Carnegie Mellon University
Electrical & Computer Engineering

THE CIRCUIT

2017

Dear friends of CMU ECE, welcome back to The Circuit!

This past year has been another exciting one; during the 2016/2017 academic year we celebrate the Judith Resnik Year of Women in ECE. Judith was an alumna of ECE; she embodied the fierce passion and boundless courage we want to be known for. To showcase and celebrate the incredible talent that women bring to our field, our departmental seminar series hosted women only this year; we also created monthly events to honor our undergraduate women, our graduate women, and many others. We hosted (together with the College of Engineering and the School of Computer Science) the Rising Stars in EECS, an academic workshop for graduate and postdoctoral women bound for academia; 70 participants joined us out of more than 200 applicants. These monthly events will continue throughout this academic year; you can learn more in a short article in this issue.

We have also reached another milestone this year; for the first time, our incoming sophomore class is 33% women! We are excited that these amazing minds have entrusted us with their education and well being; we will strive to be worthy of that trust. You can read about some of these talented students in this issue.

To honor our commitment to an inclusive and joyous culture in the department, we are training faculty and graduate students on unconscious bias, providing mental health training to staff and faculty, improving our physical spaces, expanding opportunities for students to engage with faculty in both academic and nonacademic settings as well as for the community to get together during stressful times.

The research our faculty and students do continues to garner recognition, make an impact and is followed on mainstream media.

We are looking forward to sharing our dreams and accomplishments with you through this magazine and social media (would you follow us, pretty please?), on our web and, of course, anytime you are on campus!

Jelena

Jelena Kovačević
Hamerschlag University Professor and Head

Welcome to our world! Enjoy the journey ☺

THE CIRCUIT

Electrical & Computer
Engineering Magazine

Electrical & Computer ENGINEERING

Carnegie Mellon hosts Rising Stars Workshop

The two-day career-building conference of scientific interactions and career-oriented discussions aimed to identify and mentor young stars in electrical engineering and computer science.

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Making the smart connection

Alumnus Mike Phillips, co-founder and CEO of Sense Labs, connects people to technology through speech recognition.
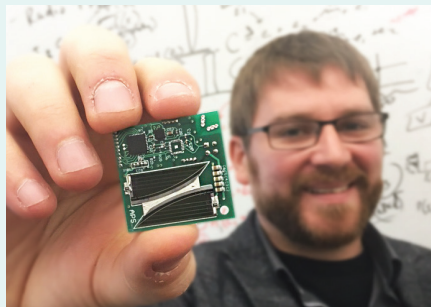
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Making energy-harvesting computers reliable

Brandon Lucia and Ph.D. student create the first programming language designed to build reliable software for intermittent energy-harvesting computers.

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Academic conferences: where diverse people inspire one another

Franz Franchetti presented at the European Forum Alpbach, a non-profit association that aims to solve Europe's societal issues.

ECE students attend regional meeting

By Samantha Jamison

This past summer, Hector Ostolaza, Malik Parker, and Maya Lassiter, three undergraduate ECE students, attended the ECE Department Head Association (ECEDHA) Regional Meeting in Philadelphia, Pennsylvania. At the meeting, Osolaza, Parker, and Lassiter attended a program specifically geared toward undergraduate students, a program that ultimately inspired Osolaza to pursue his Ph.D. in electrical and computer engineering.

The ECEDHA is a national organization of the departmental heads of accredited electrical and/ or computer engineering programs. The association aspires to advance the field of electrical and computer engineering, stimulate conversation amongst its members, and improve communication within the profession, industry, and government. Throughout the year, ECEDHA's regional groups gather independently to discuss local and state issues pertinent to the region. Vickie Woodhead, ECE's undergraduate advisor, describes how students can benefit from attending such events:

"I believe that in general, students benefit from seeing what other students, professionals, higher education institutions, etc. are doing. All of us benefit from seeing what others are doing in our field – it keeps us current

ECE students attending the ECE Department Head Association Regional Meeting with Jelena Kovačević, department head of ECE.

and competitive at what we do. I am a firm believer in diverse experiences improving many overall experiences, both personally and professionally. We broaden our own personal horizons the more that we travel and meet other people."

Woodhead believes that students who attend conferences and meetings might be encouraged to pursue higher degrees of education because they have the opportunity to envision themselves in an academic setting.

"This particular conference was a wonderful opportunity because it was centered around department heads from various schools getting together. Students want to be able to see themselves in a role in order to picture what their own future may be like, and sometimes that is challenging to do when you think about academia. Having the opportunity to meet world class faculty in a setting where they are promoting opportunities for higher education is a unique experience and offers students the chance to really start to critically think about whether that is a role they could see themselves in."

**From left to right:
ECE students Malik Parker, Hector Ostaza, and Maya Lassiter.**

Jelena Kovačević, ECE professor and department head, explained that the department will continue to support students interested in pursuing a career in electrical and computer engineering.

"This exposure [from attending conferences] allows the students to interact with faculty and students at other universities and understand the opportunities of going to graduate school. The ECE Department provides travel opportunities for students to attend professional conferences (for example, when they co-author scientific papers) as well as workshops of this kind."

If the ECEDHA keeps offering student workshops, Kovačević said that, "the ECE Department will support students to attend."

"I believe that in general, students benefit from seeing what other students, professionals, higher education institutions, etc. are doing. All of us benefit from seeing what others are doing in our field – it keeps us current and competitive at what we do. I am a firm believer in diverse experiences improving many overall experiences, both personally and professionally. We broaden our own personal horizons the more that we travel and meet other people."

Vickie Woodhead, ECE undergraduate advisor

ECE student awards

TI Innovation Award

Do you find pulling weeds to be agonizing and frustrating? Student Nishant Pol and Robotics Institute students Hannah Lyness and Sam Zeng created a robot that can help out. Their project, titled "CLEANUP" (Careful, Logical Elimination And Negation of Unwanted Plants), recently took home the prize for the "most innovative home application" from the Texas Instruments Innovation Challenge Design contest, beating out 180 other teams.
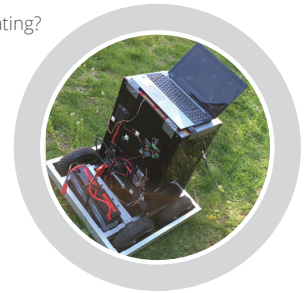

The robot uses a learning algorithm, sensors, a cordless drill, and an on-board computer to find and extract weeds. Once centered over the weed, it uses a drill to remove the weed with minimal damage to lawn. The weed eliminator can power up a 30-degree incline and maneuver over two-inch-high obstacles. The project was originally designed for the System Engineering and Capstone classes for the Carnegie Mellon Robotics additional major.

The TI Innovation Design Challenge is a competition that tasks engineering students with using TI technology to create solutions to challenges that currently face the world. The projects are judged based on industry-ready standards, like quality of design, written documentation, and effective use of TI technology. Cash prizes were awarded to the top three teams as well as categorical prizewinners, with the Carnegie Mellon team taking home $1,000 in winnings.

Red Hat Award

Preeti Murthy, an ECE master's student, has won the 2016 Red Hat Women in Open Source Academic Award. The award recognizes women who make important contributions to an open source project or the open source community.
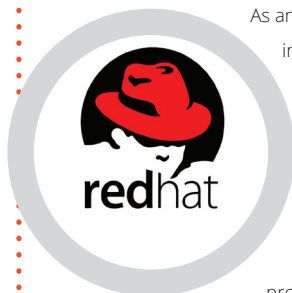
As an undergraduate, Preeti was part of a team that introduced students to open source. After graduating with her bachelor's degree, she worked for three years as a Linux kernel developer, where she contributed code, documentation, tutorials, open content, and other communications. Preeti has nearly 60 commits and reviews in the area of CPU power management. She also volunteered as a co-mentor for the Outreachy internship program. Preeti is pursuing a master's degree at Carnegie Mellon, where she and her team are working on a programming toolchain for energy-harvesting systems that they hope to open source soon.

