Carnegie Mellon University
Electrical & Computer Engineering

THE CIRCUIT

Fall 2019

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Electrical & Computer Engineering

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THE CIRCUIT

Fall 2019

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FEATURE

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Exploring the Essence of Big Data

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welcome

FROM THE DEPARTMENT HEAD

Dear Alumni and Friends,

I am now nine months into my new role as department head and I continue to be amazed by the focus and collaboration our students and faculty illustrate. I am inspired by the enthusiasm our students have for learning, and the dedication our faculty endlessly show.

This past year has been one of growth and transition for the university, college, and department. We have experienced significant leadership changes and look forward to welcoming our new dean, Dr. William Sanders, in January 2020.

I am proud that our department has maintained its rank in the U.S. News & World Report top 10 graduate and undergraduate programs. The college's undergraduate program placed at #6, and the graduate program at #4.

We continue to attract and retain world-class faculty. I'm excited to introduce our newest faculty members Vanessa Chen, Marc Dandin, Xu Zhang, and Siyang Zheng. Their expertise spans the fields of microsystems, nanotechnology, and cybersecurity. Three additional faculty members will join our community in January 2020, expanding our focus in machine learning, software engineering, and neuroscience: Daniel Bankman, Leonardo de Silva Sousa, and Yorie Nakahira.

From new buildings to industrial partnerships, our department continues to forge ahead in educational excellence. In this magazine, we present a glimpse into the exciting and innovative happenings taking place on our campuses.

I remain thankful for the support from alumni and friends like you.

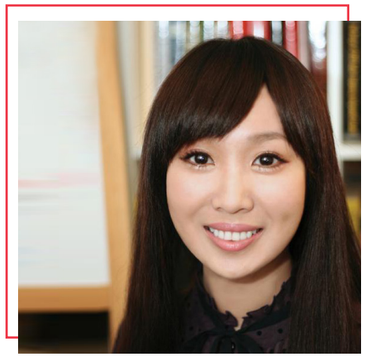
Sincerely,

Larry Pileggi
Tanoto Professor and Department Head
Electrical and Computer Engineering

NEW FACULTY MEMBERS

faculty

Daniel Bankman will join the department as an assistant professor on January 1, 2020. He earned his Ph.D. in electrical and computer engineering from Stanford University. His research lies at the intersection of mixed-signal circuit design and machine learning, with focus on neural architectures, hardware architectures, and circuits that together exercise the energy limits of scaled semiconductor technology.

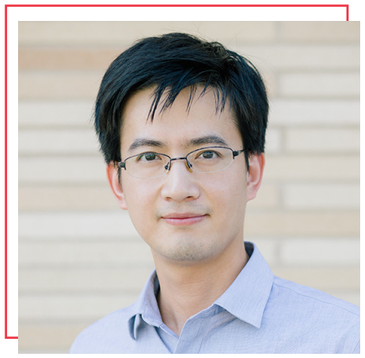


Vanessa Chen, assistant professor of electrical and computer engineering, earned her Ph.D. in electrical and computer engineering from Carnegie Mellon University. After graduation, she joined Qualcomm to develop next-generation sensing and communication systems. Her research focuses on low-power circuits and systems with work spanning the design of high-performance data converters, ubiquitous sensory interfaces, as well as hardware-based cybersecurity.

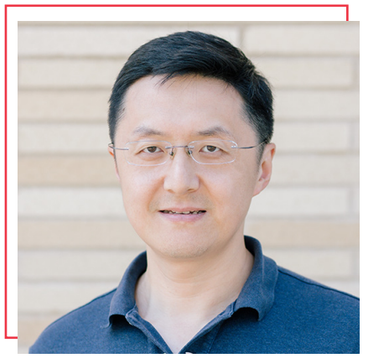
Marc Dandin, assistant professor of electrical and computer engineering, earned his Ph.D. in bioengineering from University of Maryland, College Park. His work on the development of low-noise photodetectors and CMOS VLSI readout circuits for portable fluorescence sensors, high-performance thinfilm optical filters, and packaging processes for integrated fluorometers has led to several patents. Dandin is the founder of Kiskeya Microsystems LLC, a startup company commercializing point-of-care microsystems for HIV viral load monitoring.

Yorie Nakahira will join the department as an assistant professor on January 1, 2020. She earned her Ph.D. from the Department of Computing and Mathematical Sciences at California Institute of Technology. Her research in neuroscience provides a theoretical tool to bridge the gap between neurophysiology and sensorimotor control.

Leonardo da Silva Sousa will join the department as an assistant teaching professor on January 1, 2020. He earned his Ph.D. in computer science from Pontifical Catholic University of Rio de Janeiro. His research interests include code smells, design problems, refactoring, software architecture, software testing, and machine learning.



Xu Zhang, assistant professor of electrical and computer engineering, earned his Ph.D. in electrical engineering from Massachusetts Institute of Technology. His research interests are to enable new paradigms of nano-devices and their system-level integration by leveraging the emerging nanomaterials (e.g. atomically thin 2D crystals) and nanotechnology.



Siyang Zheng, associate professor of electrical and computer engineering with a joint appointment in the Department of Biomedical Engineering, earned his Ph.D. in electrical engineering from the California Institute of Technology. His current main research interests center around biomedical micro/nano technologies and their applications to cancer and infectious diseases.

CMU-AFRICA IS MOVING AND GROWING

For the last seven years, Carnegie Mellon University has been operating its Africa site in Kigali, Rwanda, and during this time, much has changed about the program and the school's site itself. Originally, it was named for its location—Carnegie Mellon University Rwanda. However, it became clear with the program's rapid growth that it could no longer just be named for Rwanda. That's why, in the spring of 2017, the site's name was officially changed to Carnegie Mellon University Africa (CMU-Africa), to reflect the overwhelmingly pan-African nature of the location.

In the future, however, even bigger changes will be coming to CMU-Africa. Since its inception, the program has been housed in a temporary building called the Telecom House. In the next few months, however, the program will be moving into its permanent home in Kigali Innovation City.

"For the last seven years, I would say that CMU-Africa has been in startup mode," said CMU-Africa Director Vijayakumar Bhagavatula. "We were a brand new location, starting from scratch in a completely new place, and learning a new culture. And kudos to the whole team that brought us to the position we are currently in. But now—we are ready for the next step."

That next step is a 6,000-square-meter facility, designed to accommodate about 300 students. Right now, CMU-Africa has 130. That number can more than double in the new building. The facility will also contain twice as many labs, more classroom space, and modern distance education facilities. With so much additional space, the program will be able to offer a number of new things, including additional master's programs, or maybe even Ph.D. programs.

"We do know that some of this additional space will be used for an incubator to help entrepreneurs, particularly CMU-Africa students and alumni, start their own businesses," Bhagavatula said. "We're seeing increasing expressions of interest from the community in entrepreneurship, but without the proper facilities, it's easy for these future entrepreneurs to struggle and give up."

In fact, this move to a new facility underscores CMU-Africa's commitment to developing African entrepreneurs. Not only will it provide the necessary facilities to support them, but the building sits in the heart of Kigali Innovation City—the future hub of Rwanda's growing knowledge-based economy.

"We teach a lot about IT entrepreneurship in our courses," said Bhagavatula. "We have several courses, and in fact, one of the six concentration areas for our MSIT program is IT Entrepreneurship, where we prepare students to start their own companies, and to think like entrepreneurs. What does it mean to start a company in a developing environment like Rwanda or Kenya or other parts of Africa? These questions are very different, and our program equips them with the right ways to approach them."

CUTTING-EDGE ENGINEERING RESEARCH AND EDUCATION IN SOUTHEAST ASIA

Established as a collaboration between Carnegie Mellon University and King Mongkut's Institute of Technology Ladkrabang, Carnegie Mellon University Thailand (CMU-Thailand) will provide cutting-edge engineering research and education in Southeast Asia.

By bridging world-class partnerships with local context, CMU-Thailand makes technologies accessible to its society and creates innovations that will benefit Thailand and the Southeast Asia region. By applying Carnegie Mellon University's globally acclaimed research and education programs within a regional context, CMU-Thailand tackles challenges that will drive future development of Thailand and the Association of Southeast Asian Nations (ASEAN) community.

The collaboration between Carnegie Mellon University and King Mongkut's Institute of Technology Ladkrabang (KMITL), a leading engineering university in Thailand, aims to significantly expand research and education in the areas of information, computing, and autonomous technologies.

