BUILDING COMMUNITY ENGINEERING OUR FUTURE STORING DATA
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BRIDGING ENGINEERING AND HIP HOP CONNECTING CORPORATIONS

# RESONANCE

THE MAGAZINE OF ECE ILLINOIS

SPRING/SUMMER 2017


# BUILDING COMMUNITY

ILLINOIS

# TOP OF MIND

Building community has been an important part of my mission as department head. Alumni, current students, staff, faculty, state and federal government, industry, and the general public are all important parts of the ECE ILLINOIS community. Together, we are building one of the largest and best ECE departments in the world. We are doing the work that ensures we will have the same unique impact in the first half of this century as we did in the second half of the last.

This issue's feature story (beginning on page 13) highlights the significant ways that our new ECE Building has facilitated community building by enhancing the curriculum, special events, and the overall learning environment for our students and faculty. These modernizations have helped us secure and improve our reputation. None of it would have been possible without the generous support of our alumni and friends.

If you haven't been back to campus to see the new ECE Building, consider this to be your personal invitation. Let us know you're coming by visiting » ece.illinois.edu/alumni/visit. We'd love to see you.

Sincerely,

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

Our publication has evolved over the decades, and our editorial board wants to hear your ideas for the future. Take our 3-minute survey, and you'll be entered to win a box of ECE ILLINOIS gifts.

» go.ece.illinois.edu/ResonanceSurvey


## RESONANCE

SPRING/SUMMER 2017



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This publication is available in an accessible electronic format at **ece.illinois.edu/newsroom/resonance**, or you may contact Nicole Slack at 217.265.6285 or nslack@illinois.edu to request an alternative format of this publication.

**Electrical and Computer Engineering**
University of Illinois at Urbana-Champaign
1070 ECE Building, MC-702
306 N. Wright St., Urbana, IL 61801
ece@illinois.edu

Cover photo by Liam Frederick Photography

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"I remember missing the bus one semester and showing up late on my bike to the final lab challenge in ECE 110..."

Pixels.io founder Grace Woo (BSEE '05)

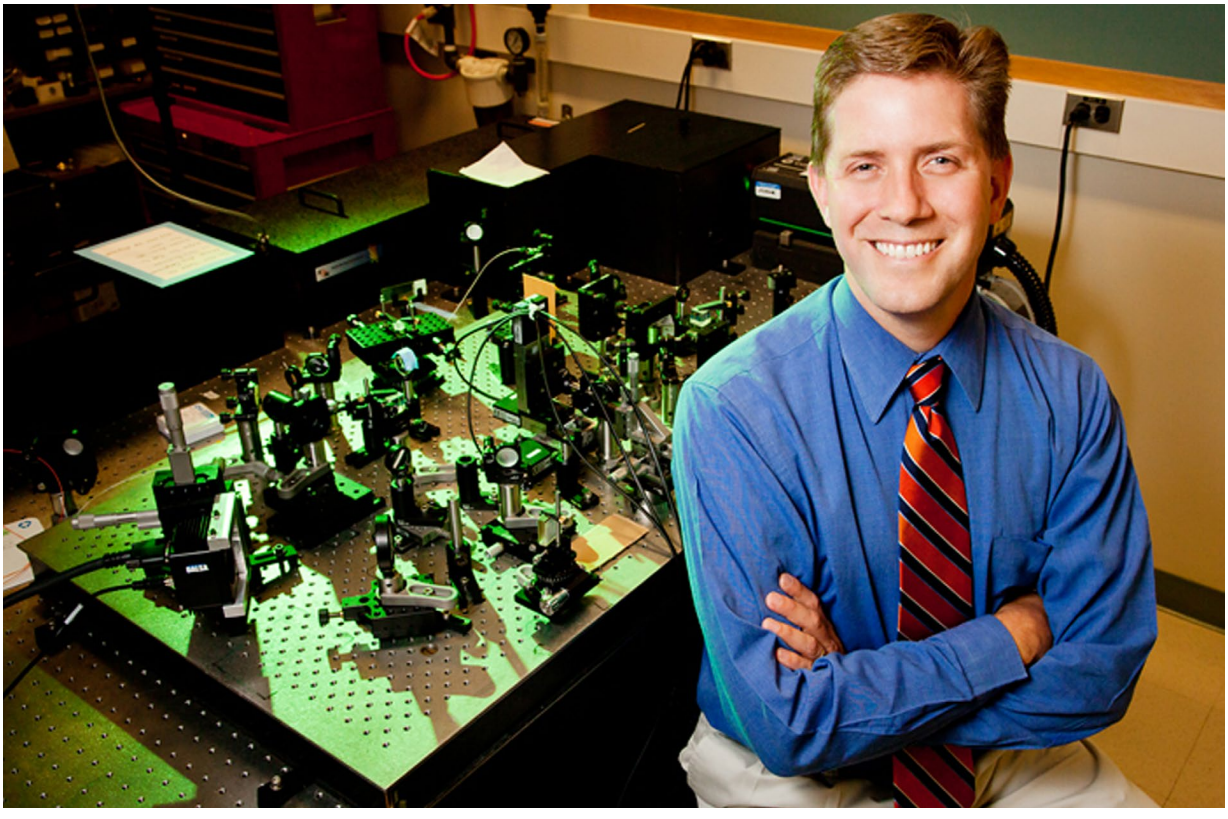
# ACROSS THE SPECTRUM

## NEW FACULTY FELLOWS AND SCHOLARS

ECE ILLINOIS named seven new faculty fellows and scholars. This appointment recognizes professors who have made a distinct contribution early in their career.

"The seven faculty members receiving this distinction have demonstrated outstanding commitment to teaching and research," ECE ILLINOIS Department Head William H. Sanders said. "Their work has been a valued asset to this department. Their exceptional scholarship and distinction can be recognized thanks to the alumni and friends who generously provided the funds to make these appointments possible."

Read the full list of newly appointed faculty fellows and scholars online.
» go.ece.illinois.edu/2017FellowsScholars.

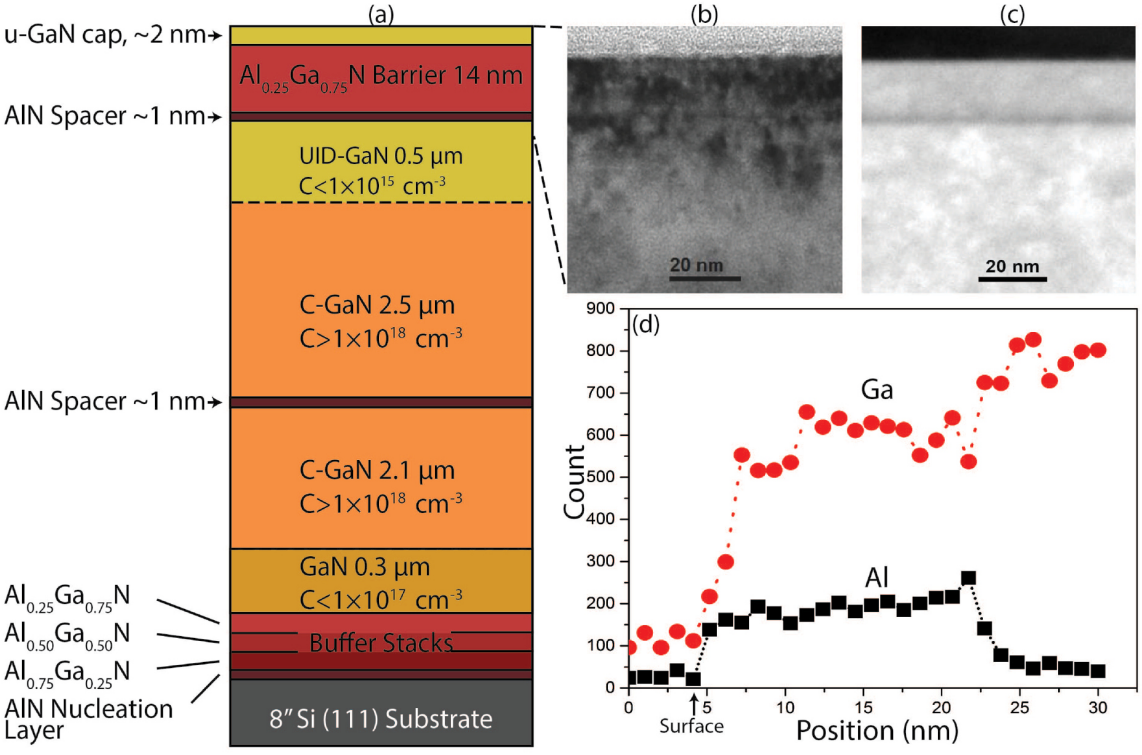


## BREAKTHROUGH IN CANCER RESEARCH

Abel Bliss Professor of Engineering Stephen Allen Boppart and his team of researchers at Illinois have discovered the major role vesicles play in the spreading of cancer cells. Together with changes in metabolism, increased vesicle production could be a cause of the large-scale changes in tumor tissue rather than just an effect. Their research also provided evidence that vesicles from cancer cells may play a role in spreading cancer to other tissues in addition to changing a tumor's local environment.

## IMPROVEMENTS IN GAN-ON-SILICON TECHNOLOGY

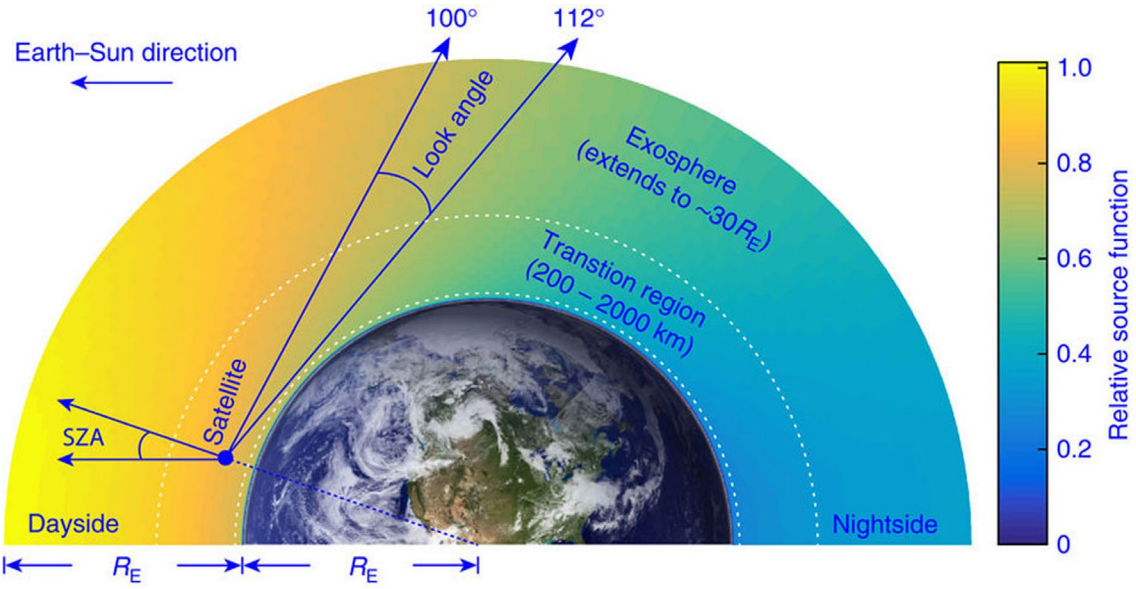
A team of Illinois researchers has advanced gallium nitride (GaN)-on-silicon transistor technology by optimizing the composition of the semiconductor layers that make up the device. Assistant Professor Can Bayram led the team who worked with Veeco and IBM to create the high electron mobility transistor (HEMT) structure on a 200 mm silicon substrate with a process that will scale to larger industry-standard wafer sizes.




