Carnegie Mellon University
Electrical & Computer Engineering

THE CIRCUIT

Fall 2018

welcome

From the Associate Department Head of Academic Affairs

The Department of Electrical and Computer Engineering at Carnegie Mellon University has a long history of excellence. We pride ourselves on producing electrical and computer engineers capable of tackling fundamental scientific problems and important societal challenges - and to do so with the highest commitment to quality, integrity, and respect for others. It is now my honor to serve as the Associate Department Head of Academic Affairs and to continue to support these traditions.

Recently, we have begun several initiatives to enhance the experiences of our students, consistent with the above vision. These were launched at the faculty retreat in September 2018 and have begun to bear fruit. They include the following:

i) Holistic Student Experience: We are seeking to create a holistic ECE student experience, where things like the sophomore seminar, core and upper level courses, student extracurriculars (like Build18), the ECE capstone course, and Tech Spark (see below) fit thoughtfully and synergistically together.

ii) Relationships over Transactions: We are seeking to make our relationships with students ever more relational rather than transactional, such that they know that we are interested in their long-term professional development in addition to their professional credentials.

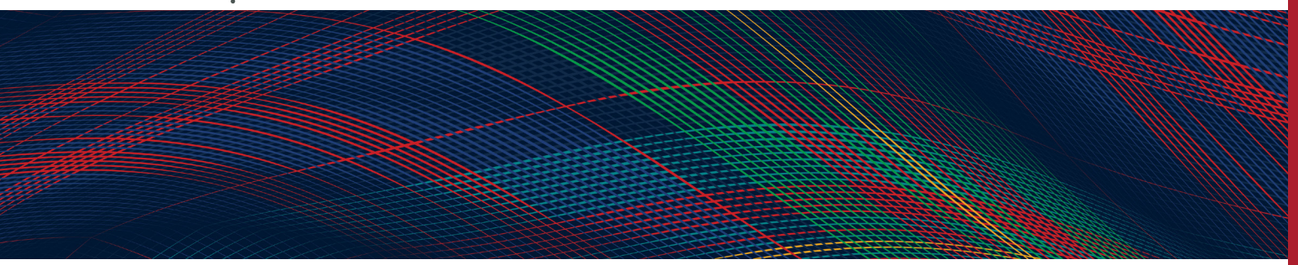
iii) Maker Culture: We are seeking to weave maker culture through the department in ever-increasing ways, an effort that is inspired by the new electronics fabrication facilities in the new Tech Spark maker space.

As we search for a new department head, the ECE community can be assured that the steadfast commitment to students, faculty, staff, and alumni will not change. Throughout this period of transition, we remain true to our goal of being a worldwide creative driving force of highest scholarly and entrepreneurial quality.

Featured in this issue are some examples of how the department is maintaining its commitment to excellence and research. From adding new master's concentrations to major student and faculty awards, I am certain that ECE will continue on its upward trajectory.

Sincerely,

Jim Bain
Associate Department Head of Academic Affairs



THE CIRCUIT

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Contributors

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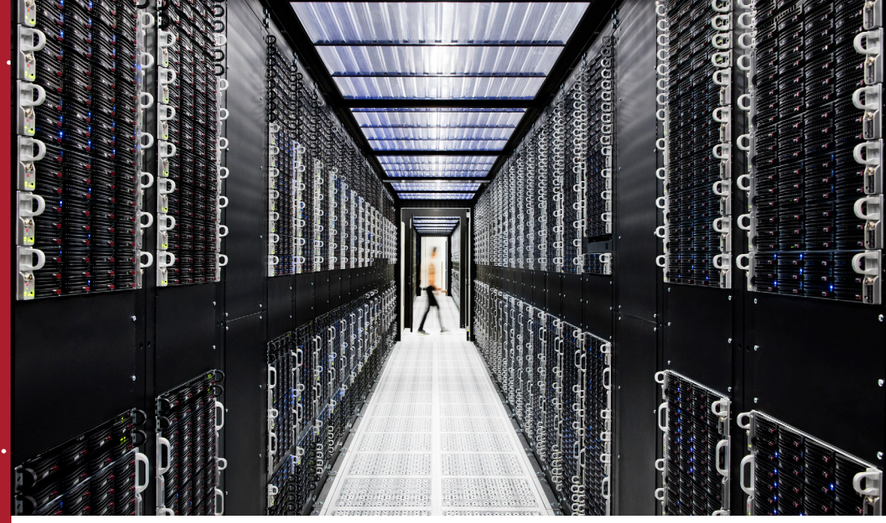


Optimizing computing systems - p. 7

A recipient of a 2018 IBM Faculty Award, Gauri Joshi is researching the analysis and optimization of computer systems.

