RESONANCE

THE MAGAZINE OF ECE ILLINOIS

SPRING 2016

CHICAGO STRONG

ECE ALUMS LEADING CHICAGO TECH SCENE

ILLINOIS

TOP OF MIND

In a world driven by technology and computing, industry demand for highly skilled engineers is ever-increasing. Students, alumni, and corporate recruiters tell us a master's degree is more important than ever for career advancement within industry. So too is the call for teaching those engineers in a way that's innovative and meets the needs of industry. ECE ILLINOIS' new master of engineering degree responds to both those demands.

We created this new professional degree, also known as the MEng, last fall and welcomed our first group of students this spring. The MEng is designed to provide students the strong foundational knowledge our department is known for, while providing the practical knowledge that will help professionals succeed.

ECE ILLINOIS is known for its faculty members who are leaders in their fields, its strong foundation in science and laboratory-based work, and its high national and international ranking. This degree will allow students focused on a career in industry to earn a master's degree in such an environment. The experience is certain to better equip them for the rest of their careers. This rigorous degree, which is highly flexible, replaces a master's thesis with required credits in professional development.

We believe the MEng will provide incredible value for our students, especially because we're additionally offering it in tandem with a bachelor of science degree. This program will allow students a seamless and efficient transition from undergraduate to graduate studies. We expect this option to become a draw for both our current students and those considering applying to ECE ILLINOIS.

We're proud to be offering the new MEng and I look forward to watching the program grow and contribute to the success of those who earn it. It's an innovative step for our department, and a strong offering for those who wish to study here. We're accepting applications for fall 2016 enrollment through July 1.

For more information about the new MEng, please read the news story on page 23.

Sincerely,

[signature]

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

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"Chicago is a rising star," said Joseph Beatty, who has been working in Chicago for 30 years. "So many engineers come out of Illinois, and so many stay in the Chicago area. That helps to explain why we've taken off as a tech startup area in the last five to 10 years."

JOSEPH BEATTY (BSEE '85)

HALL OF FAME INDUCTIONS: KUCK AND EBERHARD

Engineering at Illinois inducted five new members into its Hall of Fame last fall. Those honored included Martin F. Eberhard (BSCompE '82, MS '84), the "battery guru" of the electric automobile industry and co-founder of Tesla Motors. Also inducted was David J. Kuck, a professor of both computer science and electrical and computer engineering from 1965 to 1993. The college's Hall of Fame ceremony was a part of Impact Day, a celebration of Engineering at Illinois' past, present, and future impact.

PROFESSORS RETIRING

Professors Kanti Jain and Philip T. Krein retired from teaching at ECE ILLINOIS last summer after long, fruitful careers in the department. Jain and Krein had immensely successful research careers. Jain holds 70 patents and he's made a variety of contributions within the fields of microelectronics and optics, including the invention of laser lithography, which is used worldwide in the production of computer microchips. Krein published an undergraduate textbook, *Elements of Power Electronics*, and holds 31 U.S. patents and his research interests address power electronics, machines, and electric transportation, with emphasis on nonlinear control and distributed systems.

REINHARD: SIEBEL ENERGY SCHOLAR

Graduate student Karl Reinhard has been named a 2016 Siebel Scholar, and he's a member of the first class that includes students in energy science. His research focuses on using synchrophasor data to measure the power grid's operating state in near-real time. The Siebel Scholars program recognizes exceptional students at the world's leading graduate schools of business, computer science, and bioengineering.

» GO.ECE.ILLINOIS.EDU/REINHARD

LAUNCH
BEYOND∧

A slate of alumni and friends spoke at LAUNCH Beyond, the final celebration of ECE ILLINOIS' LAUNCH series. The event celebrated the future of electrical and computer engineering.

Visit us online to see a full list of speakers.

» GO.ECE.ILLINOIS.EDU/LAUNCHBEYOND

POWER OPTIMIZATION FOR ELECTRO-THERMAL SYSTEMS (POETS)

NSF President France Cordova visited the Illinois campus to celebrate the opening of the Power Optimization for Electro-Thermal Systems (P.O.E.T.S.) in October.

The National Science Foundation created the new $18.5 million research center to address the thermal and electrical challenges surrounding mobile electronics. ECE faculty members Philip Krein, Joseph Lyding, and Robert Pilawa-Podgurski's research will be funded through the center.

» POETS-ERC.ORG

IN MEMORIAM

PAUL W. KLOCK

Professor Paul W. Klock (MS '58, PhD '63) was born in St. Louis, Missouri, on July 18, 1931, and died Aug. 12, 2015, in Urbana. He played a key role in positioning ECE ILLINOIS as a premier institution for the teaching of high-speed and microwave measurement. His work on the theory of reflectometers helped establish rigor and accuracy in high-performance instrument calibration methods.

UPDATE ON EVERITT LABORATORY

As ECE ILLINOIS moved to its new building during the summer of 2014, Illinois' Department of Bioengineering made plans to rejuvenate Everitt Lab.

The next chapter in the building's history began with interior demolition in January 2016. After a 32-month renovation, Everitt will become Bioengineering's home in 2018. When it's complete, Everitt will feature a new Jump Simulation Center, supported by a recent $10 mil-lion contribution from Jump Trading, a Chicago-based financial technology firm. A "crown jewel" for the campus, the medical education simulation center will provide students with hands-on training. The center will allow Engineering at Illinois to be a driving force in the new Carle Illinois College of Medicine.

Engineering at Illinois will host an Everitt Groundbreaking Reception on Thursday, May 5.

» EVERITT.ILLINOIS.EDU

YOU'RE INVITED

Join us for the ECE ILLINOIS Student Awards Banquet. It's Friday, April 22 at the I Hotel and Conference Center in Champaign. To register, please visit us online.

» GO.ECE.ILLINOIS.EDU/STUDENTAWARDSBANQUET

ALUMNI VISIT FOR COMMENCEMENT

Several ECE ILLINOIS alumni returned to campus for May 2015 commencement festivities. They included National Academy of Sciences President Ralph Cice-rone (MS '67, PhD '70), pictured at left, who accepted an honorary doctorate. Professor Emeritus and Draper-Prize winner Nick Holonyak Jr. (BSEE '50, MS '51, PHD '54) received the University of Illinois' Alumni Achievement Award; Lab126 President Gregg Zehr (BSEE '76, MS '77) addressed hundreds of graduates at Engineering at Illinois' commencement ceremonies; and George Nelms (BSEE '62) picked up the diploma he earned more than 50 years ago.

ECE ILLINOIS WINS

TWO MAJOR CYBER RESILIENCY GRANTS

ECE ILLINOIS received two major grants related to cyber resiliency and infrastructure last fall.

The Department of Energy selected Illinois to lead the $28.1 million initiative to develop cyber resilient energy delivery systems. The Department Homeland Security awarded another $20 million for the Critical Infrastructure Resilience Center of Excellence. Professor David M. Nicol, director of the Information Trust Institute, is leading both initiatives.

THREE JOIN ECE FACULTY

SUMA P. BHAT

Suma P. Bhat (PhD '10) joined ECE ILLINOIS as a research faculty member in May 2015. Her research expertise is in natural language processing and human-computer interaction.

YUTING CHEN

Yuting Chen (BSEE '07) joined ECE ILLINOIS faculty as a lecturer after working at IBM Systems Group in zSystems Firmware Development.
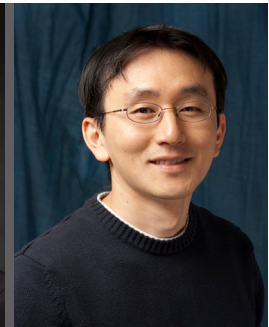
NAM SUNG KIM

Nam Sung Kim joined ECE ILLINOIS as a tenure-track faculty member after working most recently at the University of Wisconsin-Madison. His interdisciplinary research incorporates devices, circuits, and architecture for power-efficient computing.

ALUMNI HONORED

Each year, ECE ILLINOIS honors several eminent alums for a wide variety of career achievements. These winners were honored in September.
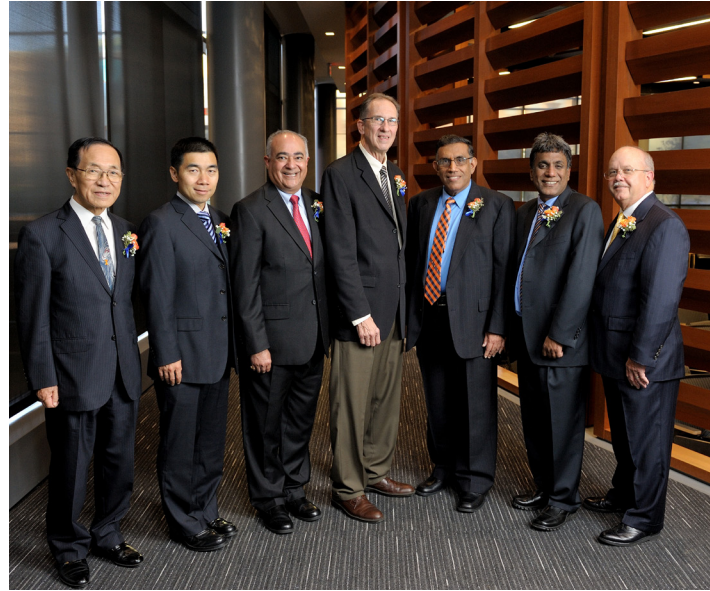
Left to right: Matsushita, Lu, Saksena, Coleman, Varshney, Srivastava, and Lindstrom.