"Technology is affecting the lives of people in their day-to-day tasks in a big way," says Murthy. "People from all across the world are able to do their tasks so much more efficiently and effectively, so I wish to contribute in my own little way to this wonderful transformation that I see all around me."

Dr. William Strecker and his wife, Nancy Strecker.

Three time ECE alumnus gives back through professorship

By Catherine Graham

William Strecker came to Carnegie Mellon to study electrical engineering expecting a career in electronic communication systems. "I wasn't, at the time, very familiar with computers," he explained. "But as I spent time at CMU, I became aware of the fundamental importance of computers and became aware that CMU was playing a leading, pioneering role in developing computer science. It was one of the things that really encouraged me to stay on."

Strecker eventually earned three degrees in electrical engineering from Carnegie Mellon: his bachelor's in 1966, master's in 1967, and doctorate in 1971.

After graduation, Strecker went on to play a significant role in the design of the VAX computer system and a number of other technologies for Digital Equipment Corporation (DEC) where he spent 28 years in senior technical and executive positions. There he met his wife Nancy, who also spent her career at DEC in sales and marketing.

During his career, Strecker amassed 16 patents in computer architecture and design, and authored numerous technical publications. Among his many honors, Strecker was elected a member of the National Academy of Engineering, a Fellow of the Association of Computing Machinery, and received the Institute of Electrical &

Electronic Engineers' W. Wallace McDowell Award. Most recently, Strecker served as EVP and CTO of In-Q-Tel, a non-profit technology firm.

Strecker has always remained committed to the university that helped him become an innovator in the computer industry. He and Nancy both feel strongly about the tremendous contribution of the CMU community — professors, students, and alumni — to information technology sciences and engineering.

So, in 2013, they generously endowed Carnegie Mellon with the Dr. William D. and Nancy W. Strecker Early Career Professorship. Through the professorship, they hope to further the university's excellence by supporting the most exceptional professors early in their careers.

"Both Nancy and I strongly believe in the fundamental and life altering contributions that education makes to our society. Sponsoring a professorship, most particularly at Carnegie Mellon, seemed like an excellent way to support our focus on education," says Strecker. "After all, Carnegie Mellon made a big impact on my life and I wanted to make an impact on Carnegie Mellon."

Making the smart connection

By Alexandra George

Mike Phillips understands the power of being connected—to devices, other people, and the surrounding environment. An electrical and computer engineering alumnus and co-founder and CEO of Sense Labs, Phillips has expertise connecting people to technology through speech recognition. So when he and his colleagues decided they wanted to tackle the energy problem by connecting consumers to their homes, he applied that expertise to develop Sense: a home energy monitor for users to track the energy consumption of their appliances.

"We have a mobile application that lets you know what is going on in your house," said Phillips. "Think of us as providing the broad-based sensing which is needed to drive intelligence of the eventual smart home."

The hardware part of Sense works like an electric meter, only rather than taking measurements for a monthly electric bill, it measures incoming power one million times per second. Then, Sense uses signal processing and machine learning to determine the electrical signatures of the various devices in a home. Connecting to a home's electrical panel and using existing sensors to detect appliances, Sense delivers a report to its smartphone app—identifying what's on or off, what state each appliance is in, and how much power each appliance uses.

"When we first developed Sense," explained Phillips, "we had a general notion that if we could know in detail how all the devices in homes use energy and could interact with their owners or inhabitants, we could treat energy as a closed-loop optimization problem—what is the most effective thing the system can do to make the building work well?"

While Phillips currently spends his time putting consumers in touch with their homes, he began his career by pioneering the way to speech recognition software. He first became involved in the area as an undergraduate at Carnegie Mellon University when he joined his advisor, ECE Professor Richard Stern, at the forefront of speech recognition research.

"It was the very early days of speech recognition technology, and the problem seemed almost impossible," said Phillips. "But, we knew that since humans could indeed perform speech recognition, then it must be possible."

Mike Phillips
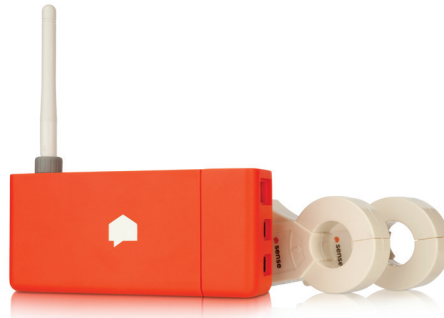
Phillips continued researching speech recognition at Carnegie Mellon for a few years before becoming a research scientist at the Massachusetts Institute of Technology. His group was one of the first to combine speech recognition and natural language processing to create early dialog systems—kind of like Siri, but on a refrigerator-sized computer with a longer response time.

Phillips later transitioned out of academia to found two speech recognition companies: SpeechWorks in 1994 and Vlingo in 2006. SpeechWorks focused on speech recognition for telephone customer service systems, and Vlingo focused on the combination of speech recognition and the natural language processing work he did at MIT, this time running on mobile phones in real systems. When Vlingo was bought in 2012, Phillips and some of his colleagues decided that they wanted to start another company, but this time it wouldn't be related to speech recognition.

"We got interested in the energy space—realizing that something like 38% of world energy is used in buildings," said Phillips. "We like consumer-facing applications (based on our Vlingo experience) so we decided to focus first on residential energy consumption."

In the long-term, Phillips hopes that Sense will drive energy efficiency and perform functions like fault detection. While the focus of Sense is not on speech recognition, the technical aspects are largely similar.

"When we started Sense, it reminded me very clearly of the early days of my work on speech recognition at Carnegie Mellon—a super hard technical problem that seemed almost impossible," said Phillips. "We are now far enough along that we have a pretty clear path ahead of continuous improvement of the technology—just like what we started at Carnegie Mellon many years ago."

ECE Alumni Council

The ECE Alumni Council is a group of highly accomplished alumni who meet twice a year to discuss ECE's educational, research, and external activities. The Council provides input and insight regarding the department's programs and strategic goals. Council members also engage with ECE to help mentor students and provide opportunities for networking as well as expand relationships between faculty and industry. For more information on the ECE Alumni Council, visit www.ece.cmu.edu/alumni/council.html

- **Nikhil Balram**
- **Ray Betler**
- **Gloria Chen**
- **Anirudh Devgan**
- **Evan Indianer**
- **Kevin Kettler**
- **Oleg Khaykin**
- **Sanjay Kumar**
- **Garrett Long**
- **Kimon Michaels**
- **Drew Perkins**
- **Mark Re**
- **Roger Rosner**
- **Jane Rudolph**
- **Archana Sathaye**
- **Shirish Sathaye**
- **Han-Ping D. Shieh**

Making energy-harvesting computers reliable

By Krista Burns

A revolutionary and emerging class of energy-harvesting computer systems require neither a battery nor a power outlet to operate, instead operating by harvesting energy from their environment. While radio waves, solar energy, heat, and vibrations have the ability to power devices, harvested energy sources are weak, leading to an "intermittent execution," with periodic power failures and unreliable behavior.