A figure from the team's article, including (a) Cross sectional structure. (b) TEM image of top 80 nm of the HEMT structure. The dark gray layer marks the start of the surface. (c) STEM image of top 80 nm. The surface starts beneath the black layer and the dark band in the image is the AlN spacer. (d) EDS chemical analysis of top 25 nm. Data before 4 nm are the background values from above the surface.

## ACM DOCTORAL DISSERTATION AWARD

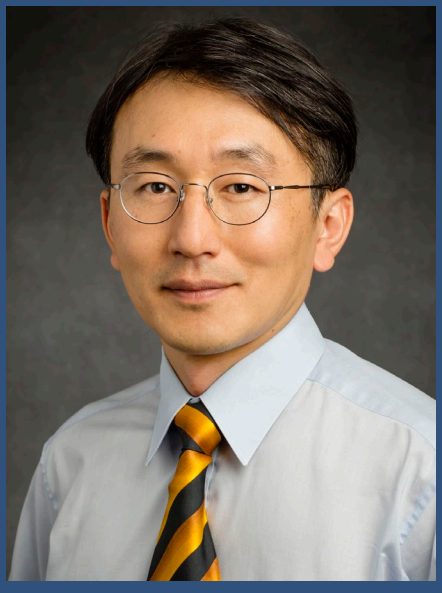
The Association for Computing Machinery (ACM) recognized Assistant Professor Haitham Hassanieh with the 2016 Doctoral Dissertation Award. In his dissertation, *The Sparse Fourier Transform: Theory and Practice,* he developed more efficient algorithms for computing the Fourier transform, a fundamental tool for processing streams of data in computer science. His algorithm was previously chosen by MIT Technology Review as one of the top 10 breakthrough technologies of 2012.




## HOT HYDROGEN ATOMS IN EARTH'S UPPER ATMOSPHERE

A team of researchers led by Assistant Professor Lara Waldrop have discovered the existence of hot atomic hydrogen (H) atoms in an upper layer of Earth's atmosphere known as the thermosphere. This finding significantly changes current understanding of the H distribution and its interaction with other atmospheric constituents. Waldrop believes the results suggest that current atmospheric models are missing some key physics that could impact different studies including atmospheric escape and the thermal structure of the upper atmosphere.

## ISCA INFLUENTIAL PAPER AWARD



As a doctoral student, Nam Sung Kim proposed a new circuit and architecture cross-cutting design technique that tackled microprocessor design challenges associated with the increase of power consumption in the circuit and architecture communities. Fifteen years later, the associate professor is being honored at the International Symposium on Computer Architecture, the largest conference in its field.

Kim's paper, *Drowsy Caches: Simple Techniques for Reducing Leakage Power*, has been given the 2017 ISCA Influential Paper Award. This recognition goes to the paper from the ISCA proceedings 15 years earlier that has had the most impact on the field.

ARM – a leader in microprocessor intellectual property used in more than 60% of the world's mobile devices – licensed patents associated with Drowsy Caches, and on-chip cache design and management techniques similar to Drowsy Caches are used by practically all commercial microprocessors.

## LEADERSHIP IN DIVERSITY

The Office of Diversity, Equity, and Access honored two members of the ECE ILLINOIS faculty and staff with awards at the 31st Annual Celebration of Diversity.

Staff member and alumnus Dan Mast (BSEE '84) was part of the Wireless Elevator Remote Control (WERC) project that was honored for Excellence in Access and Accommodations recognizing efforts to expand and improve the utilization of programs and structures by persons with disabilities.

Professor Lynford L. Goddard received the Larine Y. Cowan "Make a Difference Award" for his exceptional dedication to, and success in, promoting diversity and inclusion via research, hiring practices, courses, programs, and events.


**Photo of Mast (left) by** Rick Danzl/*The News-Gazette*

## ADVANCEMENT OFFICE

In June, ECE ILLINOIS welcomed Heather Vazquez, senior director of advancement. She has been part of the Illinois campus community for nearly twelve years, most recently serving as director of development and alumni relations for the School of Labor and Employment Relations (LER).

She is a newly elected board member of the Champaign Unit 4 School District and former president of the Junior League of Champaign Urbana. She and her husband Lucio, a Spanish teacher, are proud parents of one son.

## ALUMNI AWARD WINNERS SPEAK

Each year, a select number of elite alumni are recognized by the ECE Alumni Board for their leadership, impact, and advancement of ECE ILLINOIS' reputation.

We asked them to talk about their experiences on campus and for advice to new graduates transitioning to the next phase of their careers.

Learn some of their answers in a video at
» go.ece.illinois.edu/AlumniAdvice2016

# WHAT IS ONE TECHNOLOGY ON THE HORIZON THAT YOU THINK WILL HAVE A BIG IMPACT ON THE FUTURE?

During the Distinguished Alumni Panel, alumni awards recipients answered questions from current students. Moderator Michael VanBlaricum, ECE Alumni Board president, asked them for predictions about the future of technology. Here are some of their answers:

### MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE
-Gregg Zehr (BS '76, MS '77)

### BATTERIES AND ALTERNATIVE ENERGY
-Clifford Higgerson (BSEE '62)

### POWER STORAGE
-Jim Solari (BSEE '77)

### INTERNET OF THINGS
-Jerome Hubacek (BSEE '85, MSEE '86, PhD '92)

### MACHINE LEARNING, SWARM ROBOTICS, AND CHANGING THE PERCEPTION OF ENGINEERING
-Nancy Warter-Perez (MSEE '89, PhD '93)

### MERGING OF BIOTECHNOLOGY AND TELECOMMUNICATIONS, SUCH AS WEARABLES
-John Thode (BSEE '79)

### UNDERSTANDING THE BRAIN, ESPECIALLY EMOTIONS AND INTELLIGENCE
-Doyeol Ahn (PhD '88)

**Photo by** Mark Finkenstaedt/National Academy of Sciences via *Associated Press*

## RALPH J. CICERONE

Alumnus Ralph J. Cicerone died November 5, 2016. Recognized as one of the most influential atmospheric scientists of all time, he influenced those around him through his research, service, and teaching.

Cicerone was highly respected at Illinois, receiving several honors including an ECE ILLINOIS Distinguished Professor Award, the Engineering at Illinois Distinguished Alumni Award, and an Honorary doctorate. His work extended to various universities including the University of California Irvine where he became the Dean of Physical Sciences and then the fourth Chancellor.

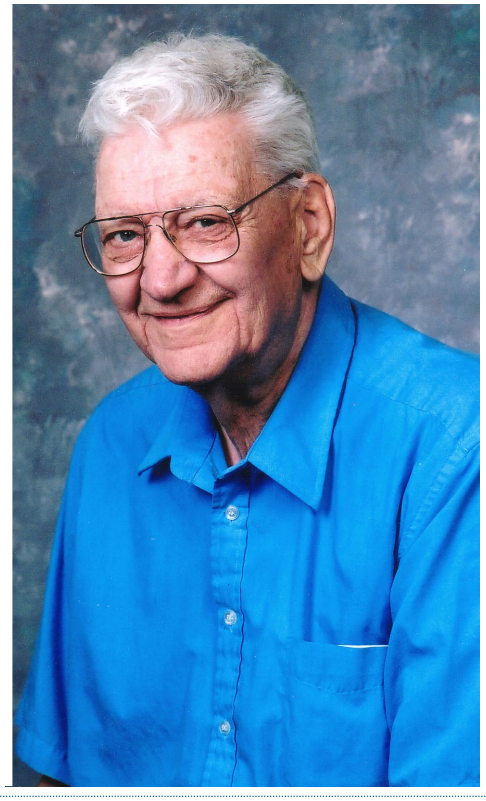
In 2005 Cicerone became President of the National Academy of Sciences (NAS) where he helped increase the number of women and minorities elected into the organization. Many important media outlets have shared the news of his death, including ***The New York Times***, ***NPR***, and ***Nature***.

## GEORGE SWENSON, JR.

Professor Emeritus George Swenson, Jr., a pioneer in radio astronomy and RF sensing, passed away on February 22, 2017.

Swenson joined the faculty of both the ECE and Astronomy departments in 1956 after receiving his PhD from University of Wisconsin at Madison and several brief stints at other universities. During his time at Illinois, he served as department head for the Astronomy department from 1970-72 and then as the ECE department head from 1979-85. Although he officially retired in 1988, he continued his presence in the department through sponsored research work until December 2012.

Swenson will be remembered not only for the significance of his achievements in his field, but also for his adventurous personality. He spent his free time piloting planes, hiking and exploring nature, which included being the first person to make it to the summit of Alaska's Institute Peak.



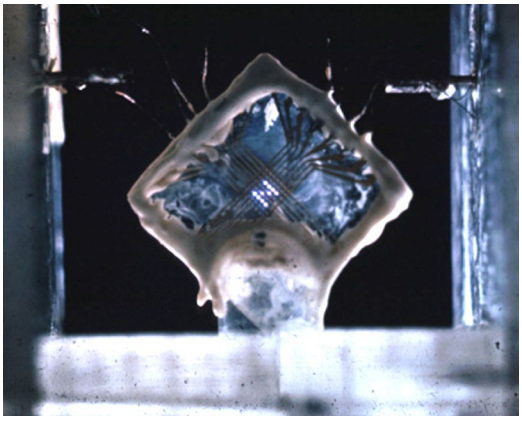
MICHAEL L. VANBLARICUM (BSEE '72, MSEE '74, PhD '76) is passionate about history and curating collections. He serves as the president of the ECE ILLINOIS Alumni Board and the Spurlock Museum Advisory Board.

He penned an article for the museum's magazine about a particularly notable artifact on display at the museum. An edited portion is reproduced below with permission.

# ARTIFACT HIGHLIGHT:

## THE 64-PIXEL PLASMA DISPLAY PANEL

BY MICHAEL L. VANBLARICUM



The 4 x 4 display in mounting bracket and display.

Read the article in its entirety and learn more about the museum at » **www.spurlock.illinois.edu.**

In the technology case, behind a nineteenth-century Chinese gimbal-mounted compass, is a small, less than 2" by 2," piece of glass with wires connected to it labeled "Prototype 64-pixel Plasma Display." This one small artifact represents major developments in the evolution of education and entertainment. In fact, this little prototype represents the beginning of the stories of the first use of a computer for pedagogy, the first time-shared education system, the first on-line community, the first flat panel computer screen, the first interactive touch screen, the start of on-line gaming, and the success of HDTV.