DISTINGUISHED ALUMNI AWARD

This award honors alumni who have made professional and technical contributions that bring distinction to themselves, the department, and the university.

JAMES J. COLEMAN
BSEE '72, MS '73, PhD '75
Professor of Electrical Engineering
University of Texas at Dallas; Dallas, Texas
For research accomplishments in the field of compound semiconductor crystal growth, teaching, and service.

SHIGENORI MATSUSHITA
MS '63
Director of the Board
DDS, Inc.; Tokyo, Japan
For contributions to the technological foundations of digital industries and business leadership, including the development of relations between companies in the U.S. and Japan.

VIKRAM SAKSENA
MS '80, PhD '82
CTO and VP of Engineering
Netscout Systems; Westford, Massachusetts
For leadership in business and technology strategy in the telecommunications industry.

SANJAY SRIVASTAVA
MS '87
Chairman and CEO
Vocareum, Inc.; San Jose, California
For leadership in semiconductor intellectual property solutions and electronic design automation for IC design.

PRAMOD VARSHNEY
BSEE '72, MS '74, PhD '76
Distinguished Professor and Director of the Center for Advanced Systems and Engineering
Syracuse University; Syracuse, New York
For his contributions to the science of information fusion, as a pioneering researcher and distinguished educator.

ECE ALUMNI AWARDS: MAKE YOUR NOMINATIONS ONLINE

Know an alumnus or alumna deserving of the ECE Distinguished Alumni Award, the Young Alumni Achievement Award, or the Marcia Peterman Award for service to the department? Make your nominations online. Questions?

» Contact Audrey LeGrande: alegrand@illinois.edu   » go.ece.illinois.edu/alumniawards

MARCIA PETERMAN ECE AWARD
Presented annually to an alumna or alumnus for dedicated service to the department.

YOUNG ALUMNI ACHIEVEMENT AWARD
Given to alumni younger than 40 who have made outstanding professional contributions to their fields since graduation.

RICHARD LINDSTROM
BSEE '76
Vice President of Engineering
ViaSat, Inc.; Middletown, Maryland
In recognition of devoted and loyal service to the University of Illinois, especially ECE ILLINOIS.

YUE LU
Assistant Professor
Harvard John A. Paulson School of Engineering; Cambridge, Massachusetts
For fundamental contributions to representation, sampling, and inference for high-dimensional data, with broad applications in sensing, communications, and imaging.

LITTLE BOX CHALLENGE

A team of ECE ILLINOIS power electronics students, led by Assistant Professor Robert Pilawa-Podgurski, has been chosen as one of 18 finalists the Google and IEEE Power Electronics Society's Little Box Challenge. The charge: to create an innovative design to make inverters at least the size of a tablet. Currently, an inverter is the size of a cooler. Pilawa's team created its prototype on a shoestring budget, and its members contributed while also working on their primary research projects.
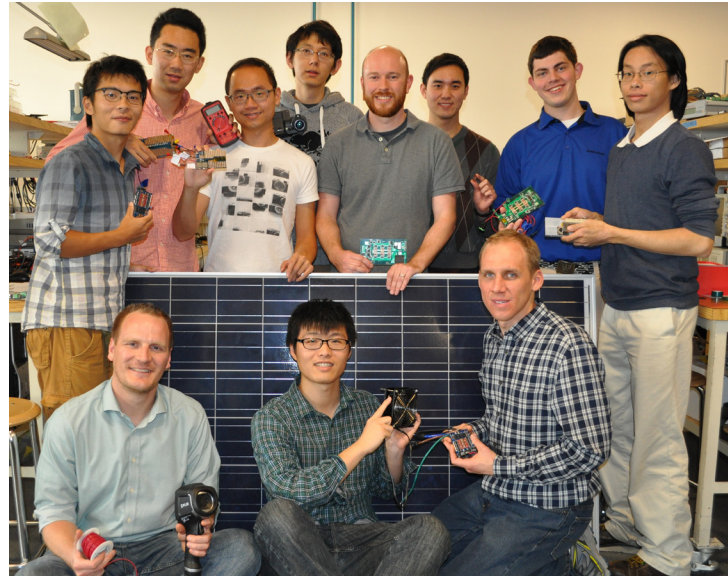
NEARING HONORED

The Marching Illini and the band's director, Barry Houser, honored Fred Nearing (BSEE '43) at Homecoming in October.

Band members recognized him with a cape in honor of his dedication and service to the group since participating in Illinois' bands during his time on campus.

>> go.ece.illinois.edu/nearing
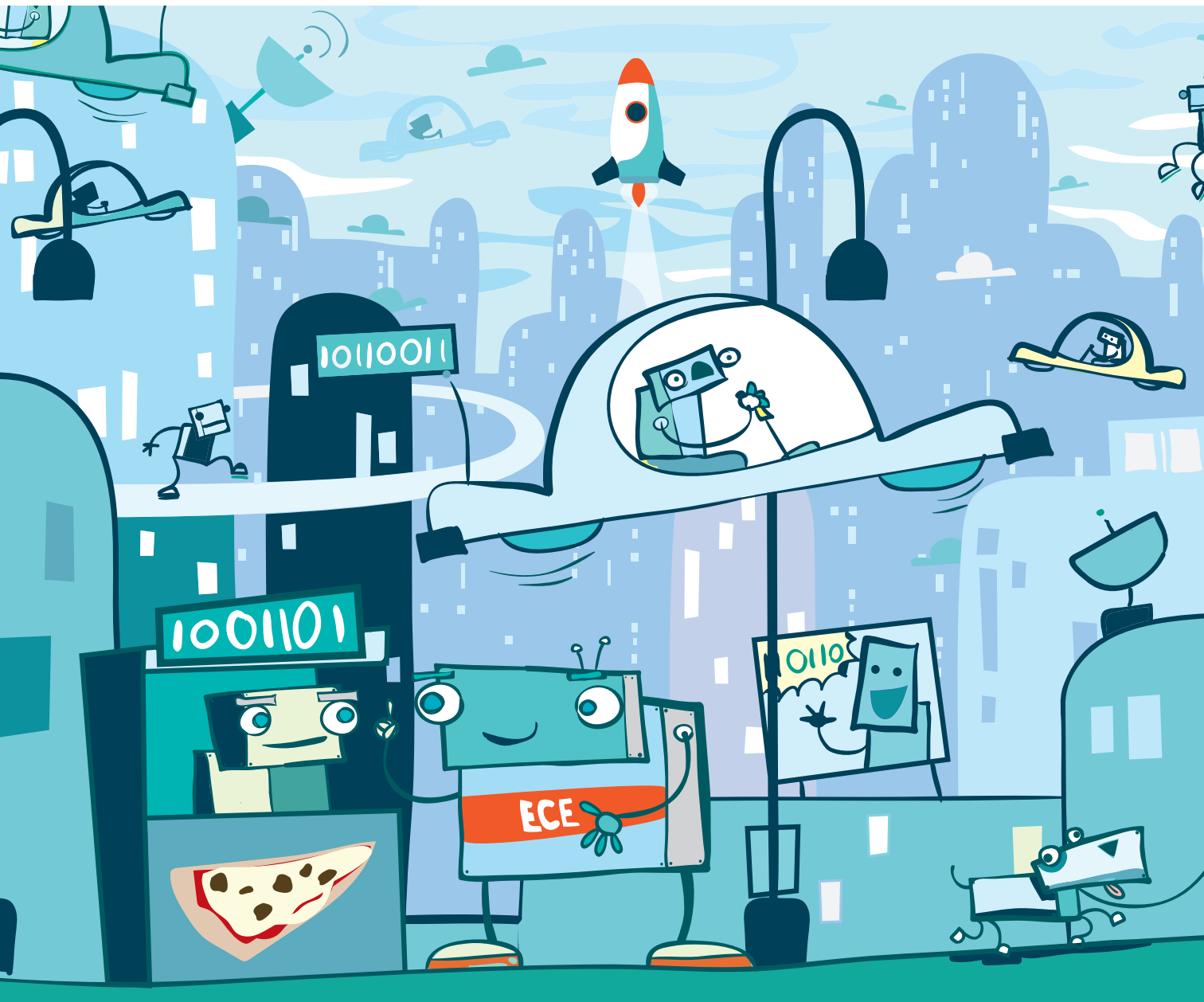
CHICAGO STRONG:
ECE ALUMS LEAD THE SURGE IN THE WINDY CITY TECH WORLD