Brandon Lucia, an assistant professor of electrical and computer engineering at Carnegie Mellon University, and his Ph.D. student Alexei Colin created the first programming language designed to build reliable software for intermittent, energy-harvesting computers. Colin presented the work at the 2016 SPLASH conference in Amsterdam, Netherlands, last fall.

"Energy is not always available in the environment for a device to harvest," explains Lucia. "Intermittent operation makes it difficult to build applications because existing software programming languages—and programmers themselves—assume that energy is a continuously available resource."

The innovative new programming language, called Chain, asks an application developer to define a set of computational tasks that compute and exchange data through a novel way of manipulating the computer's memory, called a channel. Chain guarantees that tasks execute correctly despite arbitrary power failures.

"When power is not continuously available, power failures disrupt the software's execution, often leading to unrecoverable errors," says Lucia. "Chain solves this problem by requiring computational tasks in the program to use a novel channel-based memory abstraction that ensures tasks complete without error."

Channel-based memory is the key to Chain's ability to avoid software errors: regardless of when power fails, channels ensure that a computational task always has an intact version of the data it needs when power resumes. Restarting a Chain program after a failure has virtually zero time cost, because Chain does not rely on an expensive, conventional approach, like memory checkpointing. The extreme scarcity of energy makes efficient restarting essential for energy-harvesting applications including IoT devices and implantable or ingestible medical devices.

"Chain provides important reliability guarantees in a familiar and flexible programming interface that is well-positioned to be the foundation for today's and future energy-harvesting applications," says Lucia.

Lucia, Colin, and Dr. Alanson Sample, a collaborator at Disney Research Pittsburgh, worked together to push Chain into real-world deployment; in 2017, in cooperation with nano-satellite company KickSat, software written in Chain will run on-board two tiny, postage stamp-sized satellites in a low-earth orbit of Earth. Once in orbit, these satellites will use tiny solar panels to harvest solar energy, powering them to collect and process sensor data and send information back to earth. While satellites are typically powered by solar energy, these satellites will be the first with the strong software correctness guarantees furnished by Chain, ensuring continuous, reliable operation.

"The potential benefit of reliable energy-harvesting computer systems is far-reaching," says Lucia. "Small satellites are proliferating and the space industry itself is expanding. If we can guarantee that even tiny, energy-harvesting satellites operate without interruption, we can make it easier to conduct other scientific research in space. Further out, we may even see future applications like extraterrestrial natural resource discovery relying on this technology."
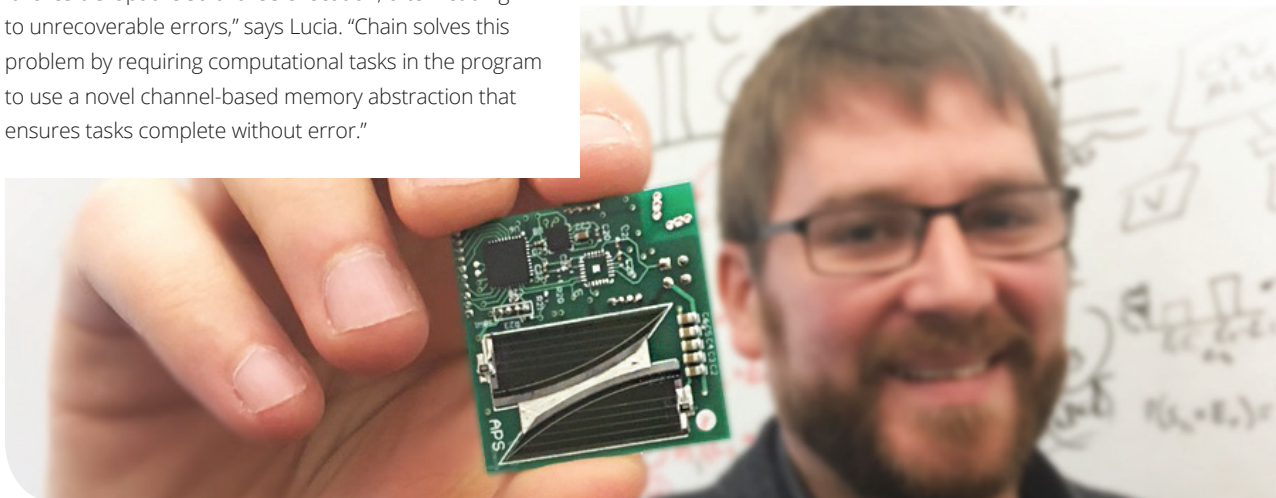
dan siewiorek

By Alexandra George

When Dan Siewiorek was hired by Carnegie Mellon University in 1971, he had completed only 10 percent of the research for his Ph.D. thesis. Working on his Ph.D. at Stanford, he wasn't on the market for a teaching position until Angel Jordan, the electrical engineering department head from Carnegie Mellon, looked him up, asked him to come to CMU for an interview, and hired him almost on the spot.

Forty-four years later, Siewiorek is currently the Buhl University Professor of Electrical and Computer Engineering and Computer Science and has had a great impact on both his field and Carnegie Mellon.

"Everyone at Stanford cautioned against joint appointments," said Siewiorek. "But a joint appointment was appealing to me, because engineers tend to think bottom-up and computer scientists tend to think top-down. Sometimes top-down thinking is the best way to solve a problem, other times bottom-up, and you could recruit from both bases."

From reliability, to register transfer modules, to design automation software (CAD), to multiprocessors, and more recently, to wearable computers, Siewiorek likes to say that he reinvents himself every ten years by working on something new. Since Moore's law predicts that the number of transistors on an integrated circuit doubles every year or two, it means that in a decade resources to open new application areas increase up to a factor of 1,000.

"The interdisciplinary nature of Carnegie Mellon is what attracted me to stay in academia," said Siewiorek. "If it weren't for Carnegie Mellon, I'd be in industry. You get to work with students who leverage your ideas. In industry, you work on one project at a time, in academia, you get to work on multiple. It's been fun."

Though Siewiorek has been responsible for many great advances in his field, he has a real interest in what his students achieve. The Rapid Prototyping course, which has been offered by ECE for a few decades with the help of Siewiorek, brings together students from different disciplines to work on a capstone design project. The capstone totals about 5,000-7,000 engineering hours.

While taking the course, students have designed and implemented projects such as a gesture-controlled interface for cars, a smart watch (a decade ahead of its time), and wearable computers. The wearable computer team's work in the 1990s won three design awards in a five-year span. "If you give undergraduates some resources, an end user, a problem to solve, and just get out of their way, they take you for a ride," said Siewiorek.

The Prototyping course in particular allows students to understand what it's like to be a startup company. Siewiorek's influence has helped students from this course and others to be successful after graduation by starting their own companies, entering industry, or continuing in academia. For example, two students, who worked on a wearable computer to coordinate field service teams for the Marines, went on with two others to co-found BodyMedia, the first wearable fitness technology company.

Siewiorek's love for his work, the students, and the university shows through his lifetime of achievement and dedication. But for him, it's been the result of following a simple principle.

"As Alan Newell said, 'Do good (high quality) science and the rest will follow'," said Siewiorek. "This way you have fun too. This way you transfer it to others."

Academic conferences: where diverse people inspire one another

By Samantha Jamison

In 2012, Associate Professor of Electrical and Computer Engineering Franz Franchetti and his colleagues received funding from the U.S. Defense Advanced Research Projects Agency (DARPA) to develop technology that could achieve the power efficiency of 75 GFLOPS/W at 7nm for DoD-relevant applications. Then, in the same year, Franchetti and his research team received a $6 million grant from DARPA to develop software that would protect unmanned vehicles and high-end cars from cyber attack. In 2016, DARPA granted Franchetti and his colleagues another $3 million to adapt applications that would operate seamlessly when faced with formidable challenges. Franchetti spends much of his time on campus collaborating with other faculty members to solve complex problems, but when he leaves his office, he connects with other Austrian scientists and scholars.