Campus news

Research

Academics

Students

Campus news

silicon valley

Professor Bob Iannucci and ECE Ph.D. candidate Ervin Teng are asking how drones can learn on the fly by becoming curious themselves. To do so, they are using machine learning and a simulation training tool to teach drones how to learn in real-time in what they call "autonomous curiosity."

Carnegie Mellon's Silicon Valley student population exceeded 200 students in the fall of 2018. In particular, the Master of Science in Software Engineering (MS-SE) graduating class is the largest to date. The MS-SE teaching faculty include Hakan Erdogmus, Cécile Péraire, and Jia Zhang.

A Carnegie Mellon University team received a $7.5M Office of Naval Research grant in collaboration with the University of Pennsylvania and Stanford University on software complexity reduction, or simplifying complex internet protocols to build greater security. The Carnegie Mellon team includes Electrical and Computer Engineering Professors Anupam Datta, Limin Jia, Bryan Parno, and Corina Pasareanu, and Computer Science Assistant Professor Matthew Fredrikson. The faculty members, from both Pittsburgh and Silicon Valley, are all affiliated with CyLab.

Brittany Reyes has been named the ECE academic program advisor for the Silicon Valley campus. Brittany now works alongside the Graduate Affairs Advising team, providing academic advising to the ECE M.S. and Ph.D. students in Silicon Valley. She acts as the first point of contact for any ECE student concerns regarding policies, procedures, upcoming deadlines and more.

Pricing and processing data far from the cloud

By Lucas Grasha

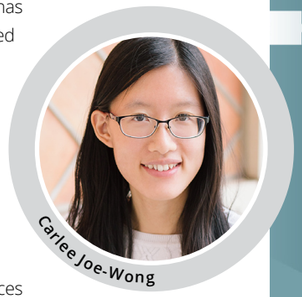
The Internet of Things (IoT), mobile networks, and edge devices have become integral to daily life. Plenty of devices have enough computing power to process large amounts of data far from a centralized entity like the cloud. Computing this way offers faster networks and smart buildings.

With their everydayness, how might one take an eye off their tasks and rather assess their economics?

ECE Assistant Professor Carlee Joe-Wong is working to establish the economic foundations for the next generation of computing. She noticed that despite the rising trend in the diversity of computing devices, nobody had seriously researched or discussed the economics. The National Science Foundation has given Joe-Wong a CAREER Award to explore this field so ripe for discovery.

Joe-Wong is trying to create an architecture for pricing usage of devices in the IoT that other innovators and companies can respond to and utilize. To her, "Figuring out how to price mobile networks is still an open question." She outlines some possible options: one is to use flat-fee plans that allow customers "unlimited" access; another is to use data-capped plans that require monthly payment for a specific amount of use, such as only five GB for a monthly cellular data plan.

"My proposed work posits that, in the future, access to mobile networks will be sold in bundles, the devices accessing combined plans on other networks," Joe-Wong says. A customer would pay for a plan sharing, for instance, mobile with Wi-Fi networks. Joe-Wong points out that this network access strategy has precedent. "AT&T sells bundled access to cellular and Wi-Fi networks, and Google Fi aggregates Sprint, T-Mobile, and US Cellular networks with Wi-Fi," she says.



But network users need different things of their plans, depending on the devices they employ. IoT devices, from smart fridges to security cameras, require different arrays of data to use with their hardware and software. Joe-Wong's proposal makes room for these realities. She proposes two forms of pricing: "simple, flat-rate plans aggregating access to multiple networks, and more dynamic plans where users bid for access on different networks according to their needs."