BY DOUG PETERSON

THE SECOND CITY IS SECOND-TO-NONE WHEN IT COMES TO CHICAGO-STYLE PIZZA, FAMOUS AROUND THE WORLD. SO IT'S ONLY FITTING THAT AN INNOVATIVE NEW MOBILE COMMERCE WEBSITE, PIZZA MOGUL, EMERGED FROM A COLLABORATION BETWEEN A CHICAGO-BASED SOFTWARE DEVELOPMENT COMPANY CALLED THOUGHTWORKS AND DOMINO'S PIZZA ENTERPRISES AUSTRALIA.
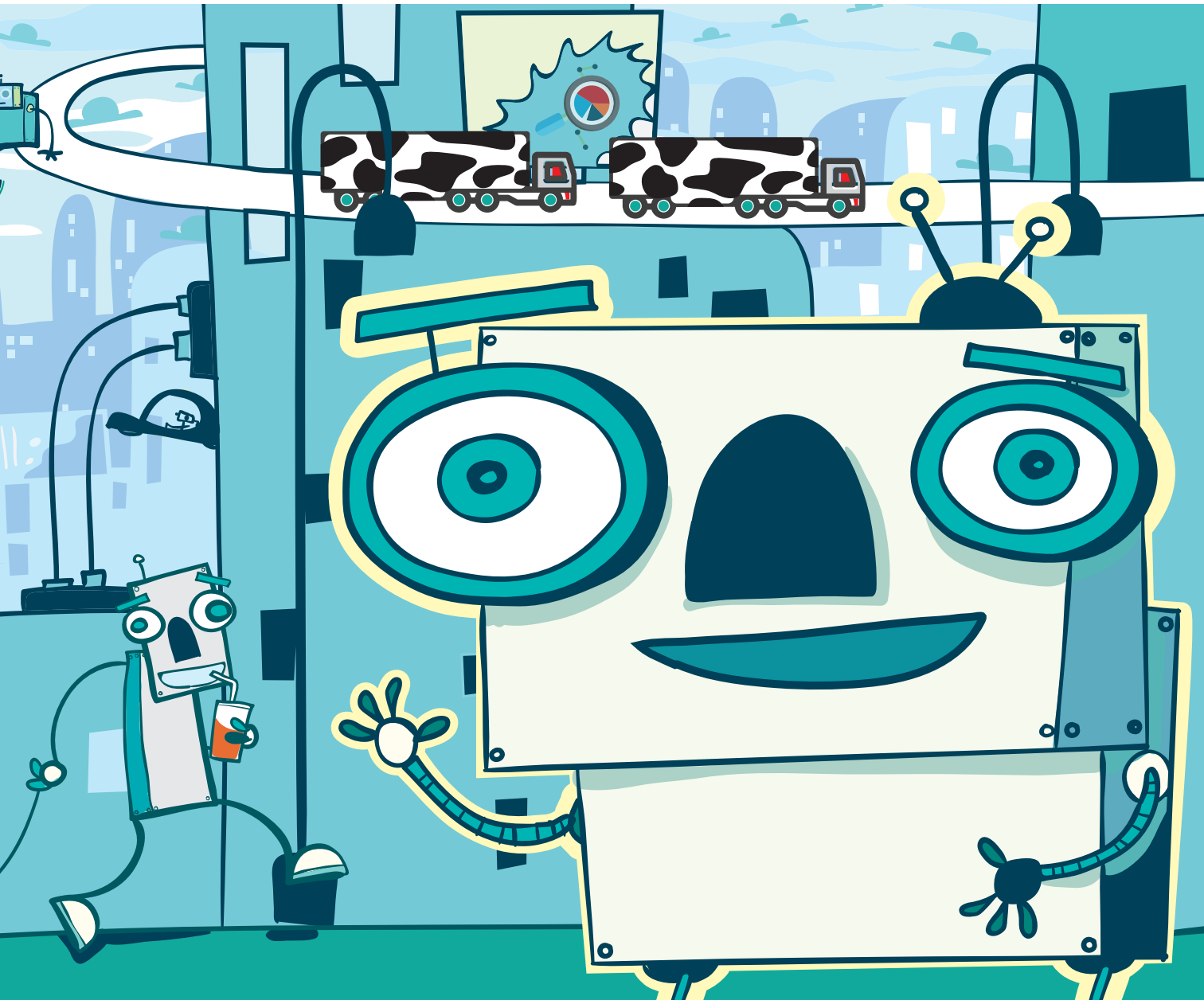
Pizza Mogul took Australia by storm in 2014, allowing Domino's customers to create pizzas online and share their ideas with others—a fusion of social media and e-commerce, said ECE ILLINOIS alumna Joanna Parke (BSEE '00), managing director for ThoughtWorks. Customers created roughly 130,000 different customized pizzas in the first year, and they shared a slice of the profits, with one pair earning $52,000 for their creation.

ThoughtWorks is one of the companies that's made Chicago a growing force in the tech world—and one of many with a strong ECE ILLINOIS presence.

"Chicago is a rising star," said Joseph Beatty (BSEE '85), who has been working in Chicago for 30 years. "So many engineers come out of Illinois, and so many stay in the Chicago area. That helps to explain why we've taken off as a tech startup area in the last five to 10 years."

The CBRE investment firm ranked Chicago "as the fifth-largest and 11th fastest-growing tech market in the country," reports *Inc.* magazine. One of the reasons, the magazine continues, is the "bevy of tech talent," and it cites the University of Illinois as a rich source for engineers and computing experts.

Chicago-based entrepreneur Nathan Laurell (BSEE '98, MS '00) said if you compare what's happening in Chicago today with what it was like when he came to the Windy City in 2000, "it's a night-and-day difference." Today, Laurell said, more investors are willing to invest in early-stage companies in Chicago. In addition, startup incubators have sprung up all over the city, such as the Chicago Innovation Exchange, which is operated by the University of Chicago but draws many ECE ILLINOIS students. ECE ILLINOIS students also partner with MBA students at the University of Chicago, where alumnus Sunil Kumar (PhD '96) is the dean of the Booth School of Business.

TO GET A SENSE OF THIS HIGH-TECH RESURGENCE IN CHICAGO, HERE'S A SELECTION OF ECE ALUMS WHO ARE DOING TECH, CHICAGO-STYLE.

ROCKET SHIP RIDE

The timing couldn't have been better. The Telecommunications Act of 1996 opened the floodgates to competition, and that's when alumnus Beatty and his partners jumped into the telecom fray.
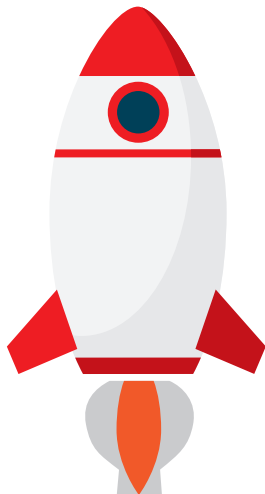
According to Beatty, fellow alumnus John Barnicle (BSEE '87) noticed roughly 80 percent of the telecom revenue was in the switches used to connect phone calls, and "no one is going after that. Why don't we?"

So Beatty and Barnicle teamed up to form Chicago-based Focal Communications, raised $25 million from venture capitalists, bought their own switches, and obtained regulatory certification. The company immediately took off. "It was a rocket ship ride," Beatty said. "We went from four guys with one idea to $240 million of annual revenue and 1,200 employees four years later."

After the Focal startup, Beatty left to take the reins of Concourse, a company they moved from Massachusetts to downtown Chicago. Their specialty was putting in shared wireless systems in airports, and once again the timing was right. When he became the CEO of Concourse in 2003, Wi-Fi was just taking off.

Then in 2007, he joined Telular as the chief financial officer, and he became CEO nine months later. Over the next six years, Telular's profits increased from $4 million $25 million annually.

Among their Internet of Things services was a sensor that monitors fuel levels in oil tanks. When a tank needs refilling, the sensor alerts Telular, and then Telular alerts the fuel service company. This saves considerable money because instead of routinely going out and filling tanks, refueling trucks are only sent when sensors indicate a real need.

Today, Beatty said, the startup mentality in Chicago is much stronger than when he began, which is one reason the city's tech community is thriving. In the past, the Midwestern attitude was to be more cautious, but startups and risk-taking have become the new normal. "It also helps that the University of Illinois sits only a couple of hours from Chicago, chock full of technologists," he said. "Chicago can change every industry because every industry is represented in Chicago."
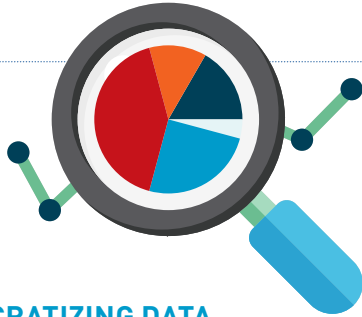
DEMOCRATIZING DATA

When the new Affordable Healthcare Act website was launched with highly publicized flaws, the Obama administration initiated several "tech surges" to fix the ailing site. In October of 2013, Gabriel Burt (BSCompE '05) was one of five experts brought in to put the site in order, and their team managed to repair it in two months.

Burt already had connections with the Obama administration because he was part of the technology team that developed a revolutionary new software platform that helped with the 2012 election.

"Once Election Day was over, we realized many of the technologies and techniques we developed were applicable to all sorts of organizations," Burt said. About 15 members of the Obama tech team started a new company, Civis Analytics, bringing the same tools to companies, non-profits, and other organizations.

Civis is located in Chicago, and it has expanded to a staff of about 100. Burt is vice president of engineering and the chief technical officer, responsible for the platform on which the tools are used.

One popular tool is the "media optimizer," which does sophisticated machine learning to target TV advertising in novel ways, combining the precision of digital with the reach of television. The media optimizer uses survey information to determine good targets for a product. Then, the model uses viewership data to predict the likelihood that certain TV programs will include a significant number of these potential customers in their audience.

In the past, "most media buys were either based on intuition or coarse demographic targeting," Burt said. The Civis model is more individualized and precise.

"We're trying to democratize access to data, and part of the way we do that is through the Civis platform," he said. "This platform helps analysts and developers and folks of all skill levels to collaborate on data science."