Franchetti serves as the President of the Austrian Scientists & Scholars in North America (ASciNA), an organization that provides Austrians, especially Austrians new to the United States, with useful information, professional development resources, social events, networking opportunities, and a 'home away from home'. He also serves as the Chapter Head of the Western Pennsylvania chapter.

"When scientists come to North America, we try to give them a local place to connect with other Austrians," Franchetti said.

The ASciNA connects young Austrian scientists with other more experienced professionals, academics, and scholars from Austria. Older and more practiced Austrians supply new members with professional and personal advice, offering bits of expertise while also sharing their favorite local restaurants or attractions. As the leader of the ASciNA, Franchetti frequently communicates with Austrian politicians, directors, and presidents of Austrian universities.

"From that direction, I must have gotten the invitation to attend the 2016 European Forum Alpbach," Franchetti said.

European Forum Alpbach (the Forum) is a non-profit association that facilitates intellectual dialogue among diverse people to solve Europe's most pressing societal issues. In August 1945, Otto Molden and Simon Moser founded European Forum Alpbach, originally called International Summer Seminars, to reconstruct and restructure Europe's intellectual life. Since individuals disagreed about the political issues of the time, Molden and Simon created an inclusive platform where people could openly communicate about peace and freedom.

Each summer, thousands of people travel to Alpbach, a small village near Innsbruck, to discuss Europe's future and how European officials can better compete with other international powers, but Franchetti says that actual societal change happens slowly because the Forum does not function as a policy workshop.

"It's more an ideas workshop that policy makers attend, read the briefings, and then they may pick up ideas. This

is a long, winding road from what I understand," said Franchetti. "The policy makers put on their lederhosen and then they spend a week or two there and everybody talks to everybody."

But that's not always enough to provoke societal change. Since policymakers often have their own agendas and their own stakes in the political arena, Franchetti believes that the Forum should focus their efforts on the eager students who attend the summer conference.

"I think the question is, 'How do you get that knowledge into policy?'" said Franchetti. "They [the Forum] bring all these young students there, and ten years from now, they will be opinion leaders. It's much, much easier to influence the next round of people thinking than changing the ones who are currently there."

This past summer, Franchetti attended the conference because Austrians wanted to learn how to incorporate the U.S. mindset into Austrian science. So, he spoke about the United States and how it encourages people to take risks in the marketplace.

Austrian scientists are learning how to invent new products while also streamlining their inventions from the university to the marketplace. However, many Austrians shy away from tackling new initiatives or establishing new startup companies because they fear the social consequences associated with failing.

In the United States, "you do startups, and it's kind of understood that only 10% of startups really succeed. So, if you try more often, your chance of success is higher. And if you fail, then you learn something," said Franchetti. "In Austria, the mindset is, 'Well, you borrowed the money, you lost the money, you're going to have to pay it back. You're a failure.' That's it. And you're branded for life, basically."

Franchetti understands why many Austrians oppose taking risks.

"It's hard to convince someone, 'Well, try. If you win, then you make a lot of money and everybody hates you for that. If you fail, then you're a failure.'"

Despite the challenges that Austrian scholars encounter, Franchetti believes that platforms like the European Forum Alpbach could eventually transform the Austrian mindset. Societal change may happen slowly and deliberately, but Franchetti seems optimistic about the future.

"It's [the Forum] this platform where people exchange their ideas, and as long as they keep that alive, it's a good thing."

CONGRATULATIONS

diana marculescu

Recipient of INSIGHT into Diversity's Inspiring Women in Stem Award and the David Edward Schramm Memorial Professorship

Dedicated to students. Committed to excellence. Respected by all.

We are honored and proud to work with Dr. Marculescu. Her impact has inspired future engineers to become intellectual leaders and technical trailblazers.

New faculty members

Gauri Joshi

Q. What excites you most about teaching at CMU?

A. I have always wanted to be a professor. Being a global powerhouse of electrical and computer engineering, CMU attracts some of the brightest students in the world.

Q. What can future students look forward to as they interact with you as a faculty member?

A. I have developed a taste for solving state-of-the-art engineering problems, using a rigorous and mathematical approach. Students working with me can look forward to this style of research, and building industrial collaborations.

Q. What is a fun fact about you that would surprise your students?

A. I love puzzles of all kinds: brain teasers, Rubik's cubes, wooden puzzles, magic tricks, jigsaw puzzles; the list is endless.

Bryan Parno

Q. What excites you most about teaching at CMU?

A. There are a huge number of interesting and important challenges in computer security right now. I'm excited to be able to share those challenges and some useful ideas, tools, and strategies with the high-caliber students at CMU. Hopefully this will start some of them down the road of solving these problems.

Q. What can future students look forward to as they interact with you as a faculty member?

A. After doing research in security, cryptography, and systems, in government, academic, and corporate environments, I've got a story, a paper, or a webcomic to recommend for almost any situation.

Q. What is a fun fact about you that would surprise your students?

A. In college, I ran with the bulls in Pamplona. It seemed like a good idea right up until everyone started running!

Giulia Fanti
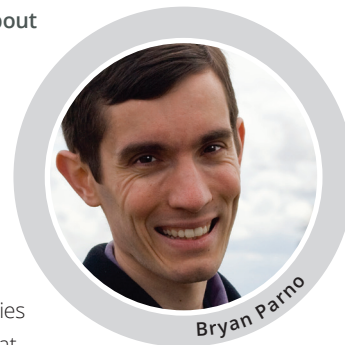
Q. What excites you most about teaching at CMU?

A. I've heard that CMU's students are really motivated and creative, so I'm most looking forward to interacting with them. I'm excited to see the projects they come up with!

Q. What can future students look forward to as they interact with you as a faculty member?

A. On the teaching side, I like to make lectures interactive, with lots of questions and problem-solving. My goal is to make it easy to stay engaged. So hopefully, students can look forward to an active learning experience. On the research side, I like to work on problems that require skills from different areas of study. Through collaboration and self-learning, students can look forward to acquiring a broad set of skills, without being limited by the tools our lab already "knows."

Q. What is a fun fact about you that would surprise your students?

A. I like to play soccer.

Carlee Joe-Wong

Q. What excites you most about teaching at CMU?

A. Working with the students! All of the students I've talked with so far have been amazingly enthusiastic and creative. The experience has only reinforced my impression that CMU has a uniquely interdisciplinary and collaborative research culture, and I can't wait to contribute to it.

Q. What can future students look forward to as they interact with you as a faculty member?

A. I want to encourage my students to develop wide-ranging and practical interests, and I hope to learn as much from them as they will learn from me.

Q. What is a fun fact about you that would surprise your students?

A. I played classical violin and piano as a child, and I still have books of old sheet music that I used to play. I haven't touched a violin in years, but I still try to practice piano when I can.
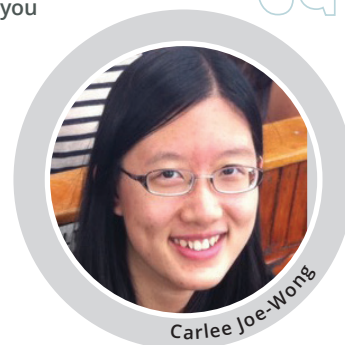
Carnegie Mellon hosts Rising Stars Workshop

By Krista Burns

Last fall, Carnegie Mellon University hosted the world's brightest female Ph.D. students, postdocs, and engineers in the fields of electrical engineering and computer science at the 2016 Rising Stars Workshop. The two-day career-building conference of scientific interactions and career-oriented discussions aimed to identify and mentor young stars in electrical engineering and computer science (EECS).