As the IoT develops, innovation and consumer interest could be determined by commercial pricing. Joe-Wong advocates for a sound strategy, wanting to "develop new types of pricing algorithms" for the IoT. More importantly, she wants to investigate these models' viability, and "whether they disproportionately benefit certain types of users." She suggests also that new pricings may spur development or take advantage of existing technology. One scenario she proposes is that a user finds it far easier to run machine learning software across multiple devices. Something like an aggregated data plan could make this possible.

For the short term, though, Joe-Wong wonders about how her work could apply to the industry. "Service providers might apply my findings to determine how to price access to mobile and computing networks for IoT applications," she says. Regardless, she may just lay the groundwork for future pricing strategies and how IoT devices might integrate more into our lives.

Campus news

africa

CMU-Africa celebrated 5th graduation

By Tara Moore

Carnegie Mellon University Africa celebrated its fifth graduation in June 2018, marking another year of the location advancing technology education in one of the fastest growing economic regions in the world. The 45 students received degrees in both information technology and electrical and computer engineering.

Since 2011, Carnegie Mellon University Africa in Rwanda has focused on addressing the shortage of information and communication technology (ICT) skills required for Africa to compete in the Fourth Industrial Revolution. Building on the digital revolution, this Fourth epic wave is characterized by physical, cyber, and biological systems converging to transform the lives and livelihoods of the world's citizens in unprecedented ways. Carnegie Mellon University's campus in Kigali, Rwanda provides students with the skills to address regional problems so that they are uniquely positioned to respond to the demands of this technical revolution in Africa.

Before graduation, the students from the graduating class worked on a variety of projects and internships that will give them the expertise to be transformative engineers in Africa. These projects ranged from research on language models for code-mixed contexts at the IBM Research – Africa lab in Kenya, to building efficient systems through programing at Rancard Solutions in Ghana. In Rwanda, students worked with the Rwanda Revenue Authority to develop a model to predict the features to be used by the Risk Differential Framework to classify taxpayers.

The ceremony also marked the graduation of the first cohort of MasterCard Foundation Scholars. Together with their colleagues, they will go on to make an impact in their communities, with more than 85% of students working in their home countries after graduation. These include six African countries: Rwanda, Uganda, Kenya, Tanzania, Ghana, and Nigeria.

faculty

Meet the new faculty members

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

George Amvrosiadis
Assistant Research Professor

Campus location:
Pittsburgh, PA

Research topics:
high performance computing, big data analytics, scalable machine learning

Qing Li
Assistant Professor

Campus location:
Pittsburgh, PA

Research topics:
nanophotonics, nonlinear optics, quantum frequency conversion, optical interconnects, RF signal