Donald L. Bitzer (BSEE '55, MSEE '56, PhD '60), along with H. Gene Slottow (PhD '64) and graduate student Robert Willson (BSEE '59, MSEE' 61, PhD '66), started investigating the use of a matrix of discrete neon cells which could be addressed as individual pixels. After a few false starts, they realized that the simplest configuration for the cells would be to drill a hole in a thin glass slide, place glass plates on either side of the slide with the hole in it, and attach driving electrodes on the outside of the glass plates.

The first device was built with an ultrasonically drilled hole fifteen thousandths of an inch (0.015 in.) wide. Very thin gold electrodes were deposited on the outside. The entire sandwich was sealed with epoxy on three sides and connected to a vacuum pump via a tube. The system was then pumped clean and back-filled with neon. This was July 1964 and the single cell glowed blue.

Until the end of 1965, the research team continued to experiment with only single cells in order to understand the processes. After the single pixel device was successfully built, tested, and understood, the research was focused on developing a matrix of pixels. By the summer of 1966, they had built several 8 x 8 display panels but tested them initially in a 4 x 4 section. The earliest photo of a working plasma matrix shows a 4 x 4 display (16 pixels) with the letter "N" displayed in a blue glow (pictured). This was a major milestone in the development of the plasma display because it was the first addressable matrix of plasma cells. Upon close observation, one can see that this panel does have 64 holes and is configured as a potential 8 x 8 panel with eight gold electrodes on a side. However, even closer inspection shows that only four of the eight electrodes are connected to external circuitry and hence this becomes a 16-pixel matrix panel. This first addressable plasma matrix display was built by graduate student Brij Arora (MSEE'68, PhD '72). The addressable 8 x 8 matrix displayed at Spurlock was built by Roger Johnson (BSEE '65, MSEE '66, PhD '70).

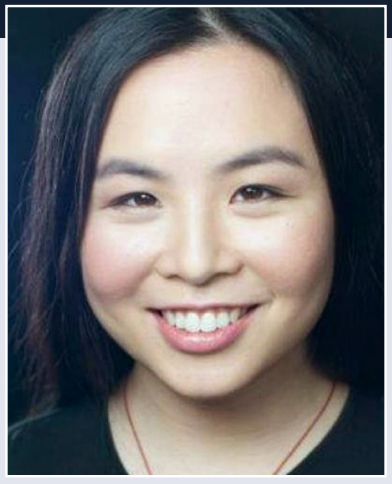
## 150 YEARS OF EXCELLENCE

For the past 150 years, Illinois faculty, staff, and students have transformed the world around us. As a leading institution of higher learning, Illinois continues to expand its global presence. On February 28, we kicked off a fifteen-month-long celebration highlighting the accomplishments of the university and our ambitious vision for the future.

There will be projects throughout the year, including design-centered opportunities for students to contribute ideas for the new Siebel Center for Design. Musical works and published books celebrate Illinois during this time, and museum exhibitions will appear all over campus. To learn more about the sesquicentennial celebration or to share your memories of Illinois, visit » 150.illinois.edu.

## REFLECTING ON A CENTURY AND A HALF

The *News-Gazette* is helping celebrate by collecting Illini stories about the places and spaces that have made indelible impressions on our campus community, including these two ECE ILLINOIS highlights.



ALUMNUS AND FORMER ECE ILLINOIS PROFESSOR KENT FUCHS (MSEE '82, PhD '85) currently serves as the President of the University of Florida.

"My strongest memory of a physical place is the intersection of West Green and South Wright streets — the center of my university life for 17 years. Everitt Lab was on the northeast corner, and it was there that I took my classes and served as a TA in my early years as a graduate student. Although my office later moved to a different building, it was in Everitt Lab that I taught courses and went to faculty meetings in my years as a faculty member," said Fuchs.

PIXELS.IO FOUNDER GRACE WOO (BSEE '05) was recognized by *The News-Gazette* as one of 10 female graduates that went on to greatness. She shared some of her memories of the University, including how one unfortunate morning turned into a stroke of luck in one of her first ECE classes.

"I remember missing the bus one semester and showing up late on my bike to the final lab challenge in ECE 110," Woo said. "The extra-credit assignment involved getting an autonomous car to catch a ball while following a windy path using infrared sensors and TTL logic. With a great stroke of luck and a minor miracle, our car caught that ball in class and I still have the toolset we won with me today."

# IN THE MEDIA


***The New York Times***, ***phys.org***, ***Fox News***, ***Popular Mechanics***, ***MSN***, ***Live Science***, and ***IEEE Spectrum*** all shared Professor Seth Andrew Hutchinson's team's latest iteration of their self-contained robotic bat. Dubbed Bat Bot (B2), the robot has flexible, articulated wings that mimic the key flight mechanisms of biological bats.

The ***Chicago Tribune*** featured Professor Nikita Borisov's suggestions on how to avoid being a victim of the Gmail phishing attack. "The way a lot of scams get perpetrated is by fooling you into thinking that you're typing your password into a legitimate site such as Gmail, but of course, you're actually redirected to a website that is run by the attacker," Borisov explained.

***NPR*** created a video explaining research led by Professor Viktor Gruev who is leveraging the unique properties of Mantis shrimp eyesight to detect cancerous cells. "It's kind of the cancer moonshot," Gruev told *NPR*. "Right now, we are still detecting cancer way too late in the game."

## ALUMNI IN THE MEDIA

***Built In Chicago*** featured alumnus Jake Battle (BSCompE '96), senior staff engineer for Civis Analytics. He encouraged engineers to turn their passion for coding into a career. "The core idea I've always found compelling about programming is that writing code is fundamentally an act of creation. When we write a program, no matter how small, it is like creating our very own little universe," Battle said in the article.

***Crain's Chicago Business*** highlighted the work of alumnus Sam Glassenberg (BSCompE '02), founder of Level EX and creator of the app iLarynx, a fiber-optic laryngoscopy simulator application to help train medical residents on their iPads. "It looks exactly like the procedure. It behaves exactly like the procedure," Glassenberg told *Crain's Chicago Business*. "The patient bleeds. The patient coughs. The device manipulates just like it would. We work very closely with the doctors to make sure that we got everything accurate."

***Forbes India*** recently profiled two alumni, Aswhin Suresh (BSEE '05) and Anirudh Pandita (MSEE '06), who co-founded the digital entertainment startup Pocket Aces in 2014. "We are laying the foundation for the nascent digital entertainment industry in India and look up to companies like Pixar as benchmarks for creative innovation," Suresh told Forbes India.

***The Wall Street Journal*** shared an article about alumni Quesnell Hartmann (PhD '98) and David Ahmari (PhD '98) who are funding the expansion of the II-VI EpiWorks Division of II-VI Incorporated in Champaign, Illinois. The expansion is expected to be complete by mid-2017 and will enable a quadrupling of capacity over the next three years.


# BUILDING COMMUNITY

BY VICTORIA HALEWICZ, KHUSHBOO JAIN, AND JULIA SULLIVAN

Where can you host a gathering for more than 400 newly admitted students? Is there a space where State of Illinois leadership can see our research in action? Our newly invested professors need a place to celebrate after the formal ceremony. Can my small group have a space to study that's close to our lecture? Where can we host a hackathon? And where do I have to go to get a good cup of coffee?

These are just some of the needs that the new ECE Building has fulfilled since it opened in 2014. At 235,000 square feet, the building is nearly twice the size of the department's former location, Everitt Laboratory.

Each space in the building is designed with intentionality, focused on creating a collaborative, superlative learning and research space. The successful execution of this concept earned the building the 2016 R&D Lab of the Year distinction. The prestigious, international competition recognizes the best new and renovated laboratories that combine all aspects of the building into a superior working environment.

Continued »

The building's lobby makes a strong first impression on visitors. Tables equipped with power outlets share the space with clusters of chairs arranged to facilitate conversation. The grand staircase draws the eye to the second floor bridge and the two-story nanofabrication lab, the first of its kind for undergraduate students in the United States. Despite its impressive appearance, this lobby functions more like a home base than a detached ivory tower.

"We certainly didn't imagine how the atrium would become so populated from day one," said Erhan Kudeki, ECE ILLINOIS professor and associate head for undergraduate affairs/chief advisor. "The moment the tables were put there, they were occupied, and we were all amazed. It became like the living room of someone's house. It was a delight to see this happen."

The lobby undergoes several transformations throughout the year. In the fall, the study tables are swapped for displays from student organizations recruiting new members during Ignition, the department's annual new student welcome event. During the year, the lobby is the location for Corporate Connections After Hours where students can meet representatives from companies to discuss internships and other opportunities (see page 32). It's also one of the many locations for Engineering Open House, connecting the public with students and their ideas.

Engineering students scatter across the entrance area Monday at the new Department of Electrical and Computer Engineering (ECE) building on the University of Illinois campus in Champaign.

Heather Coit/The News-Gazette

UPGRADED

Students find lots to like in new ECE bui

By JULIE WURTH
jwurth@news-gazette.com

The "Daily Byte" cafe isn't open yet. There are still a few holes instead of trees outside. Equipment is piled up in some rooms, and one entrance reads "Keep Out."

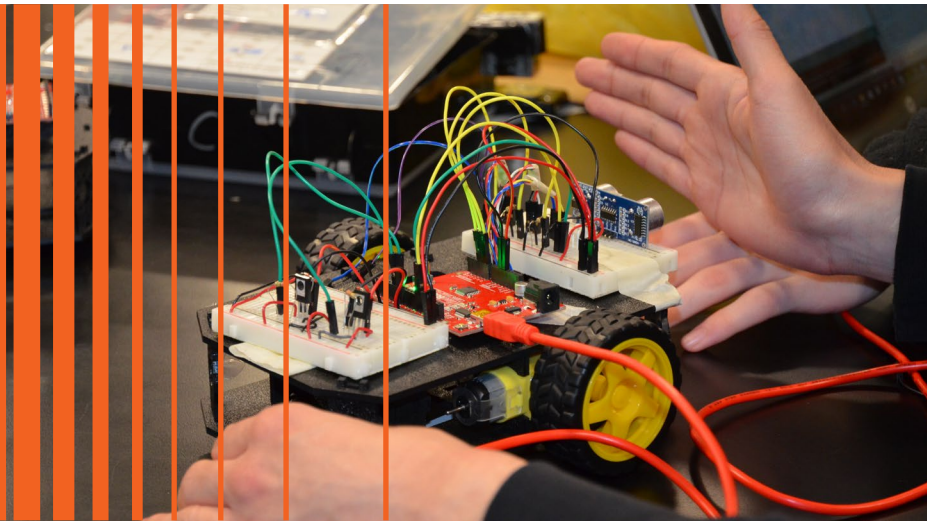
None of that seemed to matter Monday to University of Illinois students enjoying their first day of classes in the $95 million Electrical and Computer Engineering building, decades in the making and just about complete.

The consensus view: a huge, high-tech improvement over the department's home for more than half a century, Everitt Lab at Green and Wright streets.