Originally founded by MIT in 2012, the workshop focused on navigating the early stages of careers in academia. This year, the workshop was hosted and sponsored by Carnegie Mellon University's Department of Electrical and Computer Engineering, the College of Engineering, the Center for Faculty Success, and the School of Computer Science, in collaboration with MIT's Department of Electrical Engineering and Computer Science.

"We were excited to welcome the participants to Carnegie Mellon University," says Jim Garrett, dean of Carnegie Mellon's College of Engineering. "The workshop is an important leadership and development program to help to change the equation and bring more women into positions of influence and leadership."

The workshop included three poster sessions as well as presentations and panels on aspects of life in academia—from finding a faculty position to how to succeed as a junior faculty member. Participants had the opportunity to present their ongoing research, interact with faculty members from top institutions, and receive advice for advancing their careers.

"The Rising Stars Workshop is a great opportunity to become acquainted with the latest research, to meet future leaders in the field, and to network with Carnegie Mellon faculty," says Jelena Kovačević, department head of electrical and computer engineering. "The participants showcased their passion for research and education, while creating societal impact."

This year's participants had the opportunity to learn by doing, with sessions focused on landing a faculty job, navigating the promotion process, and building a professional support network, as well as many other sessions with topics of interest to women in academia. The workshop featured presentations and discussions by participants spanning the spectrum of EECS from devices, circuits and nanosystems, to cyber-physical systems, data science, and security and privacy, with particular focus on making an impact on society through work on energy, mobility, smart infrastructure, health, and quality-of-life.

"I've got good news and bad news for the participants," says Andrew Moore, dean of Carnegie Mellon's School of Computer Science. "The bad news first: being in their position is a big responsibility. Technology is one of the best bets for getting the planet through the 21st century and, as future thought and organizational leaders, it's all on their shoulders. The good news is that I can't imagine a more rewarding and interesting career!"

DSSC

Information storage at its best

By Alexandra George

The appetite for information storage is growing exponentially—we want storage for more images, more videos, and more apps. We also need places to store data from the smart electrical grid, from pollution sensors, and surveillance videos and images. However, if we don't have underlying data storage technology that can keep up with this demand, we'll be left starving.

Carnegie Mellon University's Data Storage Systems Center (DSSC) has been at the forefront of data storage technology over the past two decades. Aptly positioned as a research institution on the line between an academic discovery center and the industry's fix-it man, the center focuses on storage systems for hard disk drives and emerging technology for solid-state memory systems.

 "DSSC is the leading academic research institution in data storage technology," said Jimmy Zhu, the director of the center and ABB Professor of Electrical and Computer Engineering. "Over the years, we have had strong support from the data storage industry and exceptional industrial research funding. Our unique, multidisciplinary and collaborative research culture and our unique partnership with the industry have allowed us to have a high impact on data storage advances over the past quarter century."

In fact, the hallmark of the DSSC is this collaborative research mode among faculty, graduate students, and

industry: the best formula for generating significant technology innovations. Most of the center's research projects are interdisciplinary, bringing together researchers and scientists from different fields across the campus.

Over its lifetime, the center has graduated over 200 Ph.D. students in Electrical and Computer Engineering, Materials Science and Engineering, Chemical Engineering, Mechanical Engineering, Chemistry, and Physics. A number of DSSC alumni have become high-level executives and directors in data storage companies.

One of the most significant contributions of the DSSC is the work on signal processing detectors that enable the reading of information stored on a small disk, a project spearheaded by Professor José Moura. They estimate that roughly 60 percent of computers built from the early 2000's to the present use these detectors. But that's not the DSSC's only impact—widespread use of materials, device designs, and signal processing algorithms are other examples of the many ways that the DSSC has influenced the industry.

Started by Professor Mark Kryder as the Magnetics Technology Center in 1983, the DSSC acquired its current name in 1991, when it expanded as an NSF Engineering Research Center. Over this life, DSSC has helped to lead the transformation of the hard disk drive industry.

Twenty-five years ago, a hard drive stored a mere five megabytes, the size of today's single camera image. Today, a hard drive stores over two terabytes (a 400,000 percent increase) at 1/5 of the cost. A data center recently built by Facebook containing these modern drives occupies the area of six football fields. Without the technological advancement of the last 25 years, the same data center would have to occupy 10 times the greater Chicago area. Similarly, looking forward with the same rate of progress, the same data center 25 years from now will fit into an iPhone 7.

This is the challenge for the DSSC researchers as they look to the future. "There are physical phenomena out there that can store information far more densely and using far less power than what we're currently using," said James Bain, the associate director of the center. "Our task for the next generation of technology is to figure how to put these phenomena to work in real systems."

CyLab wins big during DefCon weekend

By Daniel Tkacik

Carnegie Mellon University's CyLab Security and Privacy Institute is celebrating winning big in Vegas, as home of the champions of two major hacking competitions last year.

Computers vs. Computers: Cyber Grand Challenge

ForAllSecure, a Carnegie Mellon spinoff startup, took home the $2 million prize as the winners of the DARPA Cyber Grand Challenge (CGC), a first-of-its-kind hacking contest in which all participants are autonomous computer systems. ForAllSecure was one of seven finalist teams in the contest, which took place in Las Vegas, Nevada.

"Our vision is to check the world's software for exploitable bugs so they can be fixed before attackers use them to hack computers," says David Brumley, who wears several hats as CEO of ForAllSecure, director of CyLab, and professor of Electrical and Computer Engineering. "We believe our technology can make the world's computers safe and secure."

ForAllSecure's system, dubbed "MAYHEM" by the team, scans software for bugs, generates exploits, and fixes vulnerabilities. The system performs every task completely autonomously.

"This is a shining moment for a startup born at Carnegie Mellon," says Jim Garrett, dean of CMU's College of Engineering. "We couldn't be more proud of ForAllSecure for applying its vision to the development of cutting-edge technology that addresses the global issue of security."

DARPA launched the CGC in response to the recent increase in software bugs, due in large part to the explosion of the Internet of Things—billions of connected devices like smart thermostats or fitness trackers that are built with little regard to cybersecurity. The challenge aimed to identify state-of-the-art technology to find these bugs quickly, and at scale.

Humans vs. Humans and Computers: DefCon Capture the Flag

Not to be outdone, Carnegie Mellon's competitive computer security team, The Plaid Parliament of Pwning (PPP), won its third title in four years at the DefCon Capture the Flag competition.

The DefCon Capture the Flag competition, widely considered the "World Series of Hacking," also took place in Las Vegas.

Brumley is the faculty advisor to PPP. "Our team has put in thousands of hours of practice, and it is rewarding to see them win amongst the best hackers in the world," said Brumley. "Every year this competition becomes harder and harder to win."

Capture the Flag (CTF) is one of the most popular competitive hacking games in the world, with hundreds of smaller CTFs being held annually. During these competitions, teams try to break into competitors' servers while protecting their own. After achieving a successful breach, teams catch virtual "flags" and earn points.

While thousands of CTF teams exist worldwide, only 15 teams representing at least 10 countries qualified for this year's DefCon CTF.

"The consistency of our team's performance over the last four years demonstrates CMU's strength in cybersecurity education and research," says Dean Garrett. "These students will clearly help drive the next level of cybersecurity."