Piotr Mardziel
Systems Scientist

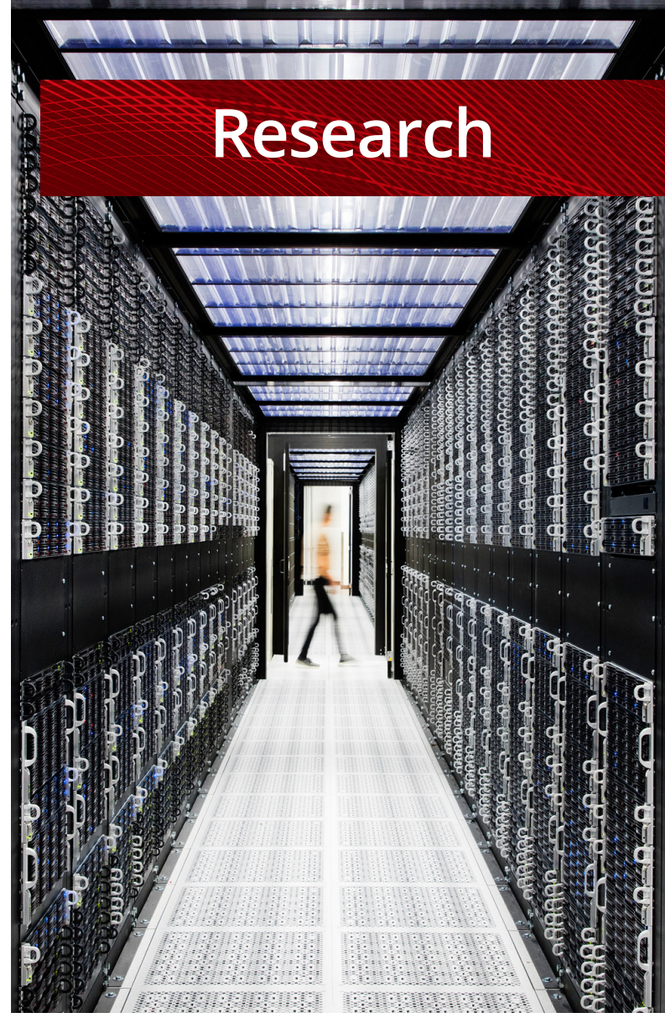
Campus location:
Silicon Valley, CA

Research topics:
transparency and accountability in machine learning with applications to privacy and fairness

Barry Rawn
Associate Teaching Professor

Campus location:
Rwanda, Africa

Research topics:
electric power systems, photovoltaics



Optimizing computing systems

By Marika Yang

Machine learning has grown incredibly in engineering and computer science in recent years, with the explosion of interest in artificial intelligence. In machine learning, humans—engineers and computer scientists—feed large data sets into a neural network model to train the model to learn from data and eventually identify and analyze patterns and make decisions.

Gauri Joshi is researching the analysis and optimization of computing systems. Joshi, assistant professor of electrical and computer engineering, has been named a recipient of a 2018 IBM Faculty Award for her research in distributed machine learning. Faculty Award recipients are nominated by IBM employees in recognition of a specific project that is of significant interest to the company and receive a cash award in support of the selected project.

Joshi's research is about distributing deep learning training algorithms. The data sets used to train neural network models are massive in size, so a single machine is not sufficient to handle the amount of data and the computing required to the analyze the data. Therefore, data sets and computations are typically divided across multiple computing nodes (i.e. computers, machines, or servers), with each node responsible for one part of the data set.

In a distributed machine learning system with data sets divided across nodes, researchers use an algorithm called stochastic gradient descent (SGD), which is at the center of Joshi's research. The algorithm is distributed across the nodes and helps achieve the lowest possible error in the data. It requires exact synchronization, which can lead to delays.

"My work is about trying to strike the best balance between the error and the delay in distributed SGD algorithms," says Joshi. "In particular, this framework fits well with the IBM Watson machine learning platform; I will be working with the IBM Watson Machine Learning vision; I will be working with the IBM Research AI team."


Gauri Joshi

In every iteration of the SGD, a central server is required to communicate with all of the nodes. If any of the nodes slow down, then the entire network slows down to wait for that node, which can significantly reduce the overall speed of the computation.

Efficiency and speed of computation are the two main things Joshi aims to improve, both without risking the accuracy of the network.

"When you have a distributed system, communication and synchronization delays in the system always affect the proponents of the algorithm. I'm trying to design robust algorithms that work well on unreliable computing nodes," says Joshi.

Prior to joining Carnegie Mellon's College of Engineering, Joshi was a research staff member at IBM's Thomas J. Watson Research Center. Because of her past experience, she was aware of the specific research projects that are relevant to the company's interests.

The funding provided by the Faculty Award will be used to support Joshi's students, who are working on the theoretical analysis for this project. In the future, she hopes to release an open source implementation of the new algorithm they have developed. Joshi plans to work with IBM to make this method available to anybody who wants to train their own machine learning algorithms using distributed SGD.

Rethinking social networks

By Daniel Carroll

Recent high profile attempts to manipulate public perception and sentiment via social media have demonstrated that we may not know as much about the formulation and evolution of social networks as we think.

It was this gap in understanding which motivated Radu Marculescu, Kavčić-Moura Professor of Electrical and Computer Engineering, to co-author a paper in *Nature Scientific Reports* outlining a new model for how social networks change and develop over time. The research, conducted in close collaboration with Mihai Udrescu and Alex Topirceanu of the Computer Science Department of the Politehnica University of Timişoara, Romania, proposes what the authors term the Weighted Betweenness Preferential Attachment (WBPA) model.