CMU-Thailand program activities occur both in Thailand and at Carnegie Mellon in Pittsburgh, Pennsylvania. To facilitate collaboration with CMU, CMKL University was established in association with KMITL to administer the program for research and education activities in Thailand.

The CMU-Thailand program involves professors, researchers, and students from CMU, CMKL University, and KMITL, as well as several industry partners from Thailand. The Department of Electrical and Computer Engineering within the College of Engineering plays a central role in the program.

Above image

Carnegie Mellon University Thailand (CMU-Thailand) hosted three of Thailand's corporate leaders at CMU's Pittsburgh campus in spring 2019. The visit was designed to foster collaboration between CMU and its new partners in Thailand.

The visiting executives were: Vanus Taepaisitphongse, chair of executive board of Betagro Group; Woranun Woramontri, senior specialist–corporate strategy of Betagro Group; and Teerapan Luengnaruemitchai, vice president, Office of Information Technology at Thai Beverage PLC. They were accompanied by two members from CMU-Thailand at CMKL University, CMU's Thai partner: Orathai Sangpetch, vice president, and Akkarit Sangpetch, program director.

PILEGGI NAMED DEPARTMENT HEAD

Carnegie Mellon University's College of Engineering has named Larry Pileggi as head of its Department of Electrical and Computer Engineering.

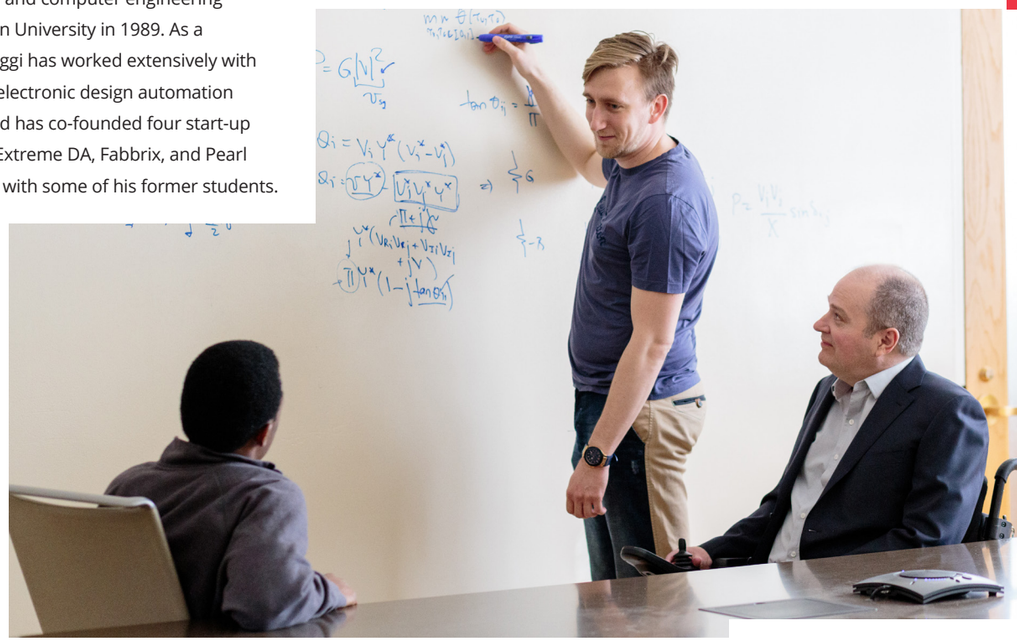
The College conducted a national search considering a diverse pool of both internal and external candidates. Pileggi was selected for his leadership in the field and his vision for the next phase of the department's growth.

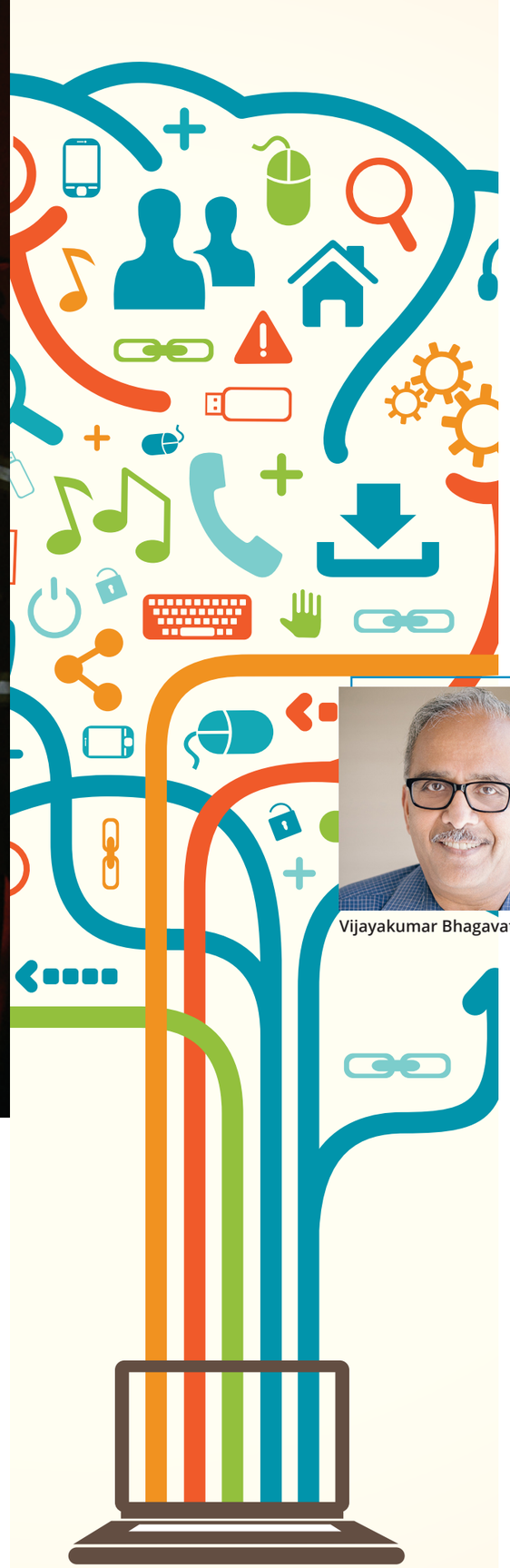
"His presentation to the ECE community outlined the creation of more maker initiatives throughout the curriculum and research thrusts," said Interim Dean Jon Cagan. "He identified the structuring of research around application domains that span from the electrical engineering to the computer engineering communities."

Pileggi is the Tanoto Professor of Electrical and Computer Engineering and has previously held positions at Westinghouse Research and Development and the University of Texas at Austin. He received his Ph.D. in electrical and computer engineering from Carnegie Mellon University in 1989. As a faculty member, Pileggi has worked extensively with semiconductor and electronic design automation (EDA) companies, and has co-founded four start-up companies (Xigmix, Extreme DA, Fabbrix, and Pearl Street Technologies) with some of his former students.

An innovative researcher, Pileggi has published more than 350 conference and journal papers and holds 40 U.S. patents. He has active programs in various aspects of digital and analog integrated circuit design, and simulation and optimization of electric power systems. He has received several national accolades, including Westinghouse Corporation's highest engineering achievement award, a Presidential Young Investigator Award from the National Science Foundation, a 2010 IEEE Circuits and Systems Society Mac Van Valkenburg Award, and a 2015 Semiconductor Industry Association (SIA) University Researcher Award, to cite just a few. Pileggi is a fellow of IEEE and has supervised 47 Ph.D. students through their degree completion.

Pileggi joins a long list of prominent department heads, succeeding Jelena Kovačević, who served in this role for the previous four and a half years. She is now the dean of the Tandon School of Engineering at New York University.





MAKING MEMORY RELIABLE

People use electronics every day, sometimes for hours on end. Take a smartphone for example. It receives texts and phone calls, records audio, holds email, takes photos, and of course, has the internet. A smartphone contains an immense amount of data that needs to be stored. When our phones die or we shut them off, we expect—we demand—that nothing is lost, that everything works just as well as before the power cycle ended and restarted. To ensure that data is stored and saved, the phones need non-volatile memories, meaning that the memories must retain content through power cycles.

One type of non-volatile memory is resistive memory, which has attracted research interest because in addition to non-volatility, it has fast speed, scalability, and rewritability—the ability to save an altered file over its previous version in the same storage location. Resistive memories, such as phase change memories (PCM) and resistive random access memories (ReRAM), store data by changing the resistance of the state for each memory cell.