Carnegie Mellon's win comes at a time that the computer security field is struggling to find suitable hires to join the workforce. These contests give people a place to practice and hone their computer security skills.

"These contests are critically important to developing a skilled cybersecurity workforce," says Brumley.
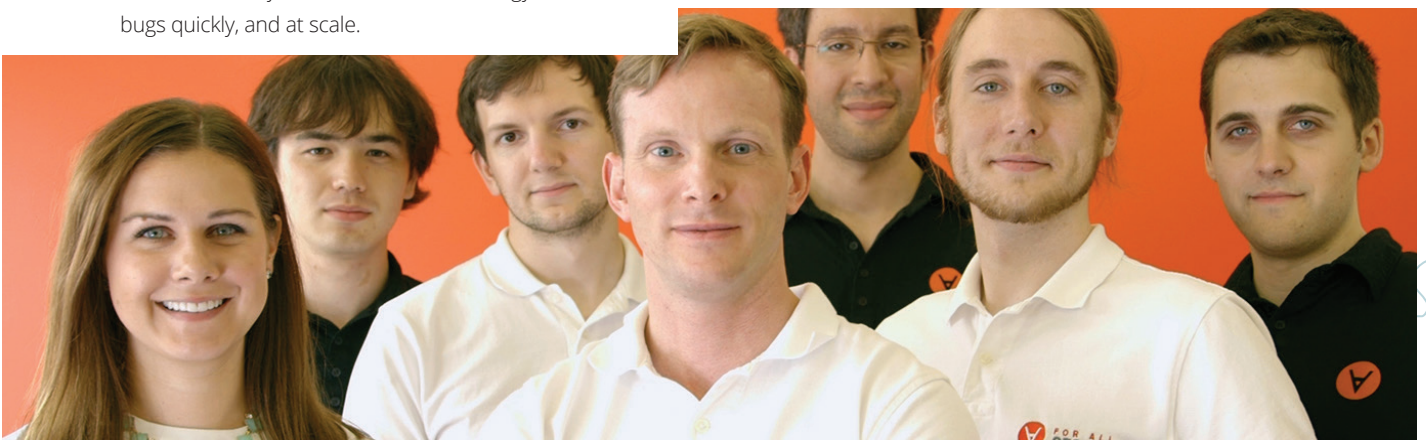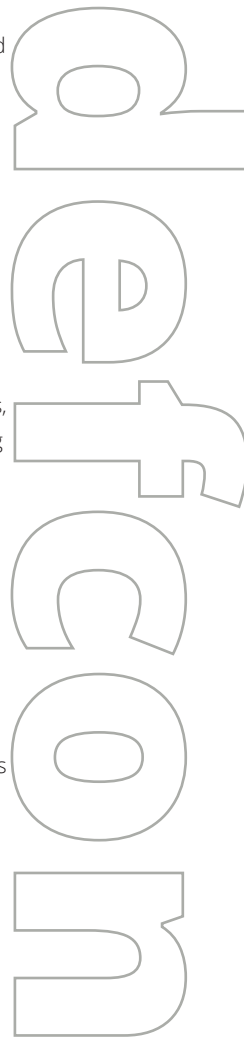
Photograph by Lauren Demby

Her heart is in the work

By Leah Pileggi

ECE administrative coordinator, Lauren Demby, has a side gig: she's a professional photographer. You can see her expertise in the ECE staff portraits that she took for the website. But it was one of her spontaneous photos that recently ended up in newspapers, magazines, and TV news reports around the world. Considering the fact that she never intended her career path to lead her to photography, Lauren is still stunned by the impact of that one photo.

Lauren earned a bachelor of arts degree in architecture from the University of Pittsburgh in 2011, with a minor in studio arts. But it was an Intro to Digital Photography class at Pittsburgh Filmmakers during her last semester of college that sparked her passion for photography.

"I needed the class to graduate, but then I started taking pictures of my family. People around the neighborhood started to notice and ask for family portraits."

Since then, she has been self-taught by reading articles and blogs, taking workshops, and assisting other photographers, and she now has her own business, Lauren Renee Designs (www.laurenreneedesigns.com).

"I'm always learning. That's what I love about photography. There's always something you can improve on."

In late 2015, Lauren was contacted about taking photos for a wedding, a typical request. But this would not be a typical wedding. The bride would be given away by a man she had

yet to meet, a man who was alive because he had received the bride's father's heart.

Bride-to-be, Jeni Stepien, and her fiancé, Paul Maenner, would be married in the Swissvale neighborhood of Pittsburgh, the same neighborhood where Jeni's father was shot and killed during an armed robbery in 2006. His family donated his organs through the Center for Organ Recovery & Education (CORE), an organization that will help donor families and transplant recipients contact one another.

Lauren Demby

The recipient of her father's heart, Arthur Thomas, lived in New Jersey. He had written a thank you to Jeni's family, and a long-distance relationship was established. When Jeni became engaged, she wondered if Mr. Thomas might consider walking her down the aisle. With her fiancé's support, Jeni wrote to Mr. Thomas and asked him. After checking with his daughter, he said yes.

"Jeni and Mr. Thomas met the day before the wedding at the rehearsal," explained Lauren. "On the day of the wedding, the bride and groom chose not to see each other before the service and they had just met this man the day before. It was a crazy emotional day for everyone involved. Everyone was in tears as she was coming down the aisle,

including myself. I was thinking in my head 'Pull it together, you need to get these shots!' As Jeni placed her hand on Mr. Thomas's heart, I captured that moment as she was being given away. Those amazing moments are what continue to drive my love for photographing weddings."

Local new reporters were also at the wedding. "They were mostly getting in the way," said Lauren. And it turned out that it was that one amazing photograph anyway that ended up on ABC and NBC news broadcasts, and in The New York Times, the Washington Post, and Glamour Magazine. Lauren was even contacted by the BBC and NPR. She said, "I had no idea that photo was going to explode like it did."

But to Lauren, the wedding was so much more than that one photograph. "Jeni was so welcoming, so genuine. I like to work with brides who don't feel like this is the only day in the rest of her life but the beginning of great things to come."

Jeni Stepien loved working with Lauren, too. "I cannot say enough good things about having Lauren as our photographer. From the first time I spoke with her on the phone, months before we met for the first time in person, and before she took the photographs that took the world's breath away, I felt like I could trust her. Trust her to capture the biggest day of my life and preserve it in a way that would bring the memories of that day flooding back in a stunning way."

Jeni went on to say, "Nobody could have predicted the attention that the wedding gathered. I was just trying to get married, bring closure to a chapter of tragedy in my life, and I wanted Lauren there to take her signature beautiful shots of it all. When I saw the picture that she captured that accompanied so many stories about my special day, I cried."

After a crazy couple of days, life returned to normal for Lauren who says, "I love working at CMU." She will continue photographing weddings, but she'll never forget the day she took the photo that brought everyone to tears.

"

"I'm always learning. That's what I love about photography. There's always something you can improve on."

Lauren Demby, ECE administrative coordinator

Meet the new staff members

ECE welcomes the following staff members who started within this past year.