Everitt wasn't designed for "the department of today. What is the electrical and computer engineering department of the future going to look like? This is a great embodiment of that vision," sa

news-gazette.com
Check out Heather Coit's video story from a busy first day at th

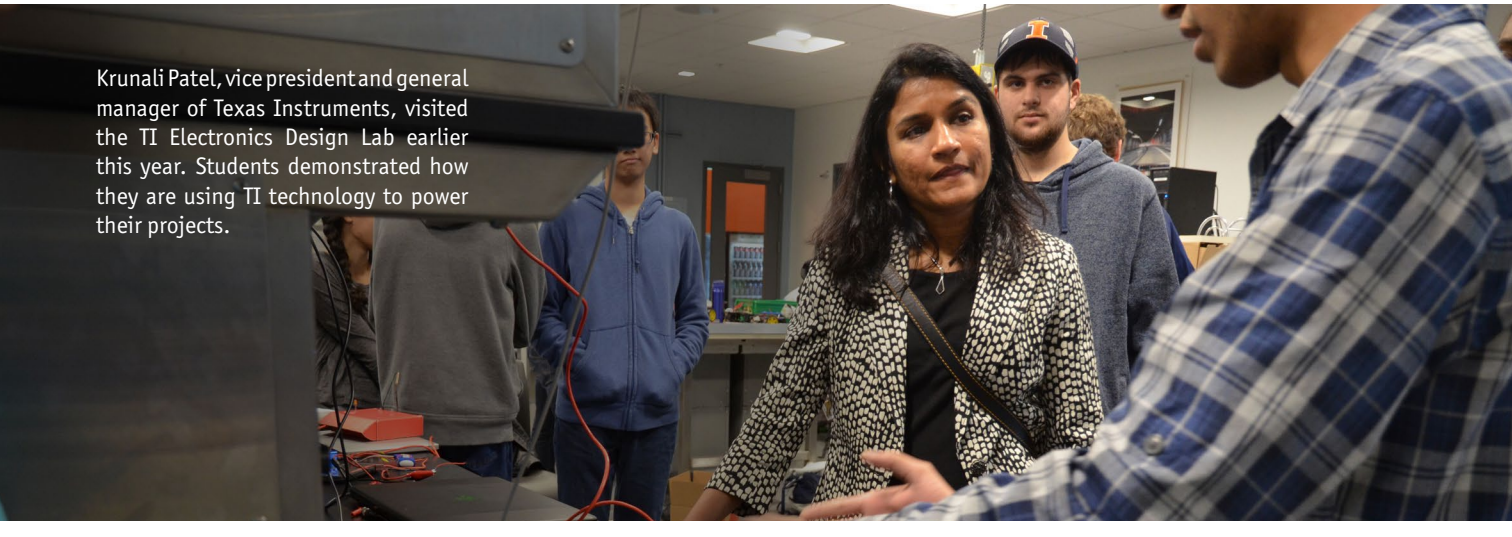

Previous page: Representatives from the Caterpillar Foundation cut the ribbon on a named classroom space in 2014. Top: ***The News-Gazette*** helped the department celebrate the first day of classes in the new building in 2014. Above: A trio of young students are drawn in by one of the exhibits at Engineering Open House in the lobby of the ECE Building. Opposite: Photo by Chad Olson



But the first floor of the building isn't just for large events. An array of glass windows offers a view inside the Texas Instruments Electronics Design Lab. This space is one of the best examples of how the new facility has helped shape curriculum. The named space is home to ECE 110, Introduction to Electronics, the fundamental course that serves nearly 500 students each semester, both in ECE and in other engineering disciplines.

The course took a major leap forward in 2014 thanks to expanded lab space and laboratory equipment generously donated by Texas Instruments. Senior lecturer Chris Schmitz and other faculty members have continued to search for ways to enhance the hands-on learning experience. Thanks to a grant from the College of Engineering's Strategic Instructional Innovations Program (SIIP), the curriculum has been adjusted to ensure stronger consistency across all four lecture sections and 16 labs. Time is now allotted towards the end of lab sections for students to work on personal projects, and a merit section for underrepresented students has been formed to help students build confidence and connect.

Learn more about the three-year project at » go.ece.illinois.edu/110revamp.



Krunali Patel, vice president and general manager of Texas Instruments, visited the TI Electronics Design Lab earlier this year. Students demonstrated how they are using TI technology to power their projects.

The Open Lab, located on the second floor, is a designated space for students to explore their interests outside of typical classroom requirements. This lab is strict about its no-homework policy. Here, students are encouraged to take an active role in their education: information learned in class is applied towards projects that can result in both personal and social impact.

Linda Reinhard (BSEE '97), VP and Market Leader for the Energy and Buildings group at Penton and a member of the ECE Alumni Board, continues to be impressed by this student-driven space.

"It is important to allow the engineers to pursue their own interests and ideas," Reinhard said. "That is the foundation of innovation."

Casey Smith (BSCompE '99, MSEE '01), senior instructional lab coordinator, explained that one of the most enjoyable things about the Open Lab is seeing engineering spread across all disciplines. Any student can apply for access.

"When I was a student, there wasn't any place to do this, you would have to do it at home, so it's really nice to have a place where the students can come between classes to maybe fiddle around with something for a few minutes," Smith said.

In just a few years, this space has inspired students to engage in lunar mining competitions funded by NASA, make therapeutic robot dolls, and teach high schoolers how to solder. Learn more about the Open Lab at » go.ece.illinois.edu/ECEOpenLab.

**"THAT IS THE FOUNDATION OF INNOVATION."**

**LINDA REINHARD**

The new ECEB not only fosters community among current students, but it also inspires alumni. Whether returning to campus to present at Explorations, a weekly seminar for undergraduate students (see page 26), or for a personal visit, many have commented on the fresh energy in the space.

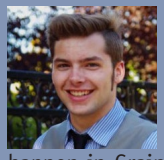
"There's definitely a sense of pride in the new building, especially for those of us that were involved in its planning and fundraising," said Chris George (BSCompE '97, MSEE '99), a Chicago-based patent attorney and former ECE Alumni Board president. "It's great to come back for alumni events in the building, rather than meeting somewhere else. We can interact with faculty and students and see what's going on in the department when we come back to campus for a visit."

Just like the ECE ILLINOIS community, the building continues to evolve. Installation of solar panels and an associated learning lab are goals of the target net-zero building design.

"Having a world-class facility that reflects the quality of our research and curriculum has been vital to our recruiting efforts," said William H. Sanders, department head. In fact, sixteen new faculty members joined ECE ILLINOIS this past academic year.

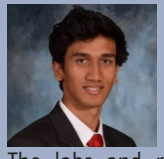
"Our building is a physical manifestation of our legacy. It is a place where engineers start, develop, and advance their careers," Sanders said. "Bright minds conduct cutting-edge research here every day in spaces that facilitate innovation thanks to the generosity of our donors, corporate partners, and friends."

Last year's seniors were the last class of undergraduates to have spent time in Everitt Lab when it was home to the department. We asked them to share some of the benefits of the new space.



"One of the best things [the new building] has done is bring ECE and CS closer, because a lot of the big CS courses happen in Grainger Auditorium. It helps bridge the gap a little more."

*- Grant Everett (BSCompE '17)*



"The new building is a lot more spacious, and the atrium is really cool because a lot of people can sit there and study. The labs and rooms [have large glass windows] and you can see all the cool projects happening there. You feel more connected to your major that way."

*- Abhideep Dasgupta (BSEE '17)*

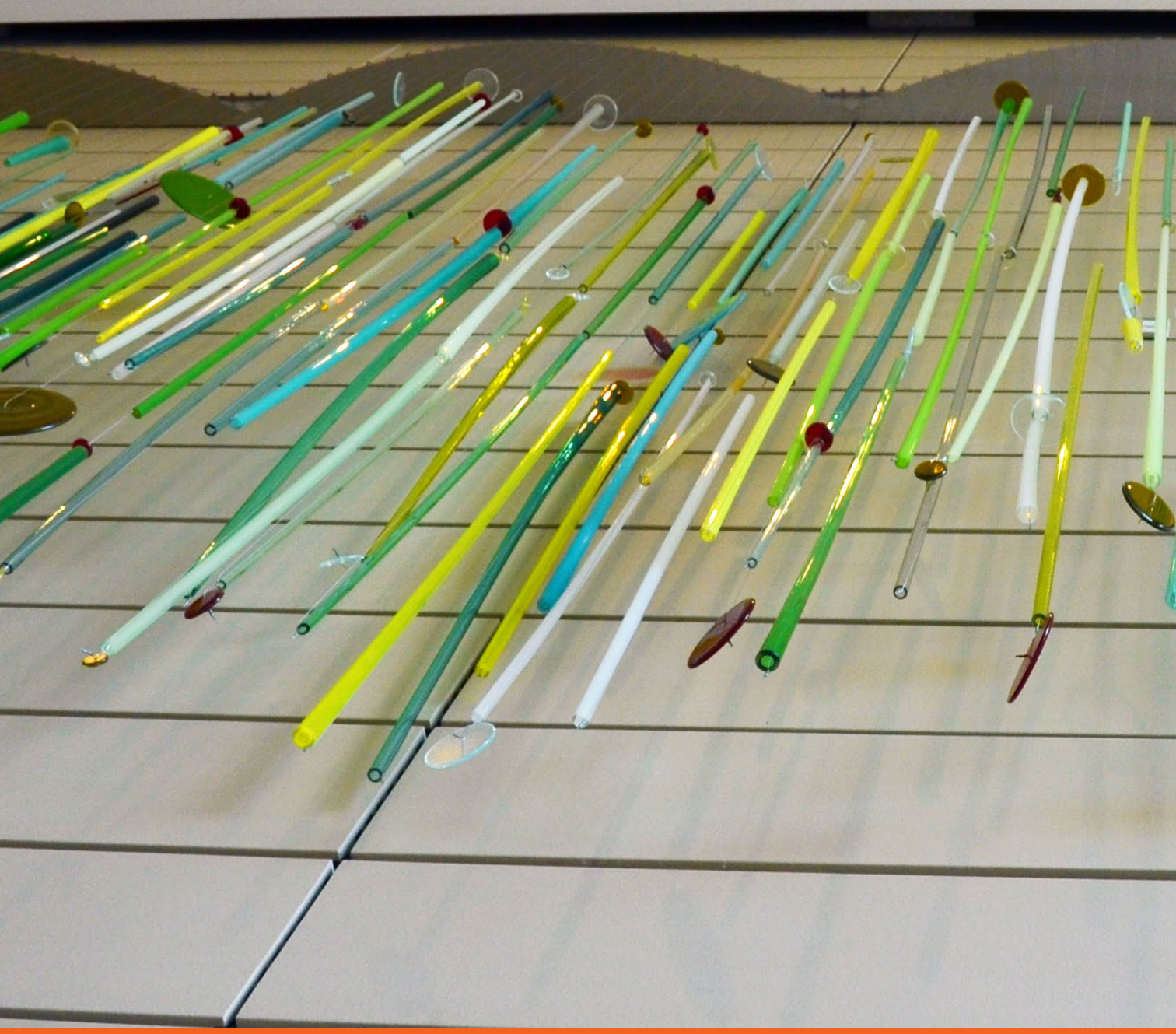
"The rooms are more versatile, especially with all the technological upgrades and outlets in classrooms. It's a very well lit building, which makes you want to study there. Having big computer labs, you tend to see people working on the same stuff that you are currently working on."