Vijayakumar Bhagavatula

For their research in resistive memories, Department of Electrical and Computer Engineering Professors Vijayakumar Bhagavatula and Jim Bain and former Ph.D. students Yongjune Kim and Abhishek Sharma, with collaborators from Western Digital Research, have received the IEEE Data Storage Best Student Paper Award, announced in the spring of 2019.

The paper, titled "Locally Rewritable Codes for Resistive Memories," considers resistive memories and what needs to be improved for future large-scale deployment. Though resistive memories have good advantages, such as fast speed and reliability, they have issues in limited lifetime and high write power consumption. Lifetime is measured by write endurance, the number of write cycles that can be applied to a block of memory before it becomes unreliable.

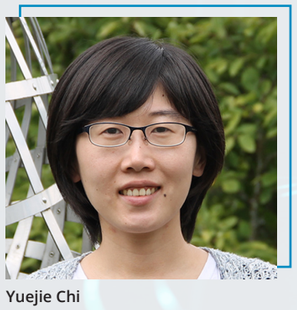
Jim Bain

Kim and Bhagavatula have continued their research in non-volatile memories in other projects, supported by Carnegie Mellon's Data Storage Systems Center.

EXPLORING THE ESSENCE OF BIG DATA

Whether you noticed or not, you are receiving and creating countless data in your everyday life, sometimes merely by sending messages and browsing items in a shopping site. Many fields, such as medicine and entertainment, have become data-rich, which drives researchers to find new ways to capture and analyze this rapidly increasing information.

Yuejie Chi, the Robert E. Doherty Career Development Associate Professor of Electrical and Computer Engineering, is one of these researchers. "There are lots of interesting questions about how you can model such data and how you can extract information from these data," said Chi. "They allow me to apply the type of tools I know to some practical problems that domain experts might be interested in."



Yuejie Chi

For her research, Chi has received the Presidential Early Career Award for Scientists and Engineers (PECASE). Established in 1996, the PECASE is the highest honor bestowed by the United States Government to outstanding scientists and engineers who have begun their independent research careers and have shown exceptional promise for advancing their fields.

Chi's research focuses on representing data efficiently to reduce complexity and improve decision making. We can obtain plenty of information from big data, but the data we observe and collect every day can be highly redundant, messy, and incomplete. Take movie sites such as Netflix as an example; the users may only review a small number of films even though there are thousands of films out there.

How, then, can people extract useful information from these raw data? Though overwhelming at first glance, the entries in big data matrices can be very correlated. There may be millions of users in a movie site, but they have many similarities such as age, country of origin, and educational background. Likewise, movies can have the same genres, directors, and main actors. If we study entries by their correlations, we can obtain their hidden features, also called latent variables.

By focusing on latent structures, movie sites can predict the missing entries and which movies the users might like. In this way, they can design algorithms to build an effective recommendation system.

"You don't directly just think about the data itself; you're trying to get some structures," said Chi. "Once you get a good model of the latent structure, you can think about solving an inverse problem where you try to recover those latent structures using optimization. We're studying how to design algorithms to recover these structures."

INTELLIGENCE BEYOND THE EDGE

Imagine an electronic device that draws energy from the environment, never needing to be plugged in. Operating by collecting small amounts of energy extracted from their environment, tapping into sources such as radio waves, solar energy, and vibration, they have the potential to impact our day-to-day lives. However, building reliable batteryless hardware and software computer systems is a challenge because energy is only intermittently available, risking the communication of the device.

In a recent paper, Brandon Lucia, assistant professor of electrical and computer engineering, and colleagues Nathan Beckman and Graham Gobieski from the School of Computer Science, demonstrate machine learning inference using deep neural networks on a batteryless, intermittent computing device. The team presented their work at the 24th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS).

“The significance of this result is that now even tiny, environmentally deployed sensor devices can use the power of machine learning to draw sophisticated conclusions about the data that they collect without the need to send all of the sensor data to the cloud,” said Lucia.

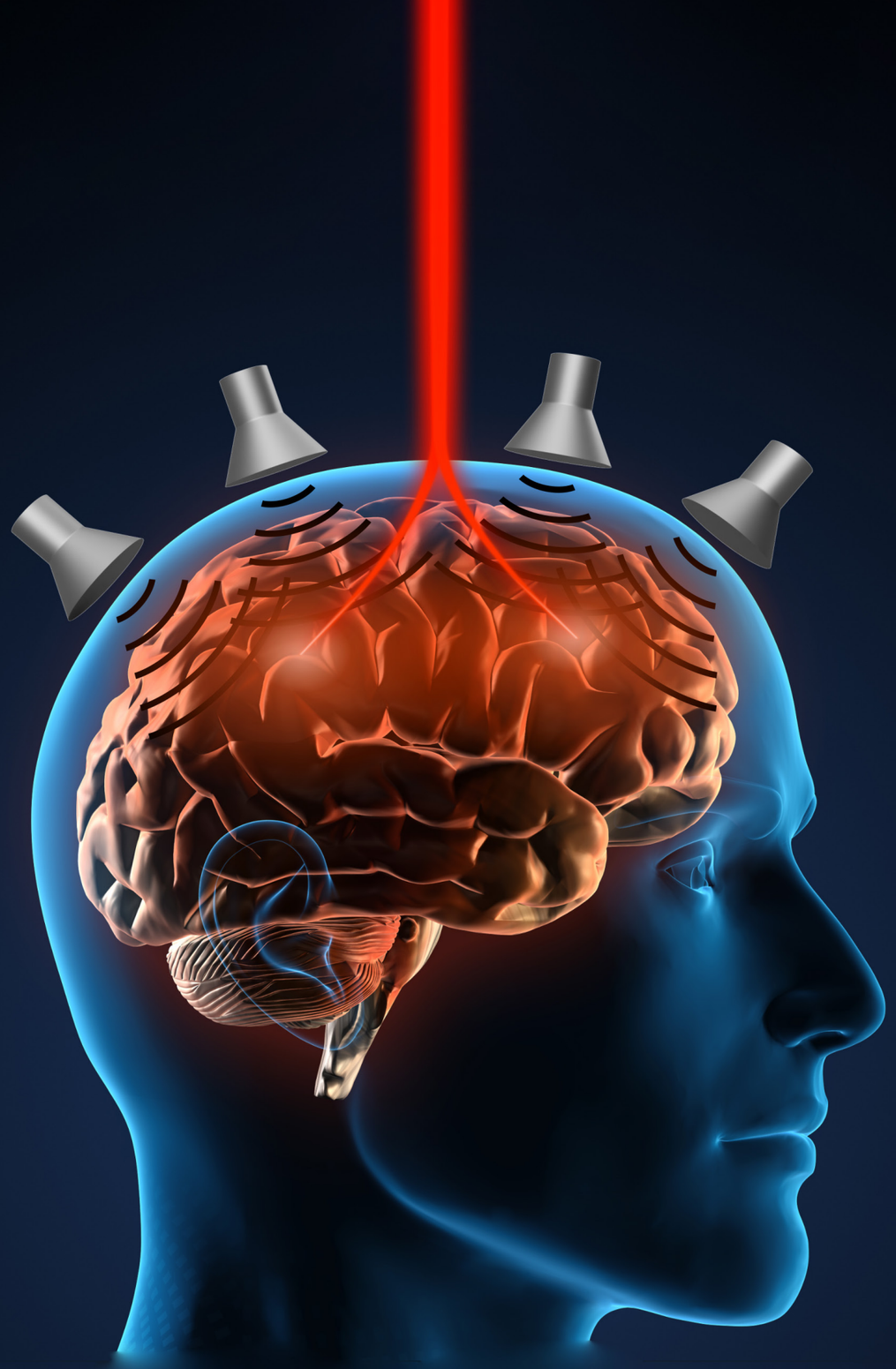
The communication part of the device is a complex system, resulting in absorbing the majority of the energy. By enabling the tiny, batteryless devices to do machine learning inference locally, the need for the complexity and energy cost of communication can be avoided.

“The techniques that we developed work for a wide variety of batteryless devices, without relying on special hardware,” said Lucia. “Our technique restructures the computation to match the intermittent operating behavior of a batteryless device, and uses novel software techniques for managing the intermediate values produced when evaluating a deep neural network.”