Dante Boni
Nanofabrication Technician

Kelley Conley
Research Administrator

Donna Frost
International Scholar Coordinator

Diana Leathers
Administrative Coordinator
Silicon Valley campus

Michelle Mahouski
Academic Services Coordinator

Jillian McCarthy
M.S. Academic Program Advisor

Bari Morchower
Student Organizations & Activities Advisor

Kimmy Nguyen
Event and Project Coordinator

Angela Racko
Finance and Business Associate

Brittany Reyes
Academic Services & Student Organizations Coordinator
Silicon Valley campus

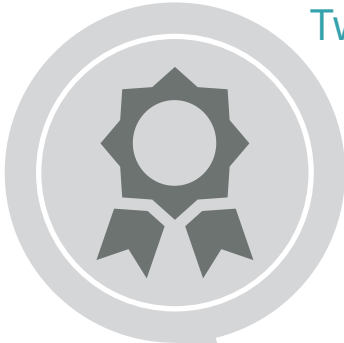**Mason Risley**
Process Engineer – Nanofabrication Facility

Holly Skovira
Administrative Coordinator

A **bright** future with bright **minds**

Two ECE faculty awarded the 2016 Dean's Early Career Fellowships

Hakan Erdogmus and Soummya Kar were awarded the 2016 Dean's Early Career Fellowships for groundbreaking work in their fields. They have been granted these fellowships to provide funding to further their outstanding research.

## Information theory, energy-efficient communication and computing, and neural sensing

If we could reduce wireless brain sensors' energy consumption, we could increase capabilities, get higher resolution neural data, and better diagnose brain diseases such as epilepsy. Pulkit Grover is researching the world-changing benefits of energy-efficient devices.

Sekar wins multiple awards

Vyas Sekar has won multiple awards, including the NSF Faculty Early Career Development (CAREER) Award to pave the way towards reliable network security assurances, a Facebook Faculty Award for his research in networking, security, and systems, and SIGCOMM's 2016 Rising Star Award, which recognizes a young researcher – no older than 35 – who has made outstanding research contributions to the field of communication networks during this early part of his or her career.

2016
faculty highlights
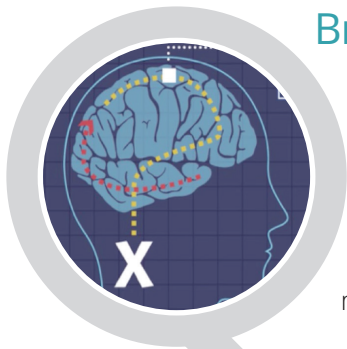
Brain computer interfaces helping people with disabilities

What if real-life telekinesis isn't that far off? By developing the appropriate statistical and machine learning methods for analyzing the activity of large populations of neurons, Byron Yu and his research team can give paralyzed patients the power to move robotic limbs with their minds.
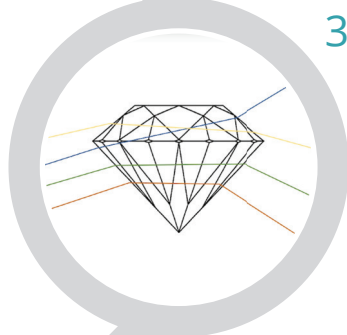
3D scanning technology that detects light interaction

Aswin Sankaranarayanan and his research team are developing a 3D scanning technology that can capture not just the 3D shape of an object but also how each surface element on the object interacts with light.

The vents in your office aren't just pumping out air

We rely on our HVAC systems to keep us cool when it's hot and warm when it's cold—but that's not all they're doing. Current systems waste huge amounts of energy and hemorrhage money as a result. It's estimated that buildings consume more than 40% of our country's energy, and of that energy, nearly one third is wasted due to outdated, inefficient systems like heating and cooling. Professors Mario Berges of Carnegie Mellon University's Department of Civil and Environmental Engineering and ECE's Anthony Rowe have come up with a way to combat these inefficiencies.

Learn more about ECE faculty research on our YouTube channel: youtube.com/c/cmuece

silicon valley

Software Engineering students build their interviewing muscles at the Coding Gym

By Adam Dove

In the competitive field of software engineering, it's rare to see potential applicants helping each other prepare for job interviews—or at least, that's what Software Engineering master's student Vincent Su thought. But when one day he saw a group of students on CMU's Silicon Valley campus doing just that, it inspired him to create a place where students could meet in that same spirit of collaboration on a regular basis. That place is the Coding Gym Club.

The idea was born out of a very familiar feeling—a fear of the future.

"Same as most students in my program, I was preparing for coding interviews and getting pretty anxious about it," Su explains. "One day, I passed by a group of second year MS students who were sitting together and solving one coding problem. They analyzed it together, bounced their ideas and solutions off each other, and grew together as a group. I thought, 'Why not make that a regular thing?'"

All it took was a quick post to the CMU-SV Facebook page for the interest to start pouring in. In particular, Hill Ma, who was at the time in the last semester of his Software Engineering master's program, thought Su's idea was brilliant. As a big fan of competitive coding himself, Ma partnered with Su to spearhead the club, hosting algorithm workshops and whiteboard coding practice.

Every Tuesday since the club's inception in fall of 2015, the group has gathered to hone its members' coding and interviewing skills. Software Engineering interview questions vary from company to company, but most consist primarily of algorithm and data structure questions.

"We aim to mimic an interview scenario," Su adds. "A problem is presented, we discuss and communicate our ideas, draw and write things down on the white board to help explain our ideas better, identify how to improve our current solutions, come to an agreement, and implement it ourselves, either on our computers or on the whiteboard."

According to Su, algorithms and data structures are particularly important for software engineers, and a sound understanding of them is essential throughout a software engineer's career—not just during the interview process. But even more than practice, the Coding Gym Club is about accountability.

"I like to use the analogy of a gym," Su says. "Everyone knows working out is good for them, but very few people actually go the gym regularly. It's a commitment. The goal here is much more than just getting better at interviewing. It is helping students lay a solid foundation in problem solving."

Ma graduated in December of 2015, leaving Su fully in charge of the group's six regular attendees. While it may be small, Su sees the group becoming a resource for anyone at the Silicon Valley campus who may need it.

"Whether people come to the sessions or not," Su says. "I want to make sure everyone knows the benefit they can get out of the Coding Gym. Peer advisor programs, mock interviews, workshops—we're here to expand the idea of 'students helping students' style career development."
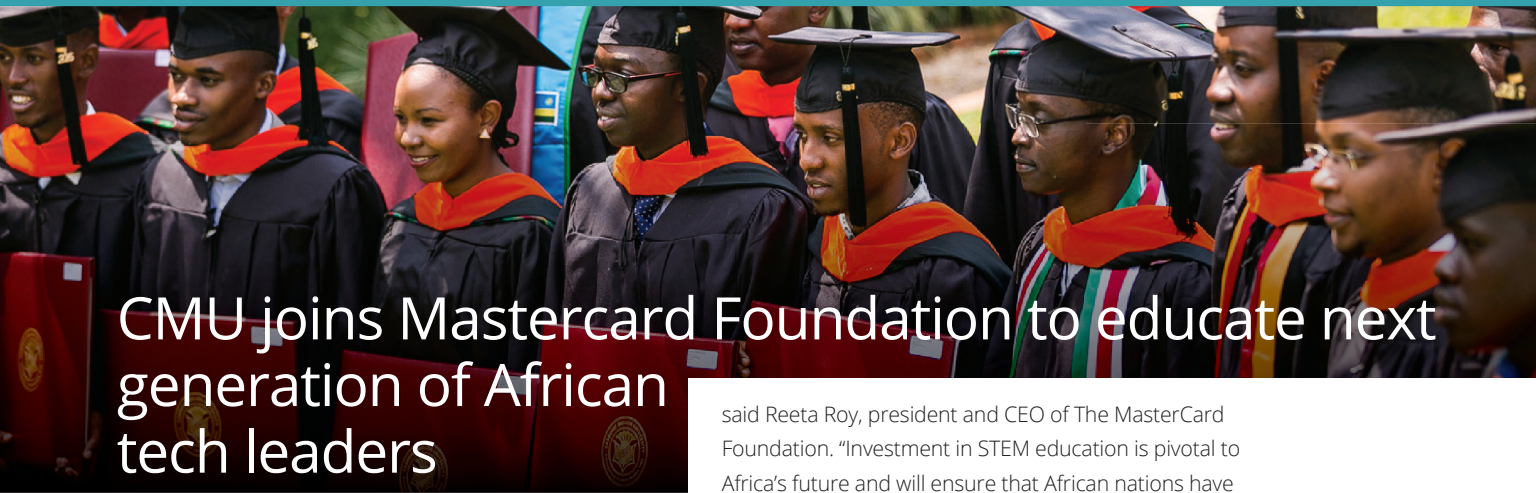
CMU joins Mastercard Foundation to educate next generation of African tech leaders