In modeling social networks, a node represents a single individual, and connections between nodes represent relationships between individuals. Prior models have focused on the amount of connections that an individual has, also called the node degree, as the driving force behind a node acquiring new connections.

In contrast, the core of the new WBPA model centers around the notion of "node betweenness." He and his collaborators discovered that this quality of being between communities is actually a greater attractor and driver for the formation of social ties than other measures of centrality like node degree. In the WBPA, rather than examining purely the amount of connections a single node has, researchers place more emphasis on the communities a node connects and the quality of those connections.

"When individuals make assessments of social attractiveness in real-world situations, they do not rely on executing algorithms or other types of complex quantitative evaluations," says Marculescu. "Instead, individuals make decisions based on their qualitative perceptions. As such, the quality of being 'in between' can be easily and quickly perceived."

The WBPA model also overcomes another limitation found in previous degree-driven models, which allow for individual node degree to grow indefinitely. This would equate to an individual being able to develop an unlimited number of friendships—a scenario which is obviously impossible.

"The new model builds on the idea that humans are better at observing qualitative aspects than quantitative ones, which is why people typically favor investing in fewer qualitative social ties rather than numerous lower quality ties," says Marculescu. "This is why there's a node betweenness redistribution process at play in the WBPA, which limits the number of new links for high-degree nodes."

This redistribution process accounts for the real-world physical and mental limitations, which constrains the amount of relationships a given individual can develop and maintain throughout their lifetime.

Finally, the WBPA can also offer insights into an individual's possible means to improve their social status. An individual can increase their personal influence by broadening their neighborhood to influential agents, which can, in turn, trigger an increase in the strength of their connections with others.

While this research focuses specifically on social networks, the WBPA model could have interesting applications in everything from modeling microbiomes to predicting the properties of new drugs and medications.

Marculescu and his collaborators' next goal is to use findings from the WBPA model to investigate how opinions spread through social networks, and how robust these networks can act in the face of adversarial attacks.

Transcending the transistor

At present, a number of compounding factors are converging to limit the future viability of traditional transistor technology. The end of the days of Moore's Law and the difficulty in dissipating thermal energy created by increasingly densely packed electronics has the tech industry scraping the upper limit of its ability to maintaining advances in transistors apace with societal demands. Perhaps more importantly, our visions for a connected world proliferated with sensor networks serving a vast and diverse host of functions has generated a need for low-energy electronics that traditional transistors simply cannot meet alone.

Gianluca Piazza, professor of electrical and computer engineering, has developed a new form of switch called the piezoelectric nanoelectromechanical relay. This device, the subject of a recent patent award, could be the key to replacing semiconductor transistors in many applications.

His relays utilize mechanical energy—rather than changes in electronic characteristics, like transistors—to initiate a change in state. They also exhibit lower current leakage, cutting both energy usage and excess heat. These two combined characteristics mean that devices utilizing Piazza's relays could potentially consume less energy than traditional electronics by multiple orders of magnitude.

Piazza and his group have already begun working with fellow researchers at Carnegie Mellon University, including Maarten de Boer of the Department of Mechanical Engineering. They're investigating how to make this technology scalable and reliable and how to integrate these relays into computing architectures across various functions. The most pressing demand, sensors, is also the most promising. The relays' low-energy demands mean that embedded sensors and implants may not necessarily require a battery and could instead harvest the small amount of energy they require from the environment around them or from the body, respectively.

With the last half a century of computing architecture design having been built around the traditional semiconductor transistor, the long-term effects of Piazza's development could reach much farther than sensors.

"We strongly believe that this new technology is poised to revolutionize the field of computing," says Piazza.

A universal memory

In our data-laden and increasingly connected world, the demand for long-term, low-power, high-capacity memory storage continues to grow. Various types of memory enable the function of everything from IoT devices and cell phones to embedded sensor networks, however a truly "universal" form of memory device has continued to elude scientists. While the most current technology under development, known as racetrack memory, may meet these requirements, its propensity for creating errors in stored data makes it unreliable.

Professors Larry Pileggi and Jimmy Zhu were recently awarded a patent for a cutting-edge form of memory device which they've termed "magnetic shift register."