This innovative technique has the potential to impact various fields, from implantable medical sensors to civil infrastructure monitors and IoT devices.

Lucia has previously been awarded a National Science Foundation (NSF) CAREER Award to further his research on the next generation of reliable, capable intermittent computer systems.

Brandon Lucia



SOUND STEERS LIGHT THROUGH THE BRAIN

If you have ever looked at a sample under a microscope, it is likely that you have used optical imaging. For most students, the compound light microscopes which populate the majority of chemistry and biology classrooms are their first encounters with imaging techniques. We remember these first hands-on experiences fondly and recall the wonder with which we gazed at the small creatures swimming through nearby pond water or the shape of the cells comprising our own skin. These are examples of using "optical methods," in which we use light to look into objects.

Optical methods enable doctors and clinicians to look at different types of tissues. Compared to other radiation-based techniques, such as X-ray or Gamma ray, optical methods are usually safer for biomedical imaging and manipulation of tissue.

Optical methods have a major shortcoming. We can only see just below the surface of the skin because most tissues are opaque against visible light. Penetration of light into tissue is mainly limited by the scattering (dispersion and random reorientation) of optical rays within the tissue.

Maysam Chamanzar

To protect light from scattering in the tissue, clinicians and biologists use miniature endoscopes and small-diameter light pipes, or "waveguides," allowing for deeper penetration of light and therefore clearer images. Unfortunately, this comes with a new set of difficulties: because they're invasive, these implantable light guides may cause tissue damage, and since they're often stiff and fixed in place upon insertion, light cannot be easily steered or guided beyond its predetermined path. A fundamental question is whether this intrinsic limitation can be overcome. That is, can we conquer the dispersive effects to guide light deeper into the body without inserting a light pipe into the tissue?

In response, Maysam Chamanzar, assistant professor of electrical and computer engineering, and his colleagues have introduced a groundbreaking technique to address this need by using non-invasive sound waves to shape light and control its trajectory deep into the tissue. This method can revolutionize optical imaging and manipulation in biology and many other applications.

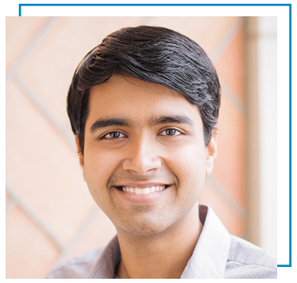
The team has shown that high-frequency sound waves (i.e., ultrasound) can, in real time, shape and sculpt a beam of light into arbitrary patterns as it propagates through the tissue. In this method, ultrasound pressure waves slightly change the local density of the tissue, which translates into a local change of optical refractive index. The interaction of light with this ultrasonically-altered refractive index pattern defines the trajectory of light through the medium.

Chamanzar, who invented this novel technique and led the project, describes the idea: "Light is an electromagnetic wave, and ultrasound is a pressure wave. The interesting part of our idea is that we use waves to control waves. Both types of waves can propagate through the target tissue, for example the brain, non-invasively, that is without causing any damage."

This innovative approach has the potential to drive a whole gamut of new applications in bio-photonics. With uses in a plethora of spheres, both medical and technological, Chamanzar's work will have immediate and long-standing effects on different fields within science.

PUSHING THE LIMITS OF COMMERCIAL RFIDS

If you travel frequently, you can be sure that at least once in your life your luggage will be lost to the black hole that is airline baggage services. According to SITA (a leading specialist in air transport technology), mishandled baggage costs the industry an estimated $2.3 billion in 2017 alone. While this frustrating experience affects millions of travelers each year, researchers are searching for new ways to improve the tracking technology.


Swarun Kumar

Most airports use a radio-frequency identification (RFID) system to track the movement of your baggage throughout the airport. This system contains two parts: a mobile tag and a stationary reader. While the reader remains at a fixed checkpoint within the airport, the tag is attached to the baggage and serves as a unique label. As your suitcase moves through the airport, it passes certain baggage checkpoints. When the tag comes within range of the reader, the two parts of the system begin to communicate with each other, transmitting and receiving signals. Through this communication, the reader can confirm that your baggage has made it to each checkpoint.

Checkpoints are placed at specific points throughout the airport, often appearing periodically along the path that the baggage must take from check-in to boarding. Unfortunately, each reader has a range that is relatively small (often around five to 15 meters) compared to the distance between checkpoints. In other words, there are often blind spots along the path, where no checkpoint can confirm that your baggage is nearby. It is these blind spots that constitute the dreaded black hole: once your baggage is outside of the range, it becomes essentially lost—even though it is most likely still somewhere along the proper path.

Recently, researchers in Swarun Kumar's lab have developed a solution that increases the range by updating the system's software.

"From a deployment perspective, upgrading software on existing readers is much more inexpensive compared to purchasing and installing new readers that are often bulkier," says Kumar, assistant professor of electrical and computer engineering.

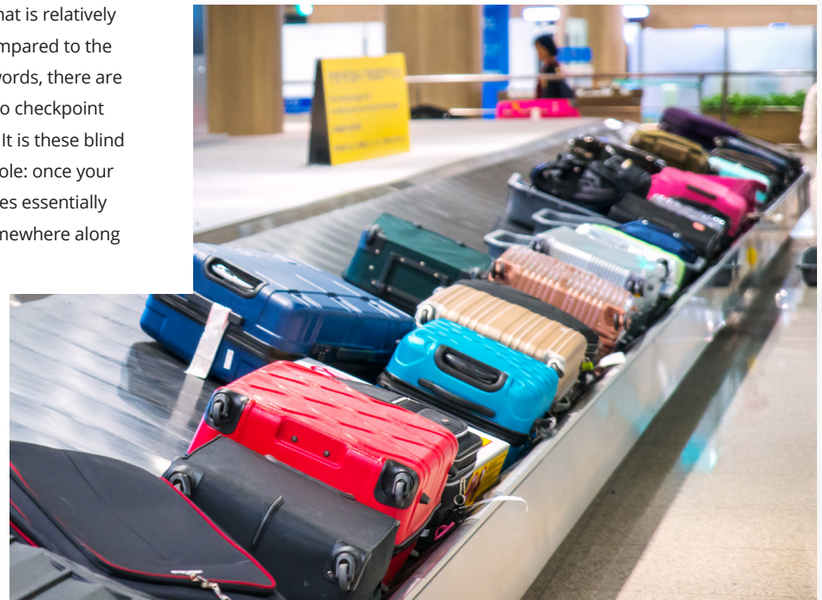
"Our solution, called PushID, uses a technique called beamforming that focuses energy from many different readers on to one tag. By carefully modifying the signals from each reader, we make sure their energy constructively adds up at the tag's location. Our key innovation is finding where the battery-free tags are to beam energy to, because they have absolutely no energy in the first place to advertise their location."

To determine where tags are located throughout the environment, the readers give out various specialized signals that intelligently smear energy through the environment in search of a tag. If a tag is within the range, it will transmit a signal in return. The reader will then receive this transmitted signal and once again sends out a signal of its own. By repeating this process every few milliseconds, the readers can quickly identify the tags in the environment and can converge on their precise locations.

Jingxian Wang, the Ph.D. student who spearheaded the project, dreams of a world in which PushID can be used for more than tracking baggage at an airport.

"The technology may one day allow us to track our phones and our clothes, every item that we don't want to lose, throughout entire cities," said Wang.

Far from the days of losing your luggage on important trips, PushID may be the answer to never losing anything again.



NANO-MAKER ECOSYSTEM

The nano-maker ecosystem is a space, philosophy, and methodology that enables rapid prototyping of nanoscale devices, engagement with industry and university affiliates, incubation for start-ups, and education and outreach activities.

Carnegie Mellon is one of the few places that facilitates a maker culture at the nanoscale, allowing researchers to use the facility to shape new materials into emerging and novel technologies. Resources for rapid prototyping of nanoscale devices include support for users with layout and fabrication of simple and complex structures, as well as access to both cutting-edge equipment and a material and process database.

The engagement with industry and university affiliates involves collaboration and partnership with local and national organizations, connections with graduate students, and a regional community of users that shares common practices. The system also supports the start-up incubation development process for Carnegie Mellon-based and local start-ups. In the future, the plan is to offer boot camps for the rapid training of industry partners and students.

In addition, the ecosystem provides education and outreach initiatives, including technical seminars for professional Nanofab users and industry collaborators, student courses that offer hands-on training in nanofabrication, and outreach programs to high school students and teachers.