By Sherry Stokes

Carnegie Mellon University's commitment to educating Africa's next generation of technology leaders and entrepreneurs received a boost with a $10.8 million commitment from The MasterCard Foundation. This new partnership, which will be established at Carnegie Mellon University's College of Engineering program in Kigali, Rwanda, will benefit 125 academically talented but economically disadvantaged students from Sub-Saharan Africa as part of The MasterCard Foundation Scholars Program. Carnegie Mellon University will join a global network of 23 Scholars Program partners, comprising educational institutions that are committed to developing Africa's young leaders.

Since 2011, Carnegie Mellon University in Rwanda has contributed to enhancing the quality of the engineering workforce in Africa. This effort has addressed the critical shortage of information and communication technology (ICT) skills required for Africa to compete in the Fourth Industrial Revolution where physical, cyber, and biological systems converge through information, computing and communication technologies to transform the lives and livelihoods of citizens around the world in unprecedented ways. The talented graduates of Carnegie Mellon in Rwanda play a strategic role in Africa's trajectory, leveraging ICT to digitally leapfrog socio-economic development across the continent. With transformative support from The MasterCard Foundation, Carnegie Mellon will be able to multiply its impact on higher education and the ICT sector in Africa, as part of the Rwanda Government's vision to create a Regional Center of Excellence in ICT and to serve as a technological hub for the region.

"We are excited to partner with Carnegie Mellon University in Rwanda, an exceptional institution committed to training the next generation of African engineers, innovators, and entrepreneurs to meet pressing global challenges,"

said Reeta Roy, president and CEO of The MasterCard Foundation. "Investment in STEM education is pivotal to Africa's future and will ensure that African nations have the opportunity to identify, develop and deploy their wealth of talent."

The MasterCard Foundation Scholars Program at Carnegie Mellon University in Rwanda will attract a diverse mix of Scholars from Rwanda and the rest of Sub-Saharan Africa, with a priority on increasing the enrollment of women.

The Program will start in fall 2016 and conclude in 2023, underscoring the importance of establishing long-term education programs in Africa. Research underway at Carnegie Mellon in Rwanda also takes a long-term approach. The faculty understand that to address Africa's technology needs, students require time to analyze and solve problems in the context in which they occur. Research at Carnegie Mellon explores critical topics relevant to Africa: wireless networking, mobile applications, energy systems, cyber security, agriculture, financial services, and telecommunications.

The partnership announcement was made last summer during Carnegie Mellon University's graduation ceremony, when 24 students received master's degrees in Information Technology and Electrical and Computer Engineering. CMU President Suresh, and Dr. Jendayi Frazer, a member of the Board of Directors of The MasterCard Foundation, attended the graduation ceremony. To date, the program has graduated 70 students hailing from Rwanda, Kenya, Uganda, and the United States. The vast majority of these graduates are working in their home countries, making an impact in the private sector, government and academia, and the rest are pursuing the creation of startup companies as well as doctoral programs.
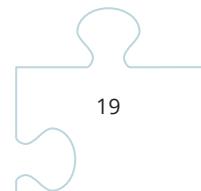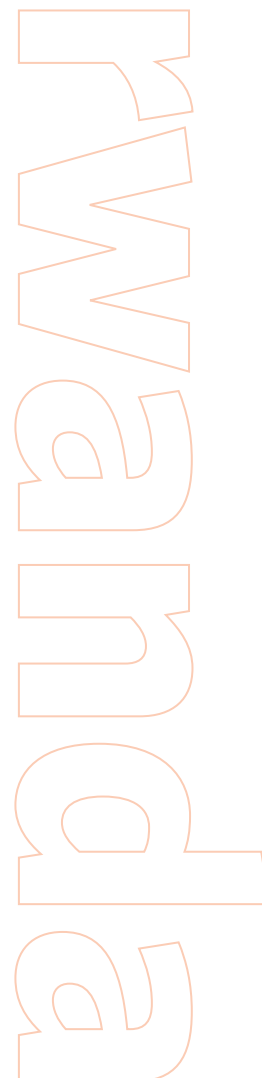
Give where your heart is
ECE funding opportunities

Giving to the Department of Electrical and Computer Engineering offers you the opportunity to make an impact on the innovative, interdisciplinary education and research taking place here. Strategic funding priorities that help the college achieve its goals include funding fellowships, faculty, and facilities projects for the college.

For more information, visit **www.ece.cmu.edu/giving**.

Department of Electrical and Computer Engineering

We are able to provide an engaging, enriching, and encouraging environment because of the support of our donors. Giving to ECE is a vote of confidence in our program, and helps to keep us at a competitive level with other world-class programs.

We need and appreciate gifts at all levels. In particular, undergraduate alumni participation rates also impact our national rankings in publications such as U.S. News & World Report.

Global Connectivity Incubator

The Department of Electrical and Computer Engineering has a global presence around the world through its educational programs and research collaborations. To continue as a leader, it is paramount that our global campus communications be seamless. The new Global Connectivity Incubator, planned for the 1200 wing of Hamerschlag Hall, will allow students and faculty to connect and work with the ECE global community. We intend to rehaul 3,300 square feet into two distance learning classrooms and collaboration space for our growing department.

Hamerschlag Hall MakerWing

Hamerschlag Hall, the iconic flagship building of the university, is ready for a transformation. We seek to reenergize 40,000 square feet into integrated maker spaces, clustered research environments and open workspaces.

This unique wing will lower barriers to multidisciplinary collaboration while cultivating creative problem solving and "learning by doing." Students across the college will be able to pursue pragmatic designs and functional applications for coursework and independent projects, like Design II capstone design projects and Build18, a freestyle product creation competition.

Dates to remember

MARCH 13-17: Spring break

APRIL 21–22: Spring Carnival

MAY 5: Last day of classes and ECE Day
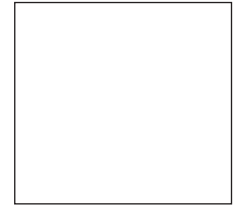
MAY 21: Commencement Weekend

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Semester snapshot

Judith Resnik
Year of Women in ECE

During this academic year, the Department of Electrical and Computer Engineering is excited to launched The Judith Resnik Year of Women in ECE. In celebration of the female students, faculty, and staff in ECE, the department hosts monthly events for the community of ECE women, including networking events, dinners, motivational speakers, and workshops. Here are a few snapshots from the Fall events.

Undergrad networking reception

WinECE fall dinner

Welcome new HKN members!

HKN inducted new members

IEEE-Eta Kappa Nu (IEEE-HKN), the honor society of IEEE, is dedicated to encouraging and recognizing individual excellence in education and meritorious work, in professional practice, and in any of the areas within the IEEE-designated fields of interest.