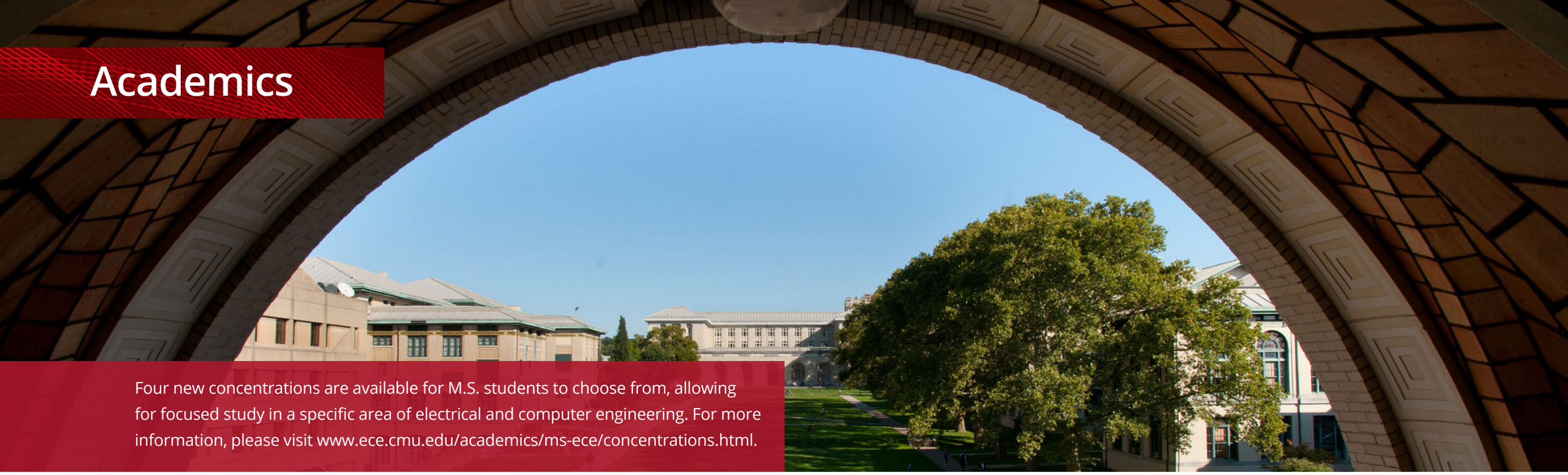
The technology is non-volatile, meaning information can be stored for long periods of time without having to maintain power to the memory unit; this also helps minimize the power requirement, making it perfect for large embedded sensor networks. And, unlike it's "racetrack" competitor, the technology exhibits a high degree of robustness in performance, meaning the data is stored consistently and reliably with fidelity

With this development, Pileggi and Zhu believe that they may have found the long-sought-after universal memory, having created a storage device with a combination of speed, reliability, and density to forever change the world of computing.

Their creation has major implications for not only high-focus technologies like sensor networks but could potentially change the architecture and path of computing itself. A true universal memory could be used in a computer to replace both the DRAM, which holds most of the information but requires power and takes longer to access, and SRAM, which is faster and does not require power, but is costly and less storage dense.

With storage a constant and ever-increasing concern, it is doubtless that they're innovative new design will attract much attention from a broad range of industries, both established and emerging.

Academics



Four new concentrations are available for M.S. students to choose from, allowing for focused study in a specific area of electrical and computer engineering. For more information, please visit www.ece.cmu.edu/academics/ms-ece/concentrations.html.

Cyber-Physical Systems

Points of contact

- Raj Rajkumar
- Pei Zhang

Perspective

The Cyber-Physical Systems concentration will enable students to learn about the foundations and principles of cyber-physical systems, including theory, tools, applications, systems, test-beds, and field deployments. CPS are physical and engineered systems whose operations are monitored, controlled, coordinated, and integrated by the cyber components of computing and communication. Domains of CPS applications include, but are not limited to, aerospace, healthcare, manufacturing, intelligent transportation systems, self-driving vehicles, smart grids, smart buildings, and defense systems. Broad CPS deployment is transforming how we interact with the physical world as profoundly as the world-wide web transformed how we interact with one another, and further harnessing their capabilities holds the possibility of enormous societal and economic impact.