COW POWER

The slogan for some dairy farms could just as well be "Got Tech?" as "Got Milk?" For example, a herd of 12,000 cows on a farm in Indiana powers a fleet of semi-trucks that roars down the roads from Chicago to Orlando.

Alumnus Nathan Laurell said he's always on the lookout for startup tech opportunities in which to invest, and that's how he came across Mike McCloskey, an Indiana dairy farmer using anaerobic digestion technology to create fuel from cow manure. Gases from the manure are captured to create compressed natural gas, or CNG, which can be used to power trucks.

However, the farm operation provides only a portion of the compressed natural gas that Laurell's company, ampCNG, uses to power specially equipped trucks for corporations such as Frito-Lay and PepsiCo. Chicago-based ampCNG has created 20 fueling stations throughout Texas, the Midwest, and the Southeast. It has eyes on eventually building a national network that could fuel trucks travelling from one coast to the other.

Compressed natural gas cuts carbon dioxide emissions by 20 percent compared to diesel fuel and virtually eliminates sulfur oxide and nitrogen oxide pollution. It is also about 50 cents to $1.50 per gallon cheaper than diesel. CNG is a small piece of the trucking fuel market, but even a small percentage is significant when you have 2.5 million semi-trucks on the road in the U.S.

Laurell started his career at a trading firm in Chicago, eventually becoming a partner. He left in 2010 to start New Frontier, a holding company from which he makes investments. He co-founded Energy.me in 2011, a company that sells electricity to energy brokers, and in 2012 he co-founded ampCNG. He loves to work on companies in their early days, when you can become a problem solver "across a diverse set of situations," he said. "To me, that's engineering."

DISRUPTIVE THINKING

At first glance, it might seem odd that Joanna Parke looks to a 19th-century countess as an inspiration for software development. But it makes sense when you realize this countess is Ada Lovelace, a British mathematician considered to be the first computer programmer in history.

Not just the first female programmer. *The first programmer*.

Parke was accustomed to being in the minority as a woman in her engineering classes, working toward her ECE degree in 2000. Today, she is the North American managing director for ThoughtWorks, based in Chicago—a company that is strongly committed to bringing aboard more female technical employees, as well as minorities.

When Parke joined ThoughtWorks in 2003, the percentage of women on staff was low, which is typical in the tech world. But a concerted effort increased the percentage of women in its North American offices to 34 percent. Even more unique, the percentage of women in technical positions is almost the same at 33 percent. "You do have to try harder" to increase diversity, she said, but ThoughtWorks is committed to putting in the extra effort.

ThoughtWorks is also committed to innovation in software, both for major companies and non-profits. As their company banner reads: "Ambitious missions need disruptive thinking."

Parke is proud of the work she did on the website for Southwest Airlines, which revolutionized and streamlined the way that people buy airplane tickets. On the nonprofit side, she said ThoughtWorks created software for tablets used in West Africa in the "red zones" of treatment centers for the deadly ebola virus.

A red zone is where confirmed ebola patients are kept, and doctors must suit up in protective equipment and cover all exposed skin before entering. Any object used in the red zone must be disinfected or destroyed, which limits the use of electronic equipment and makes communication challenging. Doctors couldn't write down dosages and struggled to remember information.

ThoughtWorks solved this problem by developing an application that could work on waterproof tablets, allowing the equipment to be disinfected. The application was intuitive and as simple as possible with large buttons, large font, and one-click actions. Doctors could enter data on the tablet even while wearing big, bulky gloves, and as a result had an electronic record of treating patients.

Parke started at ThoughtWorks writing code, and said she never pictured being a leader in a company that does $300 million of business annually and has a staff of 4,000 in 13 countries. "Being on that journey has been life-changing," she said.

832

NUMBER OF CURRENT ECE STUDENTS WITH A PERMANENT ADDRESS IN THE CHICAGO AREA

520

NUMBER OF COMPANIES RECRUITING ECE ILLINOIS STUDENTS FOR JOBS IN CHICAGO SINCE 2013

5,190

NUMBER OF ECE ALUMS LIVING IN THE CHICAGO AREA

LAW AND ORDER MEET ENGINEERING

Lawyers are trained to thoroughly deconstruct complex arguments, teasing out the intricate details of legal precedent. But when Neil Hirshman (BSEE '87) tackled one of his first cases for Kirkland & Ellis in Chicago, he also found himself taking apart smoke alarms to tease out the intricacies of the device's design.

The case involved an AC-powered smoke detector that had a battery backup for when a fire knocks out the power. Hirshman represented the Chicago company that owned the patent and was suing several rivals for infringement. The case pushed Hirshman to draw upon his ECE background—something he said happens frequently. "I spent a fair bit of time analyzing the circuitry of those devices," said Hirshman, who earned his law degree from Harvard in 1990.

ECE may not strike some as the usual path to a law career, but according to the website for Hirshman's firm, Kirkland & Ellis, about 75 percent of its intellectual property lawyers "are engineers and scientists trained with degrees and professional backgrounds in technical areas." Hirshman is one of several ECE alums in the firm.

He joined Kirkland & Ellis in Chicago straight out of law school, and he began by handling intellectual property litigation. Within a few years, he moved out of litigation and has spent most of his career working on contracts involving intellectual property or technology, including mergers and acquisitions, licenses, strategic alliances, and outsourcing transactions.

Many of these are technology deals that require him to lean heavily on his engineering background. In 2014, Hirshman helped to lead the Kirkland team that represented Zebra Technologies in its purchase of a large portion of Motorola Solutions for $3.45 billion. Zebra, based in a northern Chicago suburb, made its name as the leading company for barcode printers, but it is expanding into all sorts of new technology, including equipment to track inventory and other assets using radio-frequency identification tags.

Hirshman points out many parallels between the law and engineering. "Both are about analyzing and solving problems in an organized and methodical way," he said. "The College of Engineering prepared me for the kind of critical thinking you need in law."

FACULTY STARTUPS CONTRIBUTE
SEVERAL ECE ILLINOIS FACULTY MEMBERS' STARTUPS ARE CONTRIBUTING TO CHICAGO'S TECH SCENE

Professors Sanjay Patel, Wen-mei Hwu, and Minh Do co-founded Personify, a company that uses computer vision to develop fresh and immersive video experiences for virtual collaborations. *The Wall Street Journal* compared using it to teleportation.

Professors Stephen Boppart and P. Scott Carney co-founded Diagnostic Photonics, which recently received $3 million in equity venture capital for trials testing its high-resolution probes that can allow surgeons to identify whether they've removed all cancer tissue during surgery.

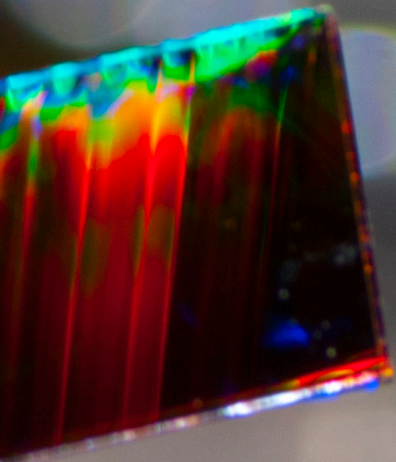PROFESSOR BRIAN CUNNINGHAM'S PHOTONIC CRYSTALS WILL
ENABLE A SMARTPHONE-BASED SYSTEM TO DETECT AND TRACK
INFECTIOUS DISEASES.

LEARN MORE ONLINE: GO.ECE.ILLINOIS.EDU/CRYSTALS

ECE ILLINOIS
Department of Electrical
and Computer Engineering

PHOTO BY GREG PLUTA

AWARDS

›PROFESSORS
›ADESIDA ›BERNHARD ›BOPPART ›C
›CHEN ›EDEN ›GODDARD ›HASEGAW
›KAMALABADI ›KILLEEN ›KIM ›KRE
›MAKELA ›MITRA ›MOULIN ›PILAWA
›ROY CHOUDHURY ›SANDERS ›SHA
›SRIKANT ›VAIDYA ›VARSHNEY ›VIS
›WASSERMAN ›WONG

FACULTY AWARDS

ILESANMI ADESIDA
Won the 2016 Functional Materials John Bardeen Award from the Minerals, Metals, and Materials Society.

JENNIFER BERNHARD
Elected to the IEEE Board of Directors.

STEPHEN BOPPART
Received the Andrew T. Yang Research and Entrepreneurship Award; won the Excellence in Research Award from Carle Foundation Hospital.

P. SCOTT CARNEY
Named an Education Innovation Fellow in the College of Engineering.

DEMING CHEN
Gave keynotes at the IEEE International Conference on Anti-counterfeiting, Security, and Identification and the IEEE international conference on ASIC; won the IEEE/ACM William J. McCalla ICCAD Best Paper Award.

J. GARY EDEN
Appointed to the Naval Studies Board, National Academy of Sciences, named associate editor of *Applied Physics Reviews*, and recognized as a distinguished lecturer in the Division of Plasma Physics of the American Physical Society. Became a member of the editorial board of *Scientific Reports* and gave a Nanqing Lecture at Xiamen University, China.

LYNFORD L. GODDARD
Named a senior member of the Optical Society of America.

MARK HASEGAWA-JOHNSON
Made team leader for one of the Second Frederick Jalinek Memorial Summer Workshops.