*- Jesse Crowe (BSEE '17)*

**"OUR BUILDING IS A PHYSICAL MANIFESTATION OF OUR LEGACY. IT IS A PLACE WHERE ENGINEERING START, DEVELOP, AND ADVANCE THEIR CAREERS."**

**-WILLIAM H. SANDERS, DEPARTMENT HEAD**

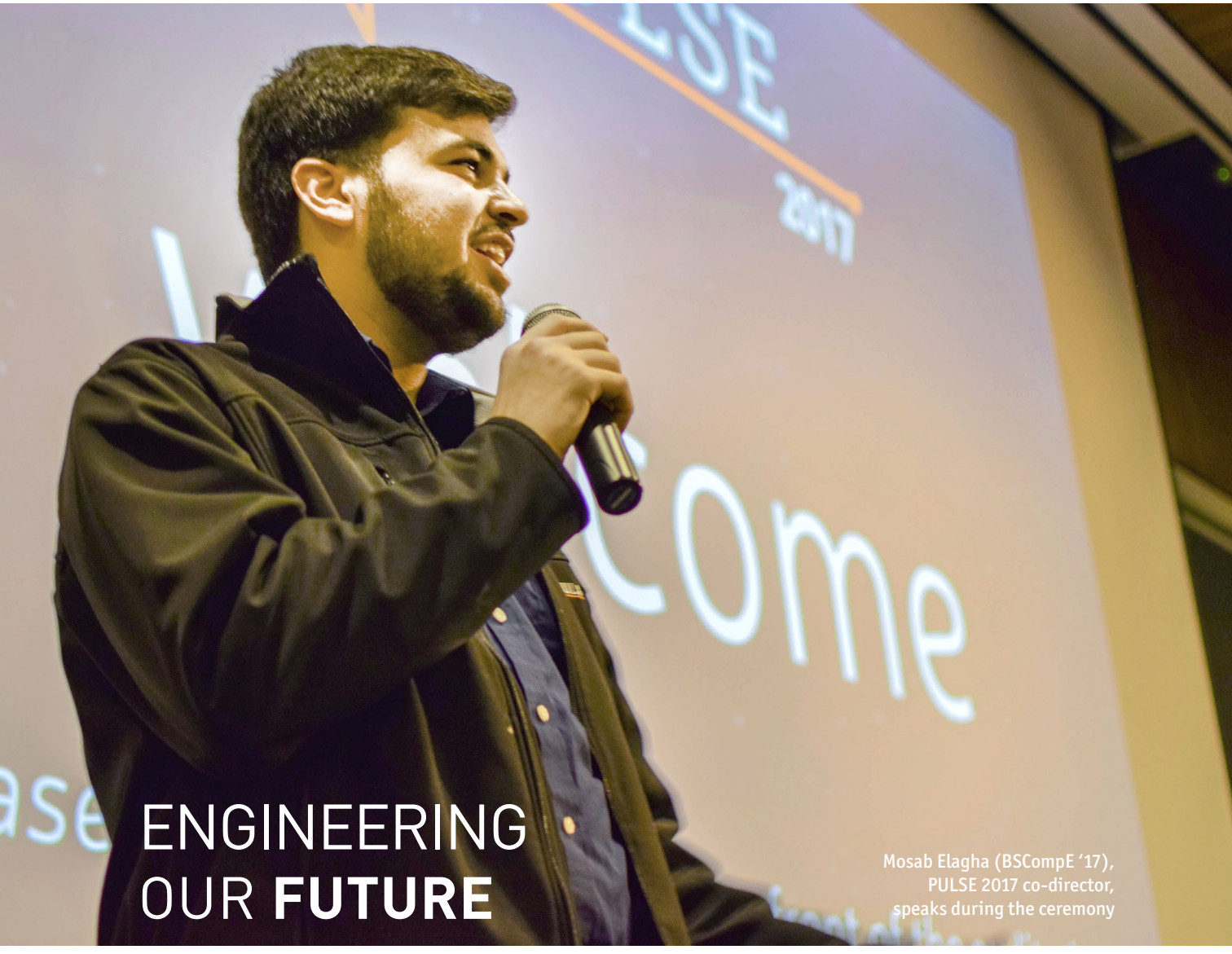
# FOCAL POINT



ECE ILLINOIS
Department of Electrical and Computer Engineering

PHOTOS BY JULIA SULLIVAN AND NATALIE FIOL (INSET)

» A NEW ART INSTALLATION ADORNS THE NORTH WALL OF THE ECE BUILDING LOBBY. CREATED BY FINE AND APPLIED ARTS ALUMNA HOLLY WOLF-MATTICK, THE PIECE IS PART OF THE STATE OF ILLINOIS' ART-IN-ARCHITECTURE PROGRAM. IT IS COMPOSED OF 210 STRANDS OF COLORED GLASS TUBING AND DISCS SUSPENDED ON STAINLESS STEEL CABLES. THE GLASS ARTIST INSTALLED HER WORK IN AUGUST ALONG WITH A REPRESENTATIVE FROM THE STATE PROGRAM AND TWO CAMPUS FACILITIES AND SERVICES STAFF MEMBERS (INSET PHOTO).



# ENGINEERING OUR **FUTURE**

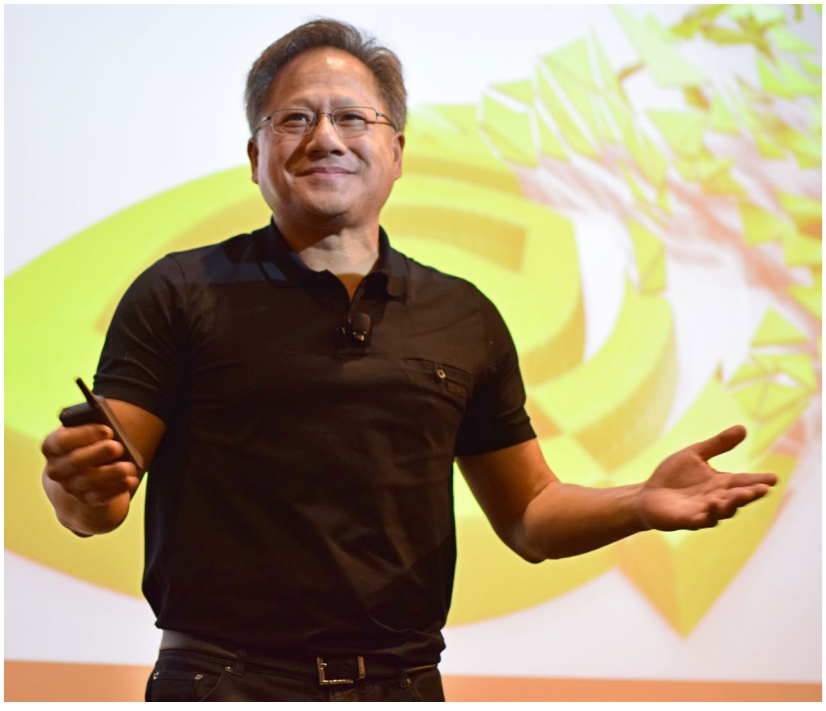
Mosab Elagha (BSCompE '17), PULSE 2017 co-director, speaks during the ceremony

BY COREY BLUMENTHAL/PHOTOS BY NICOLE XIA AND DYLAN HUANG

> **"YOU ARE ALL GOING TO CHANGE THE WORLD. I HAVE NO RESERVATIONS ABOUT THAT."**
>
> **WILLIAM H. SANDERS, ECE ILLINOIS DEPARTMENT HEAD**

A record-breaking crowd of nearly 700 filled Grainger Auditorium and the ECE Building lobby for the 2017 PULSE opening ceremony. Now in its sixth year, the entirely student-run tech conference had outstanding attendance this year, undoubtedly boosted by keynote speaker Jen-Hsuan Huang, CEO of NVIDIA.

Huang headlined tech's biggest trade show, CES, in Las Vegas earlier this year. His company's mission is to continue to improve on the technology of gaming, professional visualization, data centers, and automobiles to build a better tomorrow. The longest running CEO of any technology company, Huang is especially admired for his work with artificial intelligence. In January, Huang announced that NVIDIA would begin partnering with Audi to build the next generation AI car, the most progressive of its kind.



**"...MAKING MONEY ISN'T THE GOAL. IT IS THE RESULT OF DOING SOMETHING. YOU MUST FIND THE DIFFERENCE BETWEEN THE GAME AND THE SCORE."**

**NVIDIA CEO JEN-HSUAN HUANG, 2017 PULSE KEYNOTE SPEAKER**

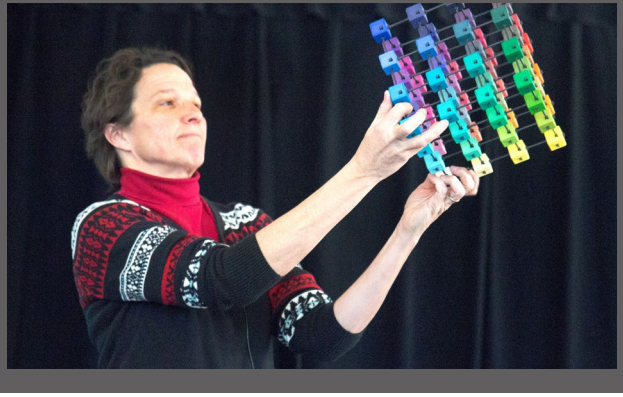
"We make it possible for people to see the future before it happens," Huang told the crowd. "We want to enable people to see what is really great for humans."

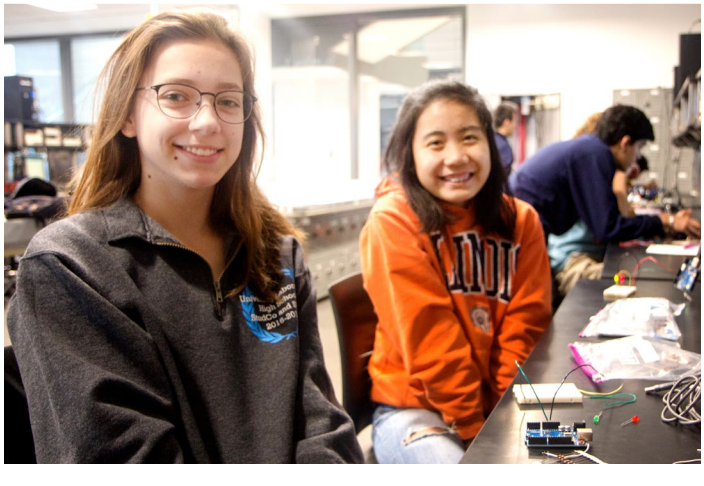
As a pioneer in the electrical and computer engineering sphere, Huang was a clear choice to speak at PULSE. He challenged the audience to think about how their work as engineers could strengthen and advance society. He discussed the specific skill that allowed him to get where he is today as well as what he has discovered along the way.

"Our contributions come from our best skills," Huang said. "My listening skill is what I am most proud of. If you stay alert, you will keep learning. We don't always make money, and making money isn't the goal. It is the result of doing something. You must find the difference between the game and the score."

