate school.

NINJAS OR PIRATES?
Pirates. I have been boating all my life and was secretary of the U of I Sailing Club. I currently own two dinghies and one canoe.

IF YOU HAD ONLY ONE PROJECT FOR THE NEXT YEAR, WHAT WOULD IT BE?
A long wavelength radar to penetrate through the icy shell of Europa down to its ocean -- one of the most probable locations to find extraterrestrial life. Both NASA and European Space Agnecy (ESA) are planning missions to the Jovian moons. The high radiation levels at Jupiter and the constraints on the radar's size, weight, and power make it very challenging.

TEN ANSWERS PROFILES AN ALUMNUS EACH ISSUE ASKING THE IMPORTANT QUESTIONS. DO YOU HAVE ANSWERS? EMAIL US AT ECE@ILLINOIS.EDU AND WE MAY FEATURE YOU IN A FUTURE ISSUE.

ASSEMBLY HALL RENAMED STATE FARM CENTER

Thanks to a $60 million donation, the Assembly Hall has been renamed State Farm Center. The money will help with a massive renovation of the stadium. Improvements include expanded student seating and the addition of air conditioning, club spaces, and exhibit areas.

State Farm and the U of I have enjoyed a long relationship, which includes the State Farm Research and Development Center at the Research Park on campus. Assembly Hall was the working title of the building for 50 years. The first major phase of State Farm Center's modernization is expected to begin in March 2014; and the final phase is scheduled to be completed in time for the 2016-17 basketball season.

NCSA

Inc.

ENTERPRISEWORKS RECOGNIZED

Inc. magazine has recognized EnterpriseWorks as one of three college-town incubators to watch. The incubator is specifically praised for its entrepreneur counseling and support. EnterpriseWorks is the technology business incubator at the U of I Research Park. It has nurtured 145 businesses in biotechnology, chemical sciences, software development, sustainability, and materials sciences. EnterpriseWorks start-ups have raised $550 million in outside capital. This is the second time *Inc.* has recognized EnterpriseWorks; the incubator was named one of *Inc.'s* 10 Start-up Incubators to Watch in the US in 2011.

VISIONING FUTURE EXCELLENCE INITIATIVE

Last fall, Chancellor Phyllis Wise began the "Visioning Future Excellence" process. Nearly 3,000 faculty, students, staff, and alumni were asked to consider society's most pressing challenges in the decades to come and how the university can address those issues. The initiative produced six major themes of importance: Economic Development, Education, Energy and the Environment, Social Equality and Cultural Understanding, Health and Wellness, and Information and Technology. The university will implement a broad range of initiatives to improve these areas, including improving faculty strength and creating the Institute of Sustainability, Energy, and the Environment (ISEE). The initiative will focus on addressing societal challenges and positioning Illinois for success for the next 20-50 years.

APPLIED RESEARCH INSTITUTE ESTABLISHED

Located at the Illinois Research Park, the Applied Research Institute (ARI) has been established to increase the impact of the knowledge generated by Illinois faculty and students. Made up of a growing team of scientists, engineers, and other experts, ARI will partner with companies and federal agencies to conduct translational research and develop products and processes for the marketplace. The institute is part of the College of Engineering and will focus on applied projects in a broad range of disciplines.

SEIDEL TO BE NEXT LEADER OF NCSA

H. Edward Seidel, the senior vice president of research and innovation at the Skolkovo Institute of Science and Technology in Moscow, has been named the director of the National Center for Supercomputing Applications at Illinois. Seidel was one of the original co-principal investigators on the Blue Waters supercomputing project at Illinois. He led NCSA's numerical relativity group from 1991 to 1996. Seidel will succeed Thom Dunning, who has led NCSA for eight years and announced his retirement from the center last year. Seidel is expected to assume his role as NCSA director on January 15.

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Look inside the new ECE building.

View the video at **ece.illinois.edu/buildingcampaign** and get a virtual tour of the new building currently under construction on the north end of campus. Along the way you'll learn more about the building's groundbreaking approach to energy efficiency and glimpse key interior spaces. Scheduled to open in Fall 2014, this world-class facility will provide coming generations of ECE students and faculty the tools they need to imagine, to build, and to lead.

Log on to follow our progress through the building blog and webcam.

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