RAVISHAKAR K. IYER
Elevated to IEEE Life Membership.

JIANMING JIN
Elected to the ACES Board of Directors, received IEEE Antennas and Propagation Society Chen-To Tai Distinguished Educator Award, received IEEE Antennas and Propagation Edward E. Altschuler AP-S Magazine Prize Paper Award, and received the IEEE Antennas and Propagation Society Distinguished Lecturer Award.

FARZAD KAMALABADI
Named a CAS associate by the Center for Advanced Study.

TIMOTHY KILLEEN
Named a fellow of the American Association for the Advancement of Science.

NAM SUNG KIM
Elevated to IEEE fellow.

PHILIP KREIN
Won the best paper prize at the IEEE Transportation Electrification Conference and was named chair of the IEEE Transportation Electrification Community.

JEAN-PIERRE LEBURTON
Named a CAS associate by the Center for Advanced Study, and recognized as an IEEE Nano Technology Council Distinguished Lecturer.

CARNEY
WA-JOHNSON ›IYER ›JIN
EIN ›LEBURTON ›LIANG ›LIU
A-PODGURSKI ›POPESCU
NBHAG ›SMARAGDIS
WANATH ›WALDROP

ZHI-PEI LIANG
Won the IEEE-EMBS Distinguished Service Award and the Distinguished Reviewer Award for Magnetic Resonance in Medicine, was recognized with the IEEE International Symposium on Biomedical Imaging Best Student Paper Award, and won the MR Spectroscopy Study Group's First-Place Paper Award from the International Society of Magnetic Resonance in Medicine.

GANG LOGAN LIU
Elected a Fellow of American Institute for Medical and Biological Engineering (AIMBE).

JONATHAN J. MAKELA
Won the Prize Lecture at the 2015 NSF-sponsored Coupling, Energetics and Dynamics of Atmospheric Regions workshop.

SAYAN MITRA
Won the Robert Bosch Sponsored Best Verification Result Award at the ARCH.

PIERRE MOULIN
Elected a member of the Board of Governors of the IEEE Information Theory Society.

ROBERT PILAWA-PODGURSKI
Won Best Paper Award at the IEEE Workshop on Control and Modeling of Power Electronics, received a google/IEEE Power Electronics Society Little Box Challenge Academic Award, was named associate editor of *IEEE Transactions on Power Electronics*, and was named associate editor of the *IEEE Journal of Emerging and Selected Topics in Power Electronics*.

GABRIEL POPESCU
Gave plenary lecture at Photonics West, the largest photonics conference in the world, and was selected as associate editor of the *Nature Scientific Reports* journal.

ROMIT ROY CHOUDHURY
Won the best demo at HotMobile 2015, the International Workshop on Mobile Computing Systems and Applications, and a 2015 IBM Faculty Award.

WILLIAM H. SANDERS
Won the 2016 IEEE Innovation Societal Infrastructure Technical Field Award.

NARESH R. SHANBHAG
Named associate editor for *IEEE Journal of Solid-State Exploratory Computational Devices and Circuit*s; received 2015 IEEE International Symposium on Circuits and Systems Best Paper Award.

PARIS SMARAGDIS
Named the IEEE Signal Processing Society Distinguished Lecturer; won an NSF CAREER Award.

R. SRIKANT
Won the 2015 WiOpt Best Paper Award; received the 2015 IIT Madras Distinguished Alumnus Award.

NITIN H. VAIDYA
Won the Best Paper Award with Lili Su at the 17th International Symposium on Stabilization, Safety, and Security of Distributed Systems.

LAV VARSHNEY
Won the NYC Media Lab-Bloomberg Data for Good Exchange Paper Award.

PRAMOD VISWANATH
Won Best Paper at SIGMETRICS 2015.

LARA WALDROP
Won an NSF CAREER Award.

DANIEL M. WASSERMAN
Won the 2015 Distinguished Promotion Award from the Illinois' Office of the Provost.

MARTIN D.F. WONG
Won the 2015 Synopsys EDA Research Award and second place in the ACM TAU 2015 CAD Software Contest on Timing Analysis.

A GRAND CHALLENGE
TALKING TO POLICY MAKERS ABOUT SCIENCE AND ENGINEERING

FROM INVENTING TECHNOLOGY THAT AFFECTS EVERY ASPECT OF MODERN LIFE, TO DEVELOPING THE INFRASTRUCTURE THAT MAKES CLEAN AIR, WATER, AND SOIL POSSIBLE, ENGINEERS HAVE ONE OF SOCIETY'S MOST INFLUENTIAL PERSPECTIVES.

BUT IT'S OFTEN A MODEST PROFESSION, SO ENGINEERS AREN'T ALWAYS VOCAL ABOUT HOW THEIR WORK SHAPES THE LIVES OF OTHERS. WITH A LITTLE ADVOCACY, THOSE LEADING ENGINEERING INNOVATORS CAN RAISE AWARENESS ABOUT THEIR CONTRIBUTIONS AND MAKE A CASE FOR WHY SOCIETY SHOULD BE PAYING ATTENTION.

FARZAD KAMALABADI: ECE ILLINOIS professor

In 2013, a committee convened by the U.S. National Academy of Engineering identified 14 challenges and opportunities for engineering during the world's next few generations.

These "Grand Challenges for Engineering in the 21st Century" focused on technical solutions to problems encountered in the realms of environment, education, energy, and health care. As engineers, we are privileged to pursue careers that empower us to overcome such challenges and push the frontiers of technical innovation.

Yet, while we are able to increasingly advance frontiers of discovery and innovation, many societal problems with roots in public policy are also increasing. I would argue that, despite common belief, engineers are well-equipped to tackle these grander challenges that humanity faces; problems that traditionally have been assumed to be under the purview of social and economic sciences and policy experts.

I am referring to problems such as global health and health care costs, ecological sustainability, climate change, the availability and distribution of diminishing resources, and problems concerning water, food, energy, and economic growth. These are intertwined with the social and economic stability and welfare of our civilization. In addition to engineering skills, addressing such problems requires developing a deeper understanding of society's needs.

The most daunting problems of our era, the problems that all of humanity will grapple with in this century, the problems that pose the greatest challenges to the next generations, do not exist because of the unavailability of engineering solutions, lack of innovation, or shortage of imagination. Rather, they stem from myopic policy decisions seldom guided by scientific and engineering considerations. Meanwhile, sound engineering-driven policy recommendations are, for the most part, unsolicited or ignored.

I believe engineering, as an intellectual discipline, is uniquely equipped to provide a methodological framework for addressing society's grander challenges, because its foundation is solution-oriented.

It is crucial that engineering leaders of the future play a more central role in social policy decision-making, and must influence policy more directly and effectively. As Neal Lane, former director of the White House Office of Science and Technology Policy and science adviser to President Clinton, said: "Scientists and engineers cannot be expected to solve the vast societal problems from within their own professional community. On the other hand, few, if any, of these problems could be solved without the science community's knowledge and skill base as a foundation. Intelligent public policy helps lead us toward the cultural and institutional change required to meet these needs. Only with a combination of the two can we hope to succeed."

While we have often been made aware of the importance of educating the public on the significance of science and engineering and STEM education in our society, we need to recognize the equally important need to educate ourselves about society's needs. In Lane's words: "While there is great need for the public to have a better understanding of science, and we should promote this in every way possible, there is as great a need for scientists to have a better understanding of the public."

Attention to introspection and self-education will not only amplify the impact of our innovations and discoveries in addressing societal needs, but also it will have a direct impact on how we as engineers are perceived and valued by our fellow citizens. We have a grand opportunity to reverse the historically aloof image of engineering and shape a more engaged culture resulting in a public image that is commensurate with the magnitude and scope of engineering contributions and impact in our lives.

Farzad Kamalabadi is a professor at ECE ILLINOIS, and is affiliated with the Department of Statistics and the Coordinated Science Laboratory. From 2010 to 2012, he was also a program director at the U.S. National Science Foundation in Arlington, Virginia. His research interests are at the nexus of statistical signal processing, remote sensing, and space science. He is an associate within the Illinois Center for Advanced Study.

GORDON W. DAY: alumnus and policy advocate

It's easy to argue that, over the course of history, engineers have done more to advance quality of life than any other profession. Science is important, too, but distinct from engineering: Scientists discover; engineers create.

The word "science" is Latin for knowledge. The word "engineer" derives from another Latin word, *ingeniare*, which is also the root of the word "ingenious." It has been said: "Without science, engineering would have no roots; without engineering, science would bear no fruit."

Policy makers may not understand the relationship between science and engineering, though it should inform many of their decisions. Most of them do know innovation is the prime ingredient in economic growth and national competitiveness. Economists have been pointing that out for more than a century, and for half a century have concluded it represents around 80 to 85 percent of growth.

Less consensus exists about how governments can stimulate innovation, yet the choices are likely to have as much impact on the future of technology and economic growth as the creativity of engineers. The options include investments in basic or applied research, support for innovative businesses, and improvements in our education system.

Economics and competitiveness are not the only arenas where it's important for policy makers to understand science and engineering. Projecting the trajectory of climate change is the domain of climate scientists. But it is the engineering community that will figure out how to reduce greenhouse gas emissions while providing the energy we need. And it is the engineering community that will find ways to mitigate the ef-

fects of rising sea levels and design structures to withstand more intense storms.