The five day conference also offered workshops with NVIDIA and PULSE co-host Texas Instruments. The NVIDIA workshop, "Getting Started with Deep Learning," explained how to utilize deep neural networks, while the Texas Instruments workshop, "Teaching Mechatronics with MSP430 LaunchPad Racerbot," allowed attendees to create wireless remote control robots. Both of these companies along with Huawei, Facebook, Qualcomm, and Capitol One hosted tech talks during PULSE.

A new Speaker Series debuted on the third day of the conference, featuring two Illinois professors. CS @ ILLINOIS Professor Cinda Heeren (below left) and Physics Associate Head of Undergraduate Programs Mats Selen shared their individual research interests. Both emphasized the need for students to leverage what they learn to help build a better future.





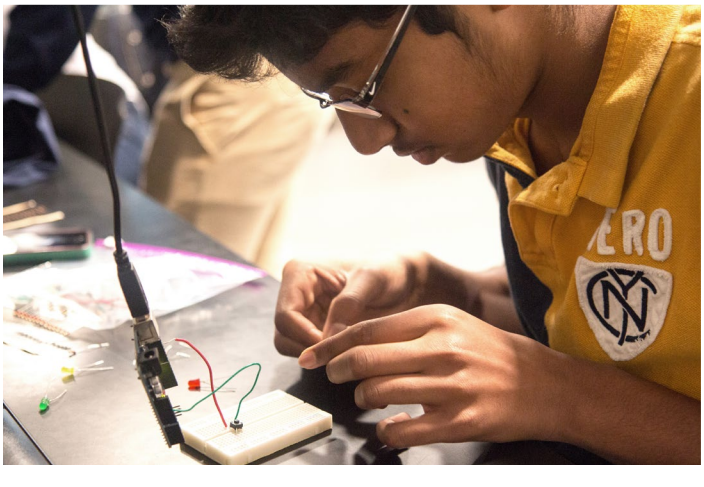
**“YOU ALL HAVE A REASON AND OPPORTUNITY TO SEEK OUT DIVERSE EXPERIENCES. DIVERSIFYING CREATES ANOTHER DIMENSION OF IDEAS,” HEEREN SAID. “I JUST WANTED TO REMIND YOU OF THAT AND THANK YOU IN ADVANCE FOR ALL THE WAYS YOU ARE GOING TO MAKE THE WORLD A BETTER PLACE.”**

Perhaps the most exciting addition to the conference was a new design competition exclusively for high school students. Students from more than six different high schools traveled to campus from as far away as Tinley Park and Arcola, Illinois, to participate.

Mosab Elagha, co-director of PULSE, was a strong advocate for expanding the reach of the conference to younger students. “After being involved for three years, I was able to see the benefits of the workshops and tech talks on undergraduate students,” Elagha said. “I figured if they had benefitted these students so much they would benefit others. Since this year’s theme was ‘Engineering Our Future,’ including the next generation of engineering students made sense.”

The high school students were able to explore the ECE Building, participate in workshops and competitions, as well as talk to members of the PULSE team.

“The high school students came to the event knowing almost nothing and left having completed their own workshops and projects,” said Elagha. “We are thinking about making it a bigger thing in the future.”



# FROM MARCHING ILLINI TO MICROSOFT

BY CAYLA WATERS

When choosing a college, cost was the largest factor in Omar Joya's decision. Thankfully, an Engineering Visionary Scholarship, combined with other support, allowed him to choose ECE ILLINOIS over competing offers.

"Many competitive programs do not carry the collaborative and supportive environment Engineering at Illinois continually tries to foster. For this reason, I could not be happier to attend this institution." During his freshman year, the caliber and rigor of the coursework was intimidating, but support from faculty, staff, and his peers helped him persevere.

This supportive and collaborative environment is what makes Illinois unique. Omar has been involved with the Society of Hispanic Professional Engineers during all four years at Illinois. Through this organization, he has met countless mentors and peers who have helped him pave the way for the rest of his career. One of his favorite undergraduate memories traveling to Beijing and Shanghai over the summer with the Hoeft Technology and Management Program.

Omar is also a member of the Marching Illini. Along with his saxophone, he has traveled with the group Dublin, Ireland, for the St. Patrick's Day Parade and New York City for the Macy's Thanksgiving Day Parade.

Omar is grateful for the incredible support of our alumni and donors. "My entire story as an engineering student would not have been possible without the support of donors. A gift goes a long way; it does not just go to a scholarship – it goes to an infinite set of experiences that otherwise would not have been possible." For this, he is proud to carry the University's name with him as he strives to make a difference in the world. "I hope that further down the line, I can support future students achieve their goals and dreams, just like someone supported me."

Following graduation this spring, he heads to Microsoft for an internship in the hardware engineering division. He plans to return to campus in the fall to pursue a graduate degree in electrical engineering.


**"MY ENTIRE STORY AS AN ENGINEERING STUDENT WOULD NOT HAVE BEEN POSSIBLE WITHOUT THE SUPPORT OF DONORS."**

Read more stories about the impact of giving at
» ece.illinois.edu/give.

Photo by the Marching Illini

# PROTECTING VOICE COMMAND PRIVACY

Could someone be recording - and exploiting - your voice commands? A new sound created by ECE researchers, including Associate Professor Romit Roy Choudhury (pictured), is completely inaudible to humans, yet detected by any microphone. It's a kind of white noise that doesn't compete with your speech, but can help shield your voice commands. Get the whole story at » **go.ece.illinois.edu/whitenoise.**

PHOTO BY DELLA PERRONE

"THE DECISION I MADE WAS TO NOT DENY ANY OF MY CURIOSITIES"

# SIMULTANEOUS SUCCESSES:
## BALANCING ENGINEERING AND HIP HOP

BY DANIEL DEXTER

Ashley Llorens' two passions came to a culmination in 2003 with a couple of significant achievements: the receipt of his master's in electrical engineering from Illinois and the release of his first hip-hop album.

Since then, Llorens (BSCompE '01, MSEE '03) has found success in both fields. He is currently the Chief of the Intelligent Systems Center at the Johns Hopkins Applied Physics Laboratory (APL). But when he's not in the research lab, Llorens devotes his time to his music career as the recording artist SoulStice, including the release of five studio albums and international tours of the U.S., Europe, and Japan.

Llorens said balancing his two professions has been "an evolution," but that it never felt like a challenge. He was just doing what he enjoyed.

"The decision I made was to not deny any of my curiosities and to accept that I was someone that had this diverse set of interests," Llorens said. "I made the commitment to myself to pursue both of the interests for as long as I could."

As the head of the Intelligent Systems Center at APL, he oversees operations and stewards the research and development efforts to discover solutions to emerging world challenges through the use of robotics and artificial intelligence. The work done at the Center provides advanced capabilities to areas of defense, intelligence, space exploration and health.

Llorens has spent his entire professional career at APL, which began serendipitously during his graduate studies at Illinois. As a master's student, he applied for the GEM Fellowship, which supports summer internship experience with a corporate sponsor to underrepresented minorities in STEM fields. He expected to

be working for a well-known corporation, so it came as a shock to learn he was going to be spending his summers at another school.

"When I opened the application I said, 'Great, I got the Fellowship... Oh man, it's another university.' I had to go halfway across the country to do an internship at another university," Llorens said. "I didn't realize that it's a not-for-profit university-affiliated research center. I was supposed to get my PhD, but I really enjoyed the internship, so I got lured away. I really connected with the work there."

What drew him in was the connection between his graduate focus of digital signal processing and the artificial intelligence projects that APL researched. When he started as a Machine Learning and Signal Processing Engineer at APL in 2003, his intention was to work for a few years before he could turn his full attention to his music. However, he came to see the creative aspects of his engineering profession as an indispensable part of his life.

While engineering was his "day job," Llorens still had the flexibility for his music career on nights and weekends. So SoulStice's reputation grew as he continued to release studio albums and perform concerts that were met with critical acclaim.

"I would do an eight hour day at work and come home and get in the studio to do some song-writing or recording," Llorens said. "On some days, I would go to a nightclub or something to do a show. Once I started to gain some attention overseas, I would take four-day weekends and go perform in places like Amsterdam. Then I would come home and go to work on Tuesday. It was a really interesting kind of run."

In 2009, he released his last studio album to date, "Beyond Borders," and his single "That Thang" was included in *The Blind Side*, the Oscar-Nominated film starring Sandra Bullock. Although family and increased work responsibilities have cut down on his touring, Llorens continues to find time, after putting the kids to bed, to write and record music in his in-home studio.

Llorens attributes his time at Illinois for helping develop both of his pursuits. He came to the University in 1997 with little background on what to expect from the computer engineering program. He just knew he had talents in math and science, and he enjoyed playing with MS-DOS on his home computer.

He still fondly remembers ECE 110, which was taught by now Professor Emeritus Timothy Trick and former ECE chief advisor Marie-Christine Brunet. The class introduced him to ideas of logic and transistors, and the material he learned confirmed his decision to study computer engineering.

Opposite page: Llorens speaks to undergraduates during ECE Explorations. Left: Portrait provided by Johns Hopkins University

What separated Llorens from most of his engineering peers was his innate interest in the liberal arts. He relished the opportunity for a diverse education by taking his required engineering curriculum along with 400-level philosophy and history classes.

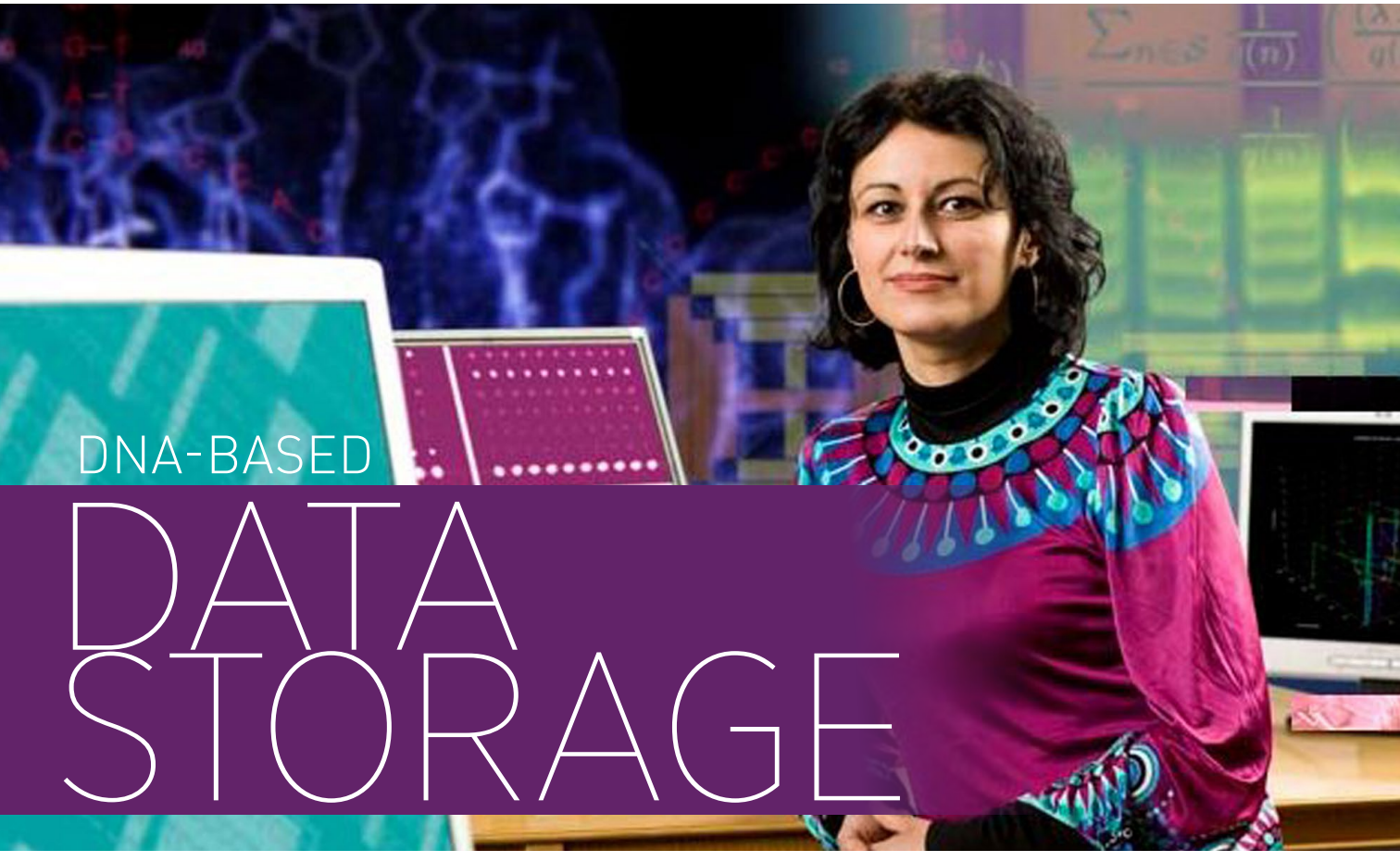
"There was a body of knowledge in all these different areas, and I had the opportunity to sample from all of them," Llorens said. "I was able to come to a place like Grainger or Everitt and talk transistors or logic, and then go a little bit south to talk philosophy and politics. All of that is right up my alley."