A HISTORY OF COLLABORATION

Carnegie Mellon has been pursuing research at the nanoscale since the early 1980s. Research in micro- and nanoscale magnetics enabled the creation of the first nanofabrication facility on campus. The original nanofab has been transformed into a collaborative space for faculty from different departments and disciplines to work together to build micro- and nanoscale devices.

Over time, the Nanofab has evolved to better facilitate this collaborative research, especially by augmenting tools and capabilities. These enhancements paved the way for the creation of the state-of-the-art Bertucci Nanotechnology Laboratory, a space that enables and leverages campus-wide collaborations and broader research thrust areas.

1980s

- The initial Nanofab was established in 1983, launched by magnetics work, its key focus.

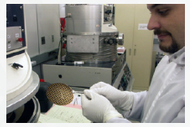
1990s

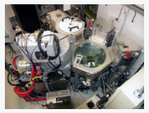
- The Nanofab remained heavily focused on magnetics [as the Data Storage Systems Center (DSSC), an NSF ERC, was created at CMU] but began to expand capabilities for MEMS in the mid- to late-1990s.
- In 1996, Roberts Engineering Hall was built with new rooms to accommodate expanding research.
- Several major equipment and facility acquisitions occurred in 1998.

2000s

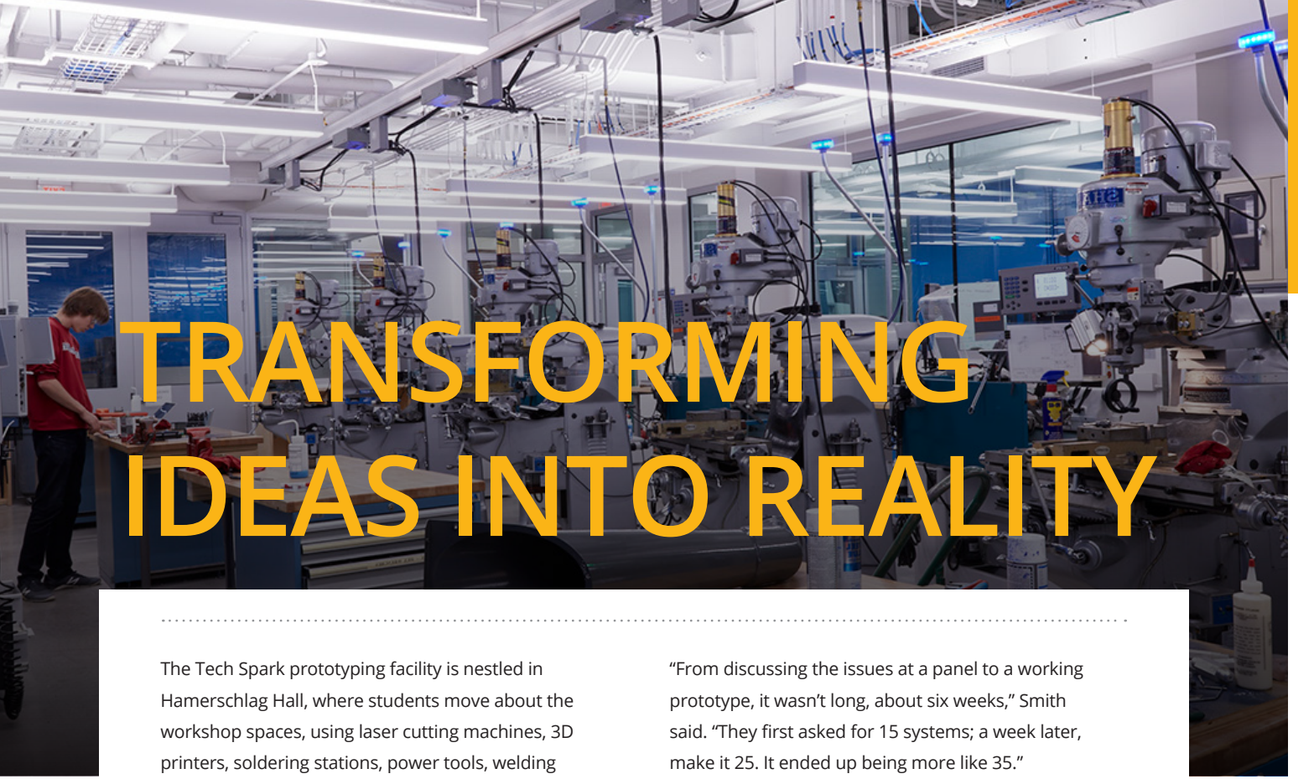
- Planning for the new lab kicked off during this decade while faculty in biomedical engineering, materials science and engineering, and mechanical engineering began using the Nanofab more, initiating a shift toward a broader and more collaborative research effort on energy, life sciences, and Internet of Things.
- More than a dozen new pieces of major equipment were acquired during this time frame in an effort to meet more modern needs and increased collaboration, as well as to keep the lab state-of-the-art.
- In 2017 the new facility opened. Equipment started to move in, and the space was opened to research.

- The Nanofab's focus became broader to include optics and photonics. Hard drive advancements began to taper off while new storage and memory technologies began to emerge.
- The MEMS effort began to ramp up and became a major focus as new equipment was added.





2010s



TRANSFORMING IDEAS INTO REALITY

The Tech Spark prototyping facility is nestled in Hamerschlag Hall, where students move about the workshop spaces, using laser cutting machines, 3D printers, soldering stations, power tools, welding equipment, metal mills, and countless other technical machinery. The rooms are filled with the sound of buzzing machines, the clanking of heavy materials, and the chatter of students working on different projects.

In 2017, the College of Engineering began to consolidate several workshops spread across multiple engineering departments on campus to create one unified makerspace, which officially opened as Tech Spark in the spring of 2018. Today, Tech Spark is a place where members of the Carnegie Mellon University community come together in a single location to design and innovate together, transforming ideas into reality.

Above each station hangs a glowing LED light system. These are special light trees that read Andrew ID cards to check safety certifications and change the color of the LED light based on the system's findings. This system is necessary due to Tech Spark's hundreds of unique users from all over campus. The call to create this check system came from Diana Haidar, assistant teaching professor of mechanical engineering and educational director of Tech Spark, who approached the Department of Electrical and Computer Engineering IT group in fall 2017.

Robert Smith, senior windows systems engineer in ECE ITS, was selected to spearhead the project. After an initial discussion of what the check system should be, completion of the project went quickly.

"From discussing the issues at a panel to a working prototype, it wasn't long, about six weeks," Smith said. "They first asked for 15 systems; a week later, make it 25. It ended up being more like 35."

For the light tree system, the housing unit of LED lights glow specific colors according to the experience and ability of the user at a given machine. When at rest, waiting for a user, the lights are blue. When users insert their Andrew ID card to access the machine, the lights will glow yellow or green—yellow if they are currently in a training course for the machine and green if they have passed the training course. For users without appropriate safety credentials, the lights will flash red and student workers will help users find necessary training.

The College of Engineering offers a multitude of training courses for a wide range of machines and technical skills. Some are full-length courses and half-semester, while others are micro courses, which last just two weeks. Some graduate students received training on machines during their undergraduate studies, but may be a bit rusty and take a micro or mini for a refresher.

Like the resources of Tech Spark, these courses are open to everyone at Carnegie Mellon. A diverse range of students across colleges and majors use Tech Spark, from students in engineering and design to those in art, architecture, computer science, business, and every college in the university

"We want to be a place for everyone, with the physical, digital, and intellectual resources open and available," said Haidar.

SIEWIOREK PROFESSORSHIP

When Dan Siewiorek was hired by Carnegie Mellon University in 1971, his joint appointment in the Department of Electrical and Computer Engineering and the School of Computer Science is what appealed to him.

"I was 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."

Forty-eight 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.

As a nod to his interdisciplinary career, Siewiorek and his wife have pledged to create the Daniel and Karon Walker Siewiorek Endowed Distinguished Professorship in the College of Engineering for a senior faculty member with a primary appointment in the Department of Electrical and Computer Engineering and a joint or courtesy appointment in the School of Computer Science.

Daniel Siewiorek

"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. I hope this professorship will inspire faculty to nurture a career in both fields."

Anthony Rowe, named the inaugural recipient of the professorship, has been inspired by Siewiorek's dedication to electrical and computer engineering and computer science.