Many policy makers recognize the need for science and engineering expertise, but relatively few scientists and engineers are naturally comfortable as advocates. Science and engineering professional societies are working to change that.

Thirty-five societies collaborate with the American Association for the Advancement of Science in sponsoring scientists and engineers to work for a year in various parts of government, including Congress. Eight societies sponsor the annual Washington Internships for Students of Engineering (WISE) Program that enables university students to spend nine weeks in Washington learning about, and practicing, policy development. And about 25 societies sponsor the annual Congressional Visits Day, on which several hundred scientists and engineers, including students, receive training on how to share their knowledge with policy makers, and then go to the hill and visit the offices of their elected representatives.

For the last three years, teams of ECE ILLINOIS students have taken part in Congressional Visits Day, with the support of alumni champions. They've grown as leaders and discovered how lending their unique perspectives to a larger effort can contribute to a greater cause.

In 2005, I served as an adviser to Senator Jay Rockefeller, sponsored by IEEE-USA, and I've also worked with the WISE Program and Congressional Visits Day. For many participants, myself included, these are life-changing opportunities, and I commend them to any scientists and engineers who would like to explore more ways to change the world.

Gordon W. Day (BSEE '66, MS '67, PhD '70) is division chief emeritus of the National Institute of Standards and Technology's Optoelectronics Division. In 2012, he served as president and CEO of IEEE. Over the last decade, much of his work has focused on technology policy. He's chairman of IEEE's Global Public Policy Committee and serves as an adviser to its European Public Policy Initiative.

ECE ILLINOIS UNVEILS
NEW MASTER'S DEGREE

BY MEG DICKINSON

THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING HAS CREATED A NEW MASTER OF ENGINEERING DEGREE. ITS FIRST STUDENTS ARE STUDYING WITHIN THE PROGRAM THIS SPRING.

The Master of Engineering, or MEng degree, is an on-campus professional master's degree intended to prepare students for full careers in industry. It allows students flexible concentrations as they choose from classes in a variety of subject areas. ECE ILLINOIS will also offer a combination bachelor's and MEng degree to students who are interested.

"We are so pleased to offer the Master of Engineering degree, which is an excellent option for students who have, or hope to pursue, important careers in industry," said ECE ILLINOIS Department Head William H. Sanders. "It's an opportunity for students to study with leading faculty members in a top-ranked program as they prepare to make a difference in the world."

MEng students can choose from a variety of subject areas within their coursework, in the outstanding facilities Illinois is known for. They'll take classes with ECE ILLINOIS' Master of Science and PhD students and the faculty members who lead their fields in their respective research areas.

"This program is designed to prepare students to compete in today's competitive industrial environment," said Professor Steven J. Franke, the associate head of graduate affairs. "The ECE MEng allows students to focus their coursework in areas that are most relevant to their professional career interests."

The program will offer admission in both spring and fall.

"ECE ILLINOIS is known for its wide selection of advanced elective courses, especially our many high-quality laboratory courses," Franke said. "The MEng program will enable students to design a program that combines technical depth, hands-on experience, and meaningful professional development opportunities."

The program's BS/MEng combination will also be an option for current students wishing to stay on to earn a master's degree, yet don't intend to pursue a PhD. Those students will take slightly less coursework for their bachelor's degree as they pursue the MEng at ECE ILLINOIS.

"I am looking forward to offering this program, and to watching it grow as a valuable tool for our students," Sanders said. "ECE ILLINOIS is among the best places one can earn a master's degree, and I believe this offering rounds out our options for all students."

MENG

>> GO.ECE.ILLINOIS.EDU/MASTEROFENGINEERING

"**I WAS ALWAYS DRAWN TO THE THINGS TOUCHING PEOPLE IN WAYS I COULD SEE. WHEN I'M DOING PROJECTS WITH THE CITY OF CHICAGO, THOSE THINGS ARE REWARDING TO ME.**"
—CHARLIE CATLETT

BY JOHN TURNER

ON A BEAUTIFUL DAY IN CHICAGO YOU MIGHT SEE THE L RUMBLING HIGH OVER THE CROWDED STREETS, OR WATCH A HANDFUL OF BRAVE TOURISTS VENTURE OUT ON THE LEDGE FOR A BREATHTAKING VIEW.

But Charlie Catlett (BSCompE '83) sees something that most don't—the vast volume of intangible information flowing through the city that could make it a more pleasant and sustainable place to live.

Catlett is a senior computer scientist at Argonne National Lab and a senior fellow in the Computation Institute, a joint center of Argonne and the University of Chicago. But it's his role as director of the Urban Center of Computation and Data that's put him at the center of a project that will soon give cities a new set of powerful predictive and analytic tools.

Dubbed the FitBit of Chicago by Curbed.com, the Array of Things is the realization of a $3.1 million grant from the National Science Foundation that will place 500 sensor-laden nodes across the city by 2017.

Designed with aesthetic input from the Art Institute of Chicago, the nodes will measure a range of factors that affect the livability of the city, such as climate, air quality, and noise. Catlett is the chief architect. Not bad, considering his first foray into electronics in high school.
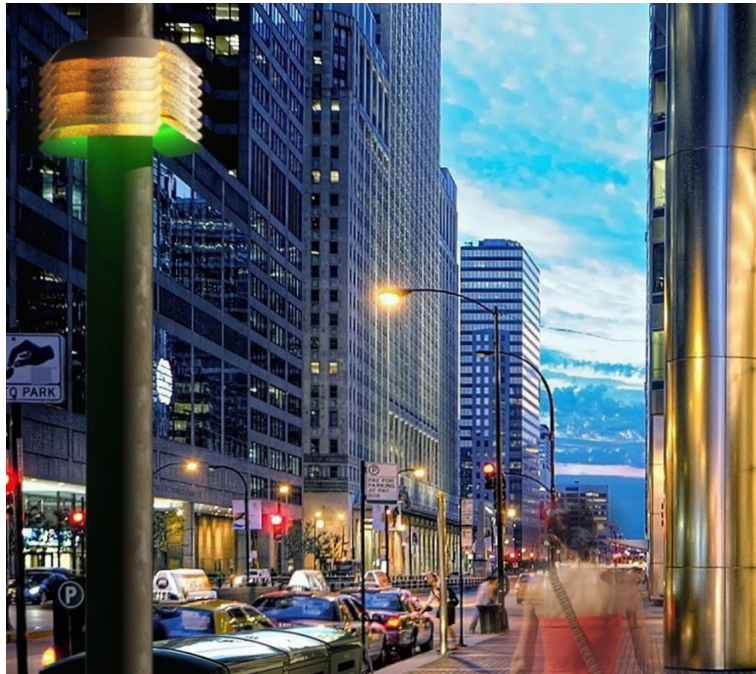
"I learned about Ohm's law because I got this really nice distortion sound by hooking two speakers up in parallel, which made their resistance drop in half. It sounded really good — until this greenish-brown smoke started coming out of it," Catlett said.

Undeterred, he pursued a degree in computer engineering at the University of Illinois, where he met his future wife, Joan, and developed a more nuanced interest in computers.

After graduating, Catlett became one of the first employees at the National Center for Supercomputing Applications, where he helped deploy NSFnet and witnessed the dawn of Mosaic and the World Wide Web. From there, he moved to Argonne, where he designed I-WIRE, the dark-fiber network linking Argonne and several other institutions, including the University of Illinois.

Next came TeraGrid, a national network connecting 11 sites across the country and a new position as Argonne's chief information officer. It was a great job, but he missed the hands-on nature of his previous work. He began searching for a new challenge, which led to his latest venture.

The Array of Things is the first project of its kind to deliver data in near-real time, in an open-source format that anyone can access, from scientist to app developers. Among other goals, Catlett hopes to help cities understand how that data is interlinked.

"We have computational models that can help us with planning things like transportation or the demand for energy," he said. "But we haven't put those models together to look at how they interact and therefore model cities in a more holistic way."

The Array of Things could change that, with affordable sensor components they can easily reconfigure or reprogram on the fly to track different things. Already, 17 cities have expressed interest, including Mexico City, which wants 15 units for a pilot project.

When it's time to analyze the data they collect, these cities may turn to centers like the Midwest Big Data Hub at Illinois. Funded by a grant from the NSF, the hub is a joint collaboration between the U of I and several other partners designed to manage and mine large amounts of data. As a member of the interim steering committee, Catlett oversees the Smart Cities and Communities Spoke of the program.

For Catlett, however, the end goal is making a difference for the people who call those cities home. "I was always more drawn to the things that were touching people in ways I could actually see," Catlett said. "So when I'm doing projects with the city of Chicago and I can see how it can connect with say the health of kids on the west side or to the amount of time that somebody might have to spend commuting ... those kind of things are rewarding to me."

TRANSFORMING THE FUTURE OF COMPUTING

BY KIM GUDEMAN

It's no secret that Moore's law is up against users who increasingly demand devices that are smaller, less costly, and provide longer-lasting battery life.

In the past, technological advances in computing power have been made possible by the frequent reduction in size of a basic building block—the transistor switch. Today, these switches are so small that their behavior is increasingly unpredictable because of nanoscale non-idealities. But the Illinois-led Systems on Nanoscale Information fabriCs (SONIC), a $30 million multi-university center, launched in 2013 under the DOD- and SRC-funded STARnet program, is overcoming the physical limitations of the nanoscale regime.