He also started to experiment with his hip-hop talents on campus and took part in his first rap battle as a freshman, which he won. He was able to find a community of people where he could hone his freestyling and on-stage abilities that eventually led to the release of his first album, *North by Northwest*.

His diverse background continues to influence his everyday life in both the studio and the research lab. He intends to help make diversity a bigger part of his peers' lives through his work as the chair of The Johns Hopkins Diversity Leadership Council (DLC). The Council's work helps advance diversity and inclusion at Hopkins through conferences and Diversity Innovation grants, which fund efforts by faculty, students and staff to create a more inclusive environment at Johns Hopkins.

Llorens believes his interests make him a "fish out of water" in any setting but he's proud of that because it allows him to bring a unique perspective wherever he goes.

"In the music space, I'm a nerdy engineer, and in engineering spaces, I'm an artist," Llorens said. "That's just who I am I guess. I really value diversity and having a diverse set of interests. I've come to understand that as a strength. I've had such a diverse set of experience that I can always add something to any conversation. That's something that I value and something that I've gained from all those different experiences."



# DNA-BASED DATA STORAGE

BY AUGUST SCHIESS, COORDINATED SCIENCE LAB

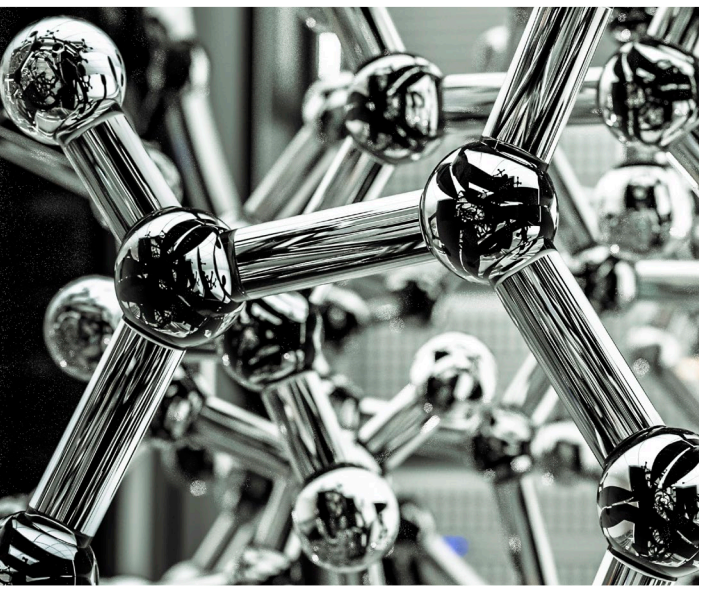
ECE ILLINOIS PROFESSOR OLGICA MILENKOVIC is determined to move DNA-based data storage beyond research to practical employment. Funded by a grant from the National Science Foundation, she continues to lead a team working on making DNA a viable data storage system. This most recent grant specifically supports investigation of how to encode data in a manner suitable for portable and robust DNA-based data storage systems.

When putting data on any storage device, from a floppy disk to a DNA strand, a "coding language" needs to be created so that the system can write, read and store, and then translate information back without detrimental errors. To make DNA into a viable medium, researchers must create a unique data coding system suitable for writing via DNA synthesis and reading via high-throughput sequencing.

DNA molecules are built using four nucleotides: cytosine, guanine, adenine, and thymine (C, G, A, and T). These letters, along with specific association and context-based grammatical rules, become the language that Milenkovic uses to store data.

"One can make DNA strings that contain any desired information by arranging the A, T, G, C letters in a certain manner," said Milenkovic. "If you encode the information with redundancy that helps in preventing and correcting errors, you can read it back without errors."

**"OUR WORK REPRESENTS THE ONLY KNOWN RANDOM ACCESS DNA-BASED DATA STORAGE SYSTEM THAT USES HIGHLY ERROR-PRONE NANOPORE SEQUENCERS, WHILE STILL PRODUCING ERROR-FREE READOUTS WITH THE HIGHEST REPORTED INFORMATION RATE/DENSITY," SAID MILENKOVIC.**



To test the method, Milenkovic and her team, based in the Coordinated Science Lab, recently stitched the data of a Citizen Kane poster and other images into the DNA. When they retrieved it without coding redundancy, the images were unrecognizable. When only 15% of redundancy was added, they came back perfectly intact—with no errors.

**"IF THERE ARE TOO MANY ERRORS, WE CAN'T READ IT BACK PROPERLY, AND EVERYTHING NATURE AND HUMAN-MADE IS PRONE TO ERRORS. SO OUR STRATEGY IS TO CORRECT ERRORS THAT ARISE AT EVERY LEVEL OF THE DATA RECODING PROCESS: DURING SYNTHESIS AND DURING DNA SEQUENCING. AND THE ERRORS ARE NOTHING WE HAVE SEEN BEFORE IN CLASSICAL COMMUNICATION SYSTEMS,"**
**SAID MILENKOVIC.**

Though creating a viable storage system in DNA comes with challenges, the reward is great: a study has shown that if all the world's data could be stored in DNA, it would fit in the trunk of a car.

Milenkovic is working with various industry partners to continue to develop this technology, including investigating the role nanopore sequencing technology could play in portable and accurate DNA coding and reading. Nanopore reading involves stringing the DNA through a tiny hole that reads the sequence content symbol-by-symbol. The nanopore reading technology is built into a low-cost and portable device.

"Our work represents the only known random access DNA-based data storage system that uses highly error-prone nanopore sequencers, while still producing error-free readouts with the highest reported information rate/density," said Milenkovic.

As this recording technology centered around nanopore sequencing develops, it represents a crucial step toward the practical employment of DNA as a storage medium.

"OUR SUCCESSES COULD NOT BE POSSIBLE WITHOUT THE VISION OF FORMER PRESIDENT OBAMA AND MANY OTHER GOVERNMENT EMPLOYEES **WHO HAVE CONTINUED TO KEEP OUR NATION SAFE AND SECURE."**
**—OSAMA NAYFEH**

## NAYFEH ADVANCES COMPUTING CAPABILITIES FOR U.S. NAVY

BY DANIEL DEXTER

Osama Nayfeh (BSEE '02) is working to improve the United States' national security by revolutionizing the efficiency of computing devices.

Nayfeh is a government engineer with the Advanced Concepts and Applied Research Branch at the Space and Navy Warfare (SPAWAR) Systems Center Pacific. SPAWAR is the Navy's information technology research and development branch, which develops some of the most advanced intelligence, cyber and surveillance systems across all war fighting domains. Nayfeh's role within SPAWAR focuses on quantum information bits (quibits) and quantum memory devices.

The development of quibits and quantum memory helps address the challenges of quantum computers and quantum entangled networks through quantum nanoelectronics. His designs have enabled the Navy's technology to operate at highly efficient and effective levels.

"This is a critical area of research for the Navy and Department of Defense because quantum nanoelectronic devices can provide faster, more efficient and more secure information systems, ranging from computers and cell phones to weapon and intelligence systems," Nayfeh said.

The cryogenic-compatible Quantum Memory Device, on which Nayfeh is the lead researcher, can perform writing, reading, and erasing operations. These functions are possible through fast and low-voltage electrical pulses generated by on-chip computational devices, which integrate all components of a computer onto a single chip.

As a result, the system is able to generate and store quantum states, which make it possible for computing devices to work significantly faster than conventional computers.

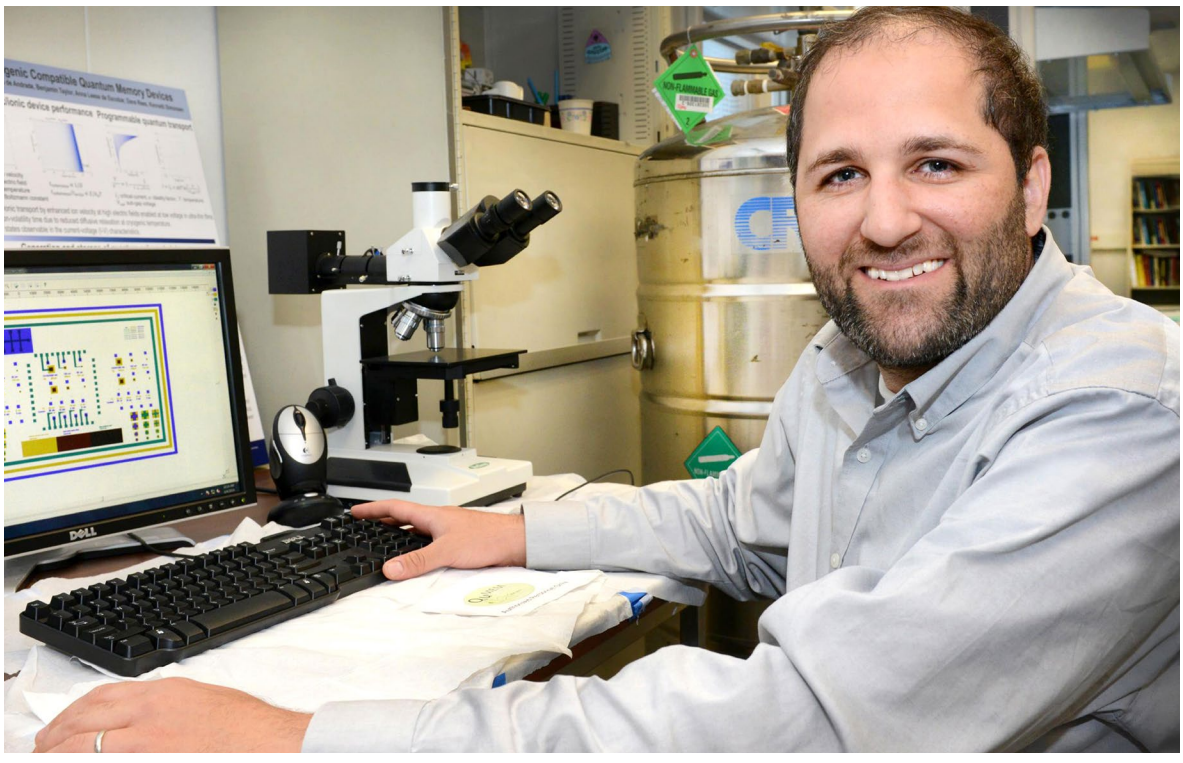



**Photo by** Alan Antczak/*Released*

**"I REMEMBER THE WONDERFUL EXPERIENCES AT ILLINOIS, WORKING TOGETHER ON PROBLEM SETS WITH THE BEST AND BRIGHTEST STUDENTS AND CONDUCTING RESEARCH WITH A WORLD-CLASS FACULTY," NAYFEH SAID.**