Anthony Rowe

"I'm very honored and deeply humbled to receive the Siewiorek Professorship," said Rowe. "The professorship takes on extra meaning, as Dan has been a great mentor to me throughout my time at Carnegie Mellon. His pioneering work across multiple fields embodies the interdisciplinary ethos of CMU, and has inspired me to collaborate with a diverse range of disciplines across the university."

A Taylor L. Booth Education Award recipient, Siewiorek has authored nine textbooks and over 475 papers. He has designed or been involved with the design of nine multiprocessor systems and has been a key contributor to the dependability design of over two dozen commercial computing systems.

Siewiorek is the former Director of the Quality of Life Technology NSF Engineering Research Center, and previously served as Director of the Engineering Design Research Center and co-founder of its successor organization, the Institute for Complex Engineered Systems. He also served as Department Head of the Human Computer Interaction Institute, Chairman of the IEEE Technical Committee on Fault-Tolerant Computing and as founding Chairman of the IEEE Technical Committee on Wearable Information Systems.

A Fellow of IEEE, ACM, and AAAS, and a member of the National Academy of Engineering, Siewiorek has been the recipient of the AAEE Terman Award, the IEEE/ACM Eckert-Mauchly Award, and the ACM SIGMOBILE Outstanding Contributions Award.

"I only have 400 more papers to write and 70 or so Ph.D. students to graduate to catch up with him," said Rowe.

MILL 19 OPENING SIGNALS NEW ERA OF MANUFACTURING

Carnegie Mellon University researchers and robots will soon occupy a state-of-the-art facility at the newly constructed Mill 19 building on the 178-acre site known as Hazelwood Green.

The first building of the new Hazelwood Green development, Mill 19 once served as the location of the Pittsburgh region's most productive steel mills, employing more than 5,000 workers during its heyday.

In September, CMU, the nonprofit Advanced Robotics for Manufacturing (ARM), which was catalyzed by Carnegie Mellon, and Catalyst Connection hosted an event celebrating the opening of Mill 19.

"Mill 19 at Hazelwood Green represents both our storied past and the promise of the region's future as a global innovation leader," said Carnegie Mellon President Farnam Jahanian. "The opening of this hub will usher in a new era of manufacturing while also serving as a powerful reminder of what we can achieve when public, private, civic, and community partners come together to fuel innovative discovery and broaden opportunity."

Before construction began on the first building, ARM and CMU's Manufacturing Futures Initiative (MFI) signed on as the anchor tenants with the Regional Industrial Development Corporation (RIDC), which owns Mill 19.

With more than 200 members, ARM prepares American companies to achieve global leadership in innovation by equipping workers with the best technological tools and workforce programs. ARM also will help small businesses that have been shut out of previous robotics advances to adapt the newest technologies to their needs, further building the manufacturing base and promoting innovation.

Also co-located at Mill 19, MFI was launched in 2017 after receiving a $20 million gift from the RKM Foundation. MFI brings CMU researchers together to advance discovery in the areas of machine intelligence, manufacturing technologies, and human intelligence. The initiative builds on CMU's strength in research and development. It aims to attract public and private sector partners to push advanced manufacturing research, bridge the gap between manufacturing research and industrial use, and foster economic development in the region and the state.

"CMU's core activities in education and research are focused on invention, discovery, and relentless innovation," said MFI Faculty Director and the Howard M. Wilkoff Professor of Electrical and Computer Engineering Gary Fedder. "MFI will serve as the mechanism through which we create new technologies that ARM will then introduce to industry and bring out into the real world for transformative impact."

Mill 19 is currently housing tenants, including the university's self-driving vehicle program. In the Roundhouse, an old building along the river in Hazelwood, CMU researchers built the Boss, a self-driving vehicle that won the 2007 DARPA Grand Challenge. The victory proved that autonomous vehicles (AV) were possible, and later the university's AV program moved to campus where it flourished under the leadership of Raj Rajkumar, professor of electrical and computer engineering. CMU's faculty and students have helped establish Pittsburgh as an international AV hub; however, our work isn't done.

That's why Rajkumar's team is returning to the site where both the Boss and the university's current self-driving vehicle were built. His is the first CMU lab established at Mill 19. The move makes sense for a variety of reasons: the new location provides ample space for researchers to develop next-generation AI and connected automation for self-driving cars, and students will benefit from their close proximity to tech companies.

ONE STUDENT'S PATH TO GRAD SCHOOL

Image source: Argonne National Laboratory

Every graduate student takes a different path to where they are now. Some attend straight out of undergrad. Some spend years in the workforce before returning to school. But for ECE grad student Bryce Smith, the path to his master's degree can be traced through a long list of internships at the Department of Energy (DOE).

Smith's involvement with the DOE started early. After his sophomore year of high school, Smith interned at Fermilab, a particle physics and accelerator laboratory operated for the DOE. At his internship, Smith shadowed someone in the morning, then attended science lessons in the afternoon, learning all the skills he needed for conducting research. In a way, "the most important internship was the one at Fermilab," said Smith. "Because it got the ball rolling."

After graduating high school, Smith attended the University of Illinois at Urbana-Champaign, where he received a bachelor's in electrical engineering. As a college student, his relationship with the DOE became stronger than ever.

"Right after my freshman year, I went back to Fermilab," said Smith. "I was working with their accelerator division on testing an instrument that measures the halo of a particle accelerator."

His research proved that Fermilab should not use the instrument.

Smith worked with the DOE for his next three internships as well. After his sophomore year, he interned at Argonne National Laboratory. He worked with their assisted driving system, making sure that vehicles were able to identify stop signs, pedestrians, and other vehicles. After junior year, he interned at the National Renewable Energy Lab, where he made a user interface for a device that allows you to run tests on solar cells. After his senior year, he went back to Argonne, where he worked on updating Gammasphere, their gamma ray spectrometer.

Smith knew he didn't want his education to end at undergrad. After applying to various graduate programs, he ultimately decided on Carnegie Mellon.

"It's one of the top engineering schools that you can go to," said Smith. "It's competitive and research-focused, and I wanted to do research in the future."

Of course, the internships haven't ended since Smith started grad school. This past summer, he took a break from the DOE and interned at GE Global Research.

"I was working on their digital womb project," said Smith. "The project is trying to monitor the vitals of premature babies without touching them." He focused on integrating the sensors that would be able to collect that data.

Looking back, Smith's internships have covered a wide range of subjects. But that variety comes with its own unique challenge.

"Because my internships were all over the place, I always had to relearn the system I was working with," said Smith. "And then figure out how I could best contribute to that system with the little time I had."

When asked for advice for other students, Smith stresses the importance of being adaptable and open to learning.

"It's okay not to know," he said. "Just talk with your boss and try to learn as much as you can."

EXPLORING THE ART OF TECHNOLOGY

From robotics to jazz performance, Sam Rainey (E 2021) is making the most of his time at CMU — and is grateful for the support that has made it possible.

"I can't describe how much it means to me to attend such an amazing institution thanks to the kindness of my scholarship donor," said Rainey, who received the Milton (E 1947, 1949) and Cynthia Friedman Scholarship. "I have fallen in love with everything about Carnegie Mellon."

This generous scholarship support has allowed Rainey to combine his passion for music with his academic work in electrical and computer engineering — both inside and outside the classroom. In addition to pursuing his degree, Rainey has designed his own guitar pedals, created musical robots through the Robotics Club's RobOrchestra project, played guitar for Scotch'n'Soda Theatre and performed with a jazz ensemble in Kresge Theatre.

"I have experienced so many 'firsts,' grown so much and learned things that can only be learned through a college experience at CMU," he said.

Rainey's scholarship not only allows him to advance his curiosity and education, but fulfill his family's dreams for his future. A first-generation college student, Rainey said affordability was a major concern for him and his parents — and that his scholarship opened the door to CMU.