SONIC brings together 24 faculty members and more than 85 graduate student/postdoctoral researchers from nine renowned U.S. universities. They focus on SONIC's mission of developing the foundations for statistical information processing on nanoscale device and circuit fabrics. SONIC's success relies on its ability to foster collaborations among diverse researchers, said Naresh Shanbhag, SONIC's director and the Jack S. Kilby Professor of Electrical and Computer Engineering at Illinois. In the last three years, SONIC's innovative research agenda has made it enormously successful by all accounts, filing six patent applications in the last year alone. Some highlights:

DESIGNING SHANNON-INSPIRED SYSTEMS

SONIC's promise to overcome the physical limitations of transistors is based on applying the work of Claude Shannon, the father of information theory, to integrated circuits. Using information processing instead of data processing to extend scaling of nanoscale devices requires a complete paradigm shift in computing.

One of SONIC's greatest accomplishments to-date, Shanbhag said, is proving that it's possible to build such Shannon-inspired and brain-inspired chips. The center has successfully developed new algorithms that have since been mapped to architectures and to functioning chips.

SONIC

TEN-TIMES IMPROVEMENT IN ENERGY EFFICIENCY AND DENSITY

As a result of the new models, SONIC researchers have reached new world records in power efficiency and power density of information processing systems. SONIC did so with the work of Associate Professor Pavan Hanumolu, who achieved a 10-times improvement in quiescent power efficiency and the smallest controller area via time-based signal representation, and Assistant Professor Robert Pilawa, whose switched capacitor DC-DC converter has a 10-times volume reduction in the power conversion stage.

"SONIC is pioneering the concept of *in situ* information processing," Shanbhag said. "This is the idea of embedding information processing in the same substrate that senses data. We want devices, such as the FitBit or Google Glass, that not only collect data, but also process it."

EMBEDDING INFORMATION PROCESSING ON EPIDERMAL PATCHES

Led by Professor and ECE affiliate John Rogers, an expert in wearable devices, SONIC researchers have demonstrated health monitoring functions. These include real-time measurement of heart and respiration rates, blood pressure, and oxygen levels on epidermal patches.

ENABLING BEYOND CMOS TECHNOLOGY

Complementary metal-oxide semiconductor (CMOS) technology, which enables a high density of logic function, is today's industry standard for integrated circuits. But the ability to scale CMOS is slowing.

While beyond-CMOS technologies have not been viewed as mature enough to replace the standard, SONIC has succeeded in implementing them into working systems. "As is the case in all of SONIC's other accomplishments, the key to this achievement is to leverage system-level Shannon and brain-inspired statistical information techniques to compensate for nanoscale non-idealities," said Andrew Singer, SONIC's associate director and Fox Family Professor of Electrical and Computer Engineering at Illinois. "The statistical information processing approach taken in the SONIC Center is enabling these device and circuit fabrics that would otherwise be considered too early-stage to be useful, to build meaningful, functionally complex computational tasks."

FUTURE DIRECTIONS

In its remaining two years, SONIC researchers plan to make the research results broadly applicable across a host of domains, including determining the fundamental limits of computing on nanoscale fabrics and demonstrating the realization of statistical information processing systems by developing in-sensor and in-memory computing platforms.

"The goal of the STARnet program is to conduct research with impact in 10-plus years," Shanbhag said. "However, quite a few of the concepts that we have come up with have potential to be implemented in the near-term. They can be built into today's emerging applications."

"THIS IS THE IDEA OF EMBEDDING INFORMATION PROCESSING IN THE SAME SUBSTRATE THAT SENSES DATA. WE WANT DEVICES, SUCH AS THE FITBIT OR GOOGLE GLASS, THAT NOT ONLY COLLECT DATA, BUT ALSO PROCESS IT."
-NARESH SHANBHAG

WANG DEVELOPS **FONT** RECOGNITION SYSTEM FOR ADOBE

BY ASHISH VALENTINE

A designer working for a boutique ad firm is stumped, trying to decide on the perfect font to complement her new banner. Ruminating on the problem on her bus ride home, she suddenly spies a concert poster on the street featuring just the font.

The bus stops for a few seconds to let out a passenger, and she whips out her phone, snapping a photo of the poster. An app immediately responds with the name of the font, and she works it into her ad that very evening.

This software, described by Adobe principal scientist Hailin Jin at the company's 2015 MAX conference as "Shazam for fonts," is DeepFont. What's more: this isn't a hypothetical technology—graduate student Zhangyang "Atlas" Wang has been developing it since a 2014 internship with Adobe Research, and the finished product was recently shipped with Adobe's latest editions of Photoshop and Typekit.

Font recognition is a huge need for designers, who traditionally rely upon professionals who charge high rates and take an average of 45 minutes to an hour to reliably determine fonts.

Before its release, a demo of the software was presented to an audience of design professionals at the MAX conference to roaring applause. Since then, DeepFont has amassed several endorsements from designers and firms around the world.

Shazam Light
Shazam Light Italic
Shazam Regular
Shazam Italic
Shazam Semibold
Shazam Italic
Shazam Bold
Shazam Bold Italic
Shazam Black
Shazam Black Italic

The software itself works using a new type of machine learning called deep learning, which aims to create algorithms that mimic the human brain by continuously learning, recognizing patterns, and improving their performance.

Wang and his Adobe collaborators started by building the first dataset of both synthetic and real-world images with texts, called AdobeVFR. They then taught their algorithm the basics of distinguishing fonts. They designed the algorithm to work from this training by feeding it new examples and allowing it to recognize patterns. It will continuously refine its recognition abilities. DeepFont can also account for text that was photographed at an angle, or is partially covered with shadows.

"The chance to work with Adobe on DeepFont was incredible," Wang said. "Besides the game-changing nature of what we were developing, the people at Adobe were always friendly and passionate about their work.

The teams were small and specialized enough that I could even have frequent lunch meetings with the development head of Photoshop. She could tell me exactly how she wanted DeepFont to look and feel, and I could work on her specifications the same day."

With DeepFont released, Wang hopes for even greater adoption of his font recognition technology, and eventually to pursue a career in academia. His adviser, Professor Emeritus and Research Professor Thomas Huang, is impressed with his ability to balance developing DeepFont while simultaneously conducting other streams of research.

In the meantime, Wang is proud to see his work ship with Adobe's products.

"I'm happy to resolve a need that the design community has been feeling for so long," Wang said. "There's definitely a sense of accomplishment when people like what you've developed, that's a great feeling."

OPPORTUNITY AWAITS

LI SELECTED TO BE ENTREPRENEURIAL FELLOW FOR THE PROGRAM'S INAUGURAL YEAR

BY DANIEL DEXTER

Professor Xiuling Li has been given the opportunity to explore taking her innovative research outcome from the lab to the market.

Li was chosen as one of four engineering faculty to be named a Faculty Entrepreneurial Fellow. She will work closely with her students to prepare their patented 2-D for 3-D nano-membrane technology for commercial development.

"What I am really looking forward to is taking this opportunity to identify the market needs, better position our technology development, and explore business strategies," Li said. "I'm grateful to the college for establishing such a program to provide support to faculty like myself in accelerating the translation of research to product."

Three ECE ILLINOIS alumni are supporting the Faculty Entrepreneurial Fellows, which is the first of its kind in a U.S. engineering program. They are: Sanjay Srivastava (MS '87), co-founder of Denali Software; John Thode (BSEE '79), president of DigitalOptics Corporation; and Andrew Yang (MS '86, PhD '89), co-founder of Apache Design Software and Anagram.

With about a half dozen patents issued or filed on the subject, Li and her team plan to refine their self-rolled-up membrane nanotechnology. They'll use potential end-user feedback to provide solutions to the current demand in RF and microwave communications: miniaturization, high-frequency operation, and wearability.

For example, their technology can make passive devices such as electrical inductors 10 to 100 times smaller than current technology. It can also make transformers with extremely high turn ratio filters with a much higher bandwidth, and antennas that are small, light, and high-frequency. The challenge is how best to integrate or introduce this disruptive technology into the market, Li said.

"We are fortunate that the three alums who supported the fellows will also generously serve as our mentors in this process," Li said. "That's incredibly valuable."

Another unique aspect of the program is student involvement. Students will join the effort in the form of a discovery course. Li said the program is in the early stages, and she is interviewing students eager to break into the entrepreneurial space.

"It's an entrepreneurial exercise with students," Li said. While in the program's first year, Li expects to learn with students as their ideas take shape. "Hopefully, we will be able to find the right path and timing to convert our technology to products."

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ECE ILLINOIS faculty and Beauchamp accepting a sponsorship check from Magnavox. Left to right: Duane Branigan, director of Illinois' School of Music; William L. Everitt, Engineering at Illinois dean; an unidentified Magnavox representative; Lejaren Hiller Jr., professor of music and director of the Experimental Music Studio; then-graduate student James W. Beauchamp; and another Magnavox representative.

THE SOUND OF MUSIC

ILLINOIS' ELECTRONIC MUSIC LEGACY:
BEAUCHAMP'S HARMONIC TONE GENERATOR RECREATED FOR SOUSA ARCHIVES

BY ASHISH VALENTINE

TODAY'S ELECTRONIC ARTISTS PLAY WITH AN EXTRAORDINARY VARIETY OF STYLES, FROM THE MINIMALIST, FUNK-INSPIRED CHILLWAVE TO THE PENETRATING, REVERBERATING BASS LICKS OF DEEP HOUSE. STEPPING BACK MORE THAN 50 YEARS, HOWEVER, THE FIRST ELECTRONICALLY-GENERATED PIECES WERE TAKING SHAPE AT ELECTRONIC MUSIC STUDIOS ACROSS THE WORLD, AND THEY SOUNDED VERY DIFFERENT.