Nayfeh's achievements in his field were recognized by the Obama administration in 2016 when he received the Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government for science professionals in the early stages of their career. The award recognizes researchers who have pursued innovative research at the forefront of science and technology as well as demonstrated a commitment to community service.

Nayfeh was humbled to receive the award and he remains ambitious about future achievements he and his colleagues can contribute towards U.S. national defense.

"It's an honor to represent SSC Pacific as a recipient of the PECASE award," Nayfeh said. "Our successes could not be possible without the vision of former President Obama and many other government employees who have continued to keep our nation safe and secure."

President Obama praised the work that Nayfeh and the 101 other PECASE recipients have done towards advancing innovation and tackling the country's challenges.

"I congratulate these outstanding scientists and engineers on their impactful work," Obama said in a White House press release. "These innovators are working to help keep the United States on the cutting edge, showing that Federal investments in science lead to advancements that expand our knowledge of the world around us and contribute to our economy."

Along with his groundbreaking research, Nayfeh also dedicates time to SPAWAR's outreach program, which helps inspire youth to become more involved with STEM at an early age. SPAWAR outreach programs include robotics competitions for K-12 students and a summer camp for middle school girls to explore their interests in engineering.

Nayfeh credited Illinois for its culture of innovation and collaboration that helped foster his interests in the advanced research he is doing today.

"I remember the wonderful experiences at Illinois working together on problem sets with the best and brightest students and conducting research with a world-class faculty," Nayfeh said.

# After HOURS

BY REBECCA NASH

Corporate Connections After Hours is an informal reception for ECE and CS students to meet company representatives in a relaxed atmosphere. More than two dozen companies participated this spring, connecting with over 800 students in one evening.

"ECE ILLINOIS is one of the best programs in the country. It's top of the line and their students are creative with their projects," said Katie Crona, a Facebook university recruiter. "We are looking for bright students who are excited about technology and can bring a different perspective to our company."

After Hours gives students the opportunity to meet recruiters in a more comfortable setting. The primary focus is on relationship building and casual conversation, with less emphasis on resume dropping.

"We search for personality beyond just engineering curriculum—students who are well-rounded and take advantage of the many opportunities Illinois has to offer like hackathons, clubs, and competitions," said Ellie Bass, Qualcomm recruiting specialist.

For both students and company representatives, connections made at After Hours can be the key to finding the right fit. "We have had a lot of success in the past from hiring ECE ILLINOIS students and we want to continue the trend," Crona says.

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CORPORATE CONNECTION
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## S. RASOUL ETESAMI (PhD '15)

**WHAT WAS YOUR FAVORITE ECE CLASS?**
My favorite course was ECE 580: Optimization with vector spaces methods. I especially liked this course for two reasons. First, it was taught by my own PhD advisor, ECE Professor Tamer Başar, and many of my office mates and friends were attending that class. Second, the course contained interesting mathematical tools which were quite helpful in my PhD studies with many applications, although the course itself was quite abstract.

**WHAT'S ONE OF YOUR FAVORITE QUOTES?**
There are many interesting quotes that I have heard or seen around, but I particularly like the one which says: "Oh God! Please give me something that you like the most for me, not the one that I like the most." I first learned this quote in a literature book in high school, describing a spiritual connection between a person and his creator. Many times in my life I was wishing for something that was not important, but luckily I did not receive it!

**WHERE WOULD YOU LIKE TO VISIT?**
My country, Iran. Specifically the house where I spent my childhood.

**WHEN YOU HAVE 30 MINUTES OF FREE TIME, HOW DO YOU SPEND IT?**
If I am at home, I cook something or go outside for a walk. If I am in the office, I usually read news from all over the world. If I am out, I call friends to chat or go out to eat.

**IF YOU COULD BE ANY ANIMAL, WHAT WOULD YOU BE?**
An eagle! I always like flying freely.

**DO YOU HAVE A SECRET TALENT, AND IF SO, WHAT IS IT?**
I do not think I have a secret talent. Although if I did, I would not speak about it, otherwise it would not be "secret" anymore!

**IF YOU COULD SPEND AN HOUR WITH ANYONE, ALIVE OR DECEASED, WHO WOULD IT BE?**
I would definitely choose my father. He passed away when I was very young, but his lessons and thoughts have always been an inspiration. Both of us would have so many things to talk about!

**WHAT'S THE BEST ADVICE YOU'VE EVER RECEIVED?**
Try your best, be patient, and believe.

**WHAT WAS YOUR HAPPIEST MOMENT?**
My marriage ceremony.

**WHO'S BEEN THE BIGGEST INFLUENCE ON YOUR LIFE?**
I think all the people who have been actively involved in my life, such as my family members, teachers, advisors, and close friends, were very influential. I think of them like a chain, tightly linked together. It is very hard for me to point at any specific person.

**Seyed Rasoul Etesami** received a BSEE from Isfahan University of Technology, Isfahan, Iran, in 2010. He then joined the University of Illinois to complete his MS degree in Industrial and Enterprise Systems Engineering (ISE) in 2012 and earned his PhD from ECE ILLINOIS in 2015. He is the winner of the first annual Coordinated Science Lab's PhD Thesis Award for his thesis, "Potential-Based Analysis of Social, Communication, and Distributed Networks."

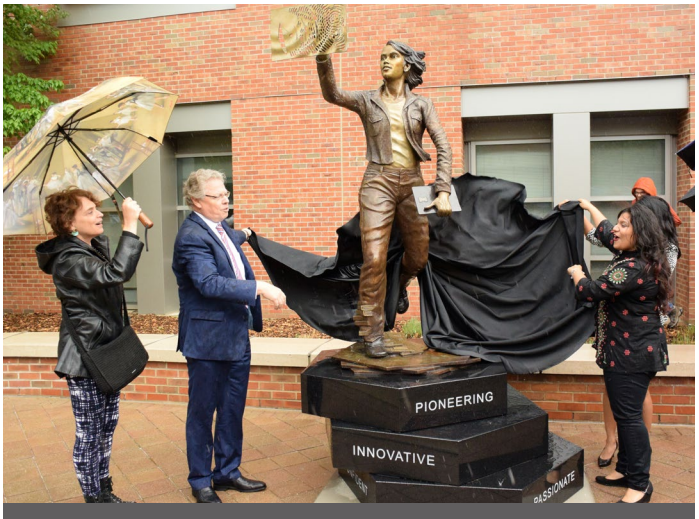
After a position as postdoctoral researcher with the Department of Electrical Engineering at Princeton University, he is returning to campus in fall 2017 as an assistant professor in ISE.

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

Photo credit: World Business Chicago

## CHICAGO MAYOR TOURS RESEARCH LABS

CHICAGO MAYOR RAHM EMANUEL visited campus earlier this year. His ECE Building tour included both the Open Lab and the Senior Design Lab where he talked to students about their current projects. He was particularly interested in ECE ILLINOIS senior Daniel Gardner's work aiming to create free WiFi thanks to a solar-powered mesh node with 16GB of flash storage. Emanuel went so far as to offer a park space on the south or west side of the city to demonstrate his team's system. The mayor's visit was part of the "ThinkChicago" campaign, established in 2011 to encourage entrepreneurial university students to explore Chicago's vibrant innovation ecosystem.



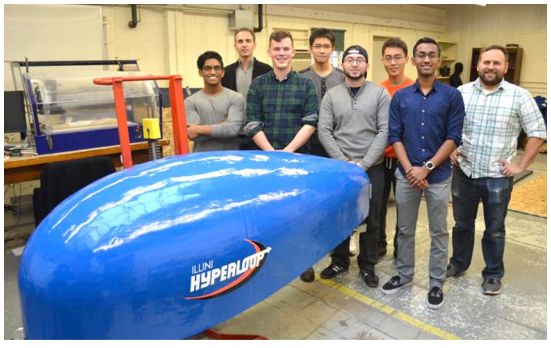

## "THE QUINTESSENTIAL ENGINEER"

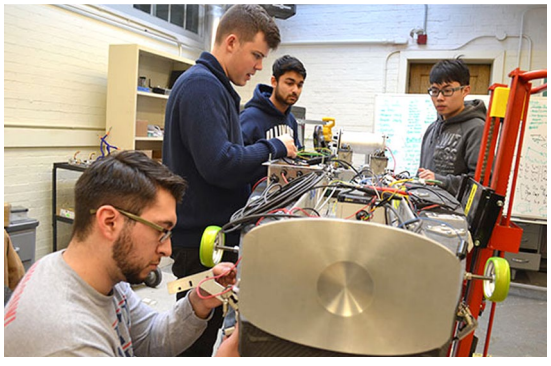
Rainstorms didn't deter attendance at the April dedication ceremony for the new Engineering at Illinois statue on campus. Four years ago, Sakshi Srivastava (right) - then an undergraduate - began a petition for a statue on campus that would serve as an inspiration for the young women pursuing engineering. She is currently pursuing her master's degree at ECE.

The dedication included remarks by College of Engineering Dean Andreas Cangellaris (center), artist Julie Rotblatt-Amrany (left), and Krunali Patel, vice president and general manager of Texas Instruments. Patel spoke about the company's decision to fund the statue and announced a new scholarship for women in electrical and computer engineering at Illinois.

## ILLINI HYPERLOOP TRAVELS TO SPACEX COMPETITION

The Illini Hyperloop team is one of 30 traveling to California for the Space-X Competition. Advised by MechSE faculty, the team has been putting in long hours in the lab preparing its pod. Their hard work has attracted media attention ranging from local TV stations to *The Wall Street Journal*.



**Department of Electrical and Computer Engineering**
University of Illinois at Urbana-Champaign
1070 ECE Building, MC-702
306 N. Wright St.
Urbana, IL 61801

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