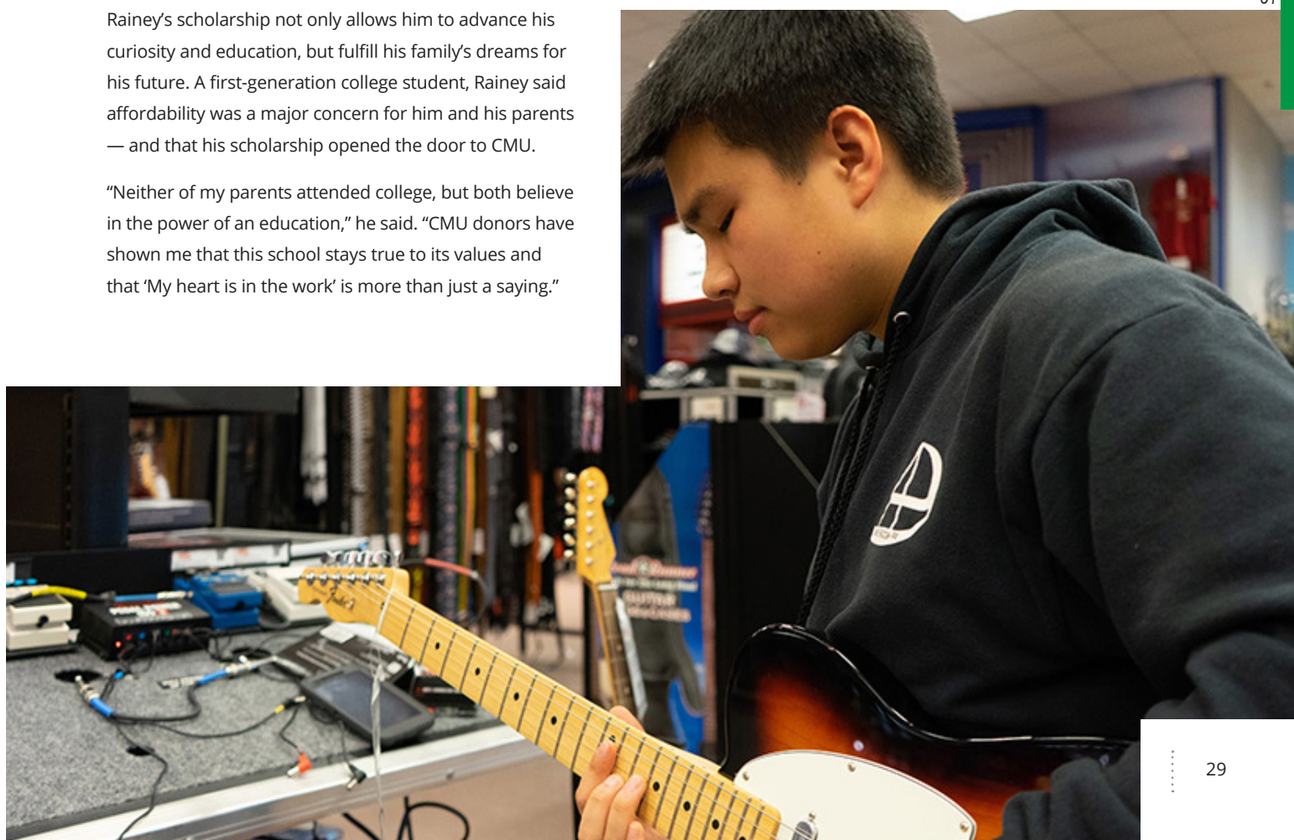
"Neither of my parents attended college, but both believe in the power of an education," he said. "CMU donors have shown me that this school stays true to its values and that 'My heart is in the work' is more than just a saying."

Rainey credits his studies with sparking his interest in signal processing, a subfield of engineering that powers innovative technologies like speech recognition, wearables, and autonomous driving. "My classroom and lab experiences have opened my eyes to so many possibilities within engineering," he said.

After graduation, Rainey plans to use his CMU education to work on "anything that uses technology to make life better," from self-driving cars to improving the accuracy of medical devices.

Rainey appreciates how Carnegie Mellon encourages creativity and exploration across all disciplines, from STEM to the arts. He has enjoyed learning alongside classmates who come from different backgrounds and have a wide range of interests and talents.

Rainey explains, "Carnegie Mellon is truly a unique place, and there is something special about the people here."



CMU CROWNED HACKING CHAMPS FOR FIFTH TIME IN SEVEN YEARS

Carnegie Mellon University's competitive hacking team, the Plaid Parliament of Pwning (PPP), won its fifth hacking world championship in seven years at this year's DefCon security conference, widely considered the "World Cup" of hacking.

PPP now holds two more DefCon titles than any other team in the 23-year history of DefCon hosting the competition.

"If you're wondering who the best and brightest security experts in the world are, look no further than the capture the flag room at DefCon," says David Brumley, professor of electrical and computer engineering at Carnegie Mellon, and the faculty advisor to the team.

Three of the five biggest data breaches ever have occurred in the past 12 months, leaking nearly 2 billion personal records. For security experts trying to defend against these types of attacks, the annual DefCon conference provides an opportunity to hone their skills and practice on one another.

Over the course of the 72-hour hacking spree, teams made up of students, industry workers, and government contractors attempted to break into each other's systems, stealing virtual "flags" and accumulating points. To add drama, team scores were hidden from view on the second day, and scores and rankings were hidden on the last day, sending teams into a hacking frenzy.

"Our team's success reflects our dedication to training the problem solvers of the future," says Jon Cagan, interim dean of Carnegie Mellon's College of Engineering.

The Carnegie Mellon hacking team first formed in 2009 and began competing at DefCon in 2010. The team previously won the contest in 2013, 2014, 2016, and 2017.

2020 BUILD18 DEMO DAY + RECEPTION

JANUARY 17, 2020

2:00 p.m. - 5:00 p.m.

Wiegand Gym, Cohon University Center

Reception for alumni, supporters, and students to follow demos.

alumni

Margaret Noel

Dear ECE Alumni and Friends,

We've had an exciting year of change in the in Department of Electrical and Computer Engineering. I'm excited to talk about some of these ongoing initiatives. Our department head, Larry Pileggi, has prioritized understanding our students' perspectives of their ECE experience and I'm happy to begin by sharing two ways alumni can help.

First, I invite you to engage, volunteer, and connect with current students through our platform, Involve. From speaking at a Women in ECE dinner to resume reviewing on First-Hand, we are adding flexible opportunities for you to engage with the department. I encourage you to learn more and sign-up.

Second, our students told Larry in a survey that a large need from their perspective was for funding to support student experiences like ECE Day – a day of celebration at the end of academic year. I'm pleased to share that you can now give directly to the ECE Special Activities Fund at ece.cmu.edu/about/giving.html. Gifts to this fund will support ECE experiences that our students say make them more likely to get to know their professors and make new friends.

It has been energizing to see so many alumni attend our annual event series in the Bay Area and Seattle featuring Associate Department Head for Research, Professor Shawn Blanton. Looking forward, we hope to see you on January 29, 2020 at the annual NYC ECE/SCS alumni gathering at the Skylark Lounge. If you weren't able to make it to a local event, please be sure to save the date and join us for the Spring Carnival & Reunion Weekend, April 16-18, 2020.