Some of the first forays into electronic composition took place at Illinois' Experimental Music Studio in the '60s, resulting in complex, chaotic pieces like Salvatore Martirano's 1965 "Underworld." These were composed using an instrument called the Harmonic Tone Generator, which Professor Emeritus James Beauchamp (PhD '65) built the year previous for his PhD project in electrical engineering.

Beauchamp created the instrument under the direction of composer Lejaren Hiller, who, in 1957, co-created with Leonard Isaacson the first piece composed entirely by computer, the Illiac Suite. The synthetic music that emerged from experiments like these would evolve and expand in popularity, morphing into the sweeping electronic symphonies of artists like Jean-Michel Jarre and Vangelis in the '70s, and finally fragmenting into the myriad genres of today's DJ scene.

"LISTENING TO MUSICAL INSTRUMENTS, WE CAN SEE THAT THE SOUNDS THEY MAKE ARE COMPOSED OF CERTAIN BASIC HARMONIC FREQUENCIES. I BUILT THIS MACHINE TO EMULATE THOSE SOUNDS VIRTUALLY, TO RECREATE MUSICAL NOTES WITH A SYNTHESIZER THAT HAS HARMONICS YOU CAN CONTROL."

-JAMES BEAUCHAMP

Early in 2015, the University Library's Sousa Archives and Center for American Music acquired the now non-functional instrument for preservation purposes. On Sept. 21, it opened an exhibit with the instrument to allow visitors to learn about the legacy of electronic music at Illinois, which runs until May 27.

Beauchamp's original instrument is accompanied at the exhibit by a redesigned instrument created by ECE Electronics Services Technician Mark Smart. Smart's device digitally reproduces the original's synthesized tones and allows visitors to experiment with creating music using the same set of controls as Beauchamp's original analog machine.

Beauchamp's original worked by using specific voltages to create audio sine waves, which could then be mixed together to make distinct musical tones. By combining and modifying these sounds on a piano-like keyboard, then using a set of knobs to tweak features like attack, delay, amplitude, or frequency, anyone could create entire compositions based on the synthetic tones.

"Listening to musical instruments, we can see that the sounds they make are composed of certain basic harmonic frequencies," Beauchamp said. "I built this machine to emulate those sounds virtually, to recreate musical notes with a synthesizer that has harmonics you can control."

While doing research on electronic music, Smart came across Beauchamp's thesis, and decided to try to recreate the machine in his spare time. He emailed with Beauchamp, and created a basic software emulation of Beauchamp's original instrument in a weekend.

Smart loaded the software onto a laptop and wired it to a set of circuit boards connected to a keyboard and knobs similar to the set on the original device. He also continually sent Beauchamp sounds to critique so that the digital tones that his machine generated would accurately recreate those made by the original.

Scott Schwartz, archivist for Music and Fine Arts and director of the Sousa Archives, agreed to house the old instrument at the Sousa Archives for preservation and fund Smart's reconstruction project. Schwartz built an imitation rack to house Beauchamp's instrument as it would have looked in the original studio and a wooden frame for Smart's new device.

"After being housed at the Illinois' Experimental Music Studios, the device was given back to me and it sat under my workbench at home for about 25 years," Beauchamp said. "I was glad the Sousa Archives wanted to preserve it. Mark worked very hard on recreating the original generator, and it's gratifying to see his efforts converged into such an excellent solution."

SOUSA ARCHIVES & CENTER FOR AMERICAN MUSIC
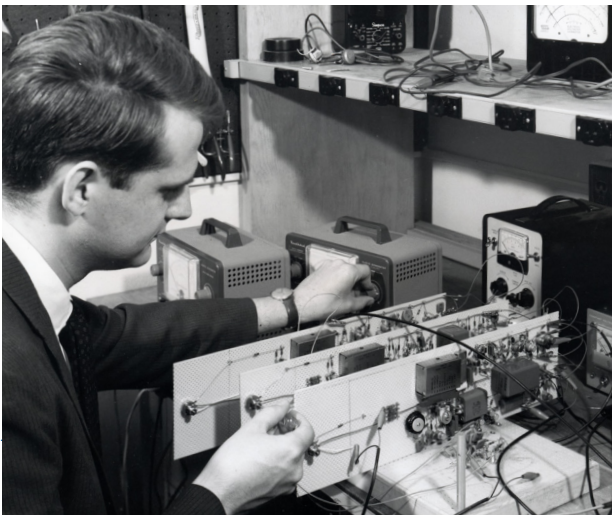
JAMES BEAUCHAMP ADJUSTING THE CONTROLS ON A BREADBOARD VERSION OF THE HARMONIC TONE GENERATOR.

TEN ANSWERS

Yemaya Bordain (PhD '15) is an Internet of Things engineer at Intel. She graduated as the first African-American female PhD from ECE ILLINOIS in the spring of 2015. She's also the mother to 4-year-old Caden and 11-month-old Candacee.

WHY IS DIVERSITY IMPORTANT IN TECH AND THE ENGINEERING FIELDS?
Diversity in thought, experience, and background is important because it leads society to the best solutions to problems.

WHAT'S YOUR FAVORITE FOOD?
I love West African food in general. However, thieboudienne, which is the national dish of Senegal, tastes like heaven. The combination of fish, rice, veggies, and roots and the sweet and sour, slightly tangy flavor identify its Senegalese origins.

WHAT INSPIRES YOU?
Human ingenuity inspires me most, especially when resources are scarce. I love seeing the underdog overcome obstacles.

IF YOU COULD SPEND AN HOUR WITH ANYONE, WHO WOULD IT BE?
My oldest brother passed away from cancer when I was a teenager. I'd spend the hour introducing him to his son, who was too young when he passed to know him.

WHAT WAS YOUR FAVORITE ECE CLASS?
The course that stole my heart was ECE 340, Solid State Devices. This course was like the guy who you hated when you first met, the one you fought with often, the one you thought was stupid. But with time and understanding, he grew on you, and without warning, you were in love.

IF YOU COULD CHOOSE A SUPER POWER, WHAT WOULD IT BE?
I'd probably choose time manipulation. Time is the one resource that I seem to never have enough of.

WHAT'S YOUR FAVORITE TECHNOLOGICAL ADVANCE SO FAR?
Here's my shameless plug for Intel: My favorite technological advance would be Moore's law as applied to the microprocessor. This powerful combination enabled the democratization of technology so the entire world can benefit. Moore's law is responsible for the giant generational leap between my dad learning electronics as a kid by building radios and my 4-year-old son learning by building autonomous robots.

WHAT'S YOUR FAVORITE THING TO READ FOR PLEASURE?
My favorite book is W.E.B. Du Bois's *Souls of Black Folk*. Du Bois was the first person of African descent to earn a PhD at Harvard. While teaching at my alma mater, what was then Atlanta University (now Clark Atlanta University), he wrote this classic.

HOW DO YOU OVERCOME A CHALLENGE?
Einstein once said, "If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions." That's sums up how I handle life. I devote considerable time identifying the root cause of the challenge, then I develop a solution.

IF YOU HAD TO PICK A DIFFERENT PROFESSION, WHAT WOULD IT BE?
I love people. I love giving. I love solving problems. With that said, I'd choose to be a career philanthropist/consultant. I'd spend all of my time understanding complex societal problems, specifically those which technological ingenuity alone cannot solve.

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YEMAYA BORDAIN

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CAMPUS TEAM DEVELOPING ACCESSIBLE VOICE AMPLIFIER

A team including Skot Wiedmann, an ECE ILLINOIS electronics services shop technician, earned a $10,000 proof-of-concept award from the university's Office of Technology Management. They're developing a wheelchair-attached amplifying device for people whose voices aren't loud enough to carry in crowded spaces. The team is carrying on the project in memory of student Alexis Wernsing, who was working with them to design the device to fit her needs in the classroom and died in October.

COMPANIES MOVE INTO RESEARCH PARK

The Research Park at the University of Illinois welcomed last fall the Dow Agrosciences Innovation Facility, the Capital One Illinois Digital Campus Lab, Granular and Agrible, Inc. The companies employ students pursuing a range of subject areas, from data science to chemical and biological analysis. Research Park created a "You're Welcome" initiative to promote Urbana-Champaign as a hub for high-tech innovation and startup talent.

CROP YIELDS WILL NEED A BOOST

Researchers from Illinois and the CAS-MPG Partner Institute of Computational Biology in Shanghai argue in the journal *Cell* that plants' photosynthetic efficiency must be boosted to increase crop yields enough to feed a skyrocketing world population. The report proposes several methods using high-performance computing and genetic engineering to model photosynthesis and overcome bottlenecks in the process.

BARBARA WILSON APPOINTED INTERIM CHANCELLOR

The University of Illinois Board of Trustees' Executive Committee appointed Barbara Wilson as acting chancellor of the Urbana campus last fall. She is serving as interim chancellor until the university selects a new permanent replacement. Wilson is Harry A. Preble Dean of the College of Liberal Arts and Sciences. Former Chancellor Phyllis Wise stepped down in August.

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