Computer Security

Points of contact

- Lujo Bauer
- Vyas Sekar

Perspective

The Computer Security concentration will provide students the opportunity for in-depth specialization in the areas of computer security and privacy. Students will take a broad introductory course that covers computer security fundamentals and will gain additional depth in a core topic area such as software, systems and networking, privacy, and cryptography. In addition, students will also have the opportunity to apply the security skills to specific problem domains such as web, wireless, or mobile systems. Students will gain exposure to both foundational security and privacy principles as well as hands-on tools and best practices for building secure and privacy preserving infrastructures.

Data and Network Science

Points of contact

- Radu Marculescu
- Aswin Sankaranarayanan

Perspective

The Data and Network Science concentration will provide students the opportunity for in-depth specialization in data and networks science, and their applications to various natural and technological systems. Students will take introductory courses that cover data network foundations and information processing and then will have ample opportunities to specialize in one of several more focused topic areas such as wireless and sensors networks, energy systems and networks, social sensing, and advanced image and neural processing. In addition, students will also have the opportunity to apply the data and network science skills to specific problem domains such as personalized healthcare, smart grid, computational photography, or social networks. Students will gain exposure to both foundational data and network principles, as well as hands-on tools and best practices for smart and interconnected infrastructures.

Wireless Systems

Points of contact

- Bob Iannucci
- Peter Steenkiste

Perspective

The Wireless Systems concentration gives students the opportunity to explore the core wireless technologies and systems-level issues that are at the heart of the Internet of Things. This includes both traditional broadband and emerging low-power wide area networks as platforms for wide-area cyber-physical systems, survivable and resilient mobile systems, antenna system synthesis, mobile network and device security and privacy, power- and energy-optimized devices, federation of IoT systems, context and situational awareness, and cloud-connected embedded computing. This concentration takes a systems perspective, looking across the traditional layered communications system architecture, giving students experience in thinking through design issues -- such as power -- the solutions for which cannot be found at any one layer.

CMU and Howard offer dual engineering Ph.D. degrees

By Marika Yang

The College of Engineering is pleased to announce a new partnership with the College of Engineering and Architecture of Howard University. This partnership will cover a wide range of initiatives between the two institutions, including a dual-degree Ph.D. program that allows students to earn a Ph.D. degree from both schools.

To qualify for this dual-degree program, students must apply and be admitted to engineering Ph.D. programs from both institutions, but the programs need not be in the same department at both institutions. Students will spend balanced time at each institution, including at least three academic semesters in each location.

Students will have an advisor from each program who will collaborate with them on research and to select relevant coursework from both schools that satisfies the requirements of each program. They may transfer courses between the programs and will submit and defend a single dissertation.

In addition to the benefit of two academic advisors, students will also have access to a greater number of courses, a larger set of research facilities, and a wider research community located in two major metropolitan areas (Pittsburgh, PA and Washington, D.C.).

"The clear opportunities presented by this new CEA-CMU Partnership constitute yet another outstanding example of what we can and will continue to accomplish as a college," says Achille Messac, dean of Howard University's College of Engineering and Architecture. In addition to this dual degree program, the partnership will include a bridge program to provide eligible undergraduates with the opportunity to engage in research at the other institution over the summer. The program will also include coaching for those students transitioning into the dual-degree Ph.D. program, as well as professional development programs.

Jonathan Cagan, the College of Engineering associate dean for graduate and faculty affairs, and Shawn Blanton, professor of electrical and computer engineering and chair of the Diversity, Inclusion and Outreach Committee, will lead the dual-degree program and other initiatives.

"Our aim is to explore a number of different forms of collaboration between Howard and CMU, such as joint research proposals and a dual-Ph.D. program," says James H. Garrett, Jr., dean of the College of Engineering.

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>
> **James H. Garrett, Jr., dean of the College of Engineering**

Carnegie Mellon team dives into DARPA Subterranean Challenge

By Byron Spice

A team from Carnegie Mellon University will compete in the systems track of the Defense Advanced Research Projects Agency Subterranean Challenge, a multi-year robotics competition with a $2 million prize in which robots will autonomously search tunnels, caves, and underground structures.

The Carnegie