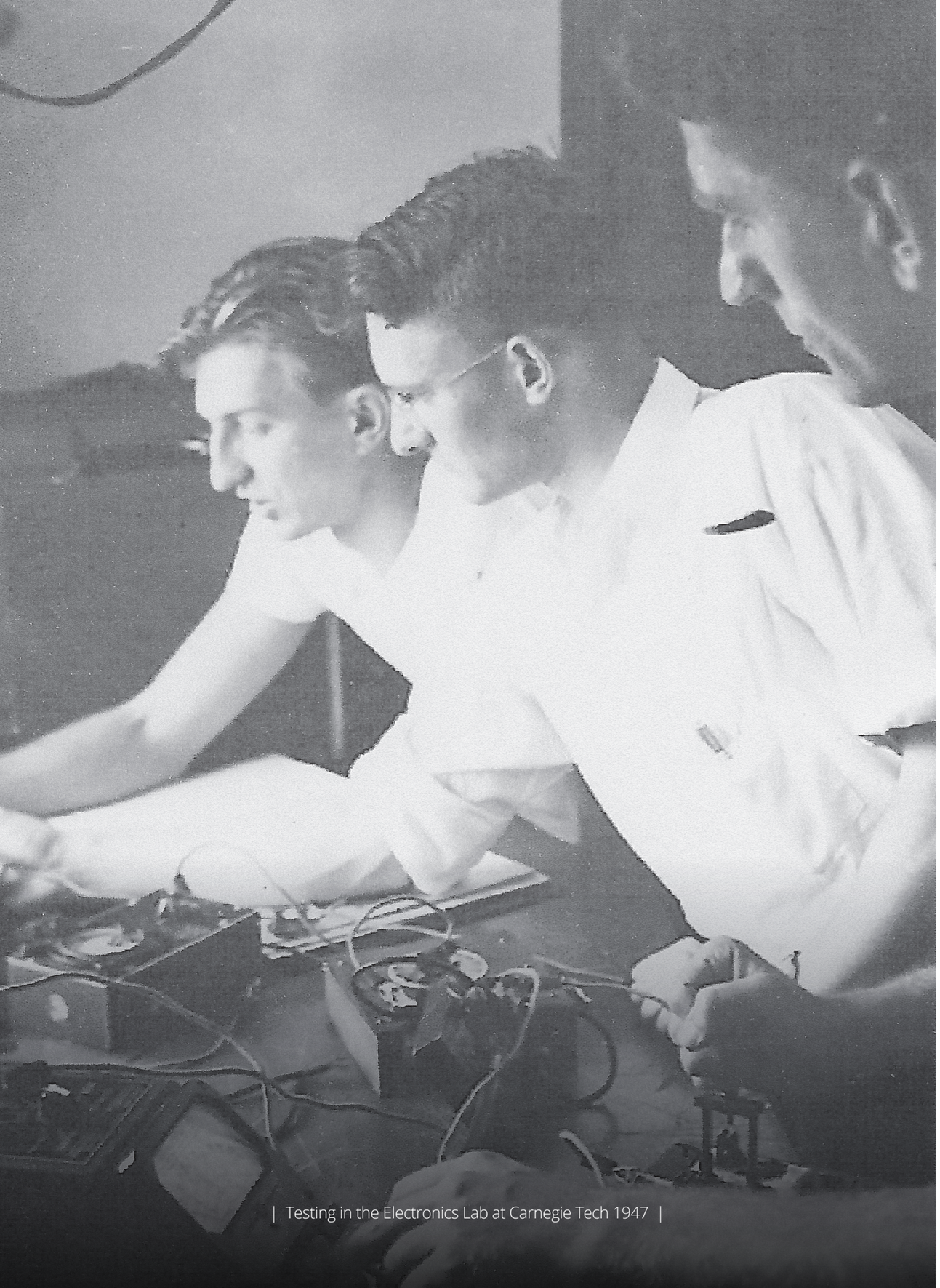
A number of you asked for alumni focused receptions at popular university and industry events. And we listened. Meet-ups for ECE alumni will now take place annually at the national Grace Hopper Celebration. Alumni are now invited to join us on campus in Pittsburgh for the annual Build18 hardware festival demos the afternoon of January 17, followed by an alumni reception with students and sponsors.

Finally, the department has launched a quarterly electronic newsletter that will keep our alumni up to date with department news and opportunities to connect. Keep an eye on your inbox for the next issue.

I hope you find these changes exciting and refreshing. As I near my second year in ECE, I am so appreciative of your support and engagement. Please feel free to reach out to me via email, or let me know the next time you are on campus.

Sincerely,

Margaret Noel
Associate Director of Alumni Relations and Annual Giving
Electrical and Computer Engineering



| Testing in the Electronics Lab at Carnegie Tech 1947 |

ALUM REFLECTS ON ENGINEERING CAREER

Don Abell's engineering career took him from the suburbs of Pittsburgh to the far side of the world, spanning over 60 years and nearly every continent.

Abell was born in Pitcairn, just outside of Pittsburgh, in the 1920's. He enrolled at the Carnegie Institute of Technology (CIT) and completed his first year of engineering coursework, but at that point World War II was fully underway and the U.S. had entered the war. Knowing that he may very well soon be called to serve his country, Abell took the initiative and joined a Navy training program.

After his induction into the Navy, he was sent first to Cornell, then to Georgia Tech, and finally to Naval Officer's Radar School in Maine, where he learned technological skills such as assembling a radio from parts and how to operate and repair the recently invented radar system. Abell went to sea just in time to witness the end of the war, though he and his shipmates still braved the dangers of undetonated Japanese naval mines as they worked to ferry troops and supplies back home.

After three round-trips across the Pacific, he left active Navy service and returned to CIT. His tuition and books were payed for under the GI bill, and after attending three universities and having gone halfway across the world, he would finally obtain his degree back where it had all begun.

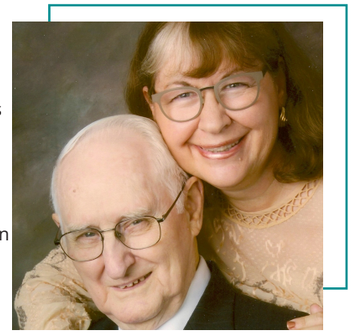
One class in particular stuck in his memory, in which the students were given information on a real-world scenario and asked to identify and solve the problem—a skill which he would exercise and refine for decades to come.

After graduation he entered a rotational program with Westinghouse and eventually found himself drawn towards their industrial automation division, landing in Buffalo, N.Y. Between the stagnation of the Great Depression and the necessity for uninterrupted production during the war, American industry was badly in need of an update.

"I designed the control systems for the machinery, for the motors that ran the different kinds of mills," says Abell. "Then I had to go out and actually supervise the installation of the equipment and make sure it was all functioning properly."

One of his first projects took him abroad, this time crossing the Atlantic to France as part of the larger effort to rebuild Western Europe under the Marshall Plan. Future projects would take him around the U.S., Mexico, South America, and India.

Abell worked his way up the chain at Westinghouse over the course of 28 years, reaching his height as general manager of the Industrial Systems Division. But sensing that the company itself was on the wane (it would soon undergo a complete overhaul to escape financial trouble) he began looking elsewhere.



He was approached by Alvey Inc., an international company specializing in industrial automation, and soon joined as Vice President of Engineering. With Alvey he would travel again to Europe and Japan, working to automate production lines for major corporations such as Anheuser-Busch.

Finally, after over 40 years in engineering and with 18 patents to his name, Abell retired. His legacy is probably best summed up by the phrase that had become a common adage at the company; "if you have a problem, go see Don."

involve

engage **volunteer** connect

The Department of Electrical and Computer Engineering, in partnership with the School of Computer Science, is excited to introduce Involve, an alumni volunteering platform. Opportunities for alumni to engage, volunteer, and connect with current students, alumni, and the department will be listed here. From speaking at a student organization dinner to sharing advice through resume reviews on our ECE/SCS advisor network, it's now easier to sign up for opportunities.

"I loved coming to speak at the WinECE dinner! I was WinECE Executive Chair for two years, right when we became a joint undergrad/grad organization. It's so wonderful to see WinECE continue to thrive. I loved connecting with the current students."

Lauren Chikofsky Coblenz E'07, E'08

Visit **www.ece.cmu.edu/alumni** to learn more, sign up, and help inspire our future ECE alumni.

Questions? Contact: involve@andrew.cmu.edu or margaretnoel@cmu.edu

Carnegie Mellon University
Electrical & Computer Engineering +
School of Computer Science

BOB STRATTAN
EE '59, '62

Bob has fond memories of his doctoral research at CMU: adapting an electrical power systems simulator lab in Machinery (now Hamerschlag) Hall.

After graduating, Bob worked for Boeing and North American Aviation, and then joined the faculty of the University of Tulsa where he taught and performed research for 30 years.

Bob is one of only a few faculty members inducted into the University of Tulsa College of Engineering and Natural Sciences' Hall of Fame.

Bob and his wife Vada have created a lasting legacy at Carnegie Mellon through a charitable trust that will provide support to the Department of Electrical and Computer Engineering where it is most needed.

They give back because Bob says Carnegie Mellon was the pathway to a successful and rewarding life.

As a retired engineer, Bob still enjoys spending his time tinkering. He restores vintage cars, such as his father's 1946 Chevrolet pickup.

GIVE STRATEGICALLY, SUPPORT GENEROUSLY.

Learn how easy it is to achieve your philanthropic vision through a planned gift by visiting giftplanning.cmu.edu.

Contact the Office of Gift Planning today at 412.268.5346 or askjoebull@andrew.cmu.edu.

Carnegie Mellon University
College of Engineering

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SAVE THE DATES

Build18 Build Week: January 13-17, 2020

Build18 Demo Day and Reception: January 17, 2020

NYC Alumni Gathering: January 29, 2020

Spring Carnival: April 16-18, 2020

ECE Day: May 1, 2020

Commencement: May 17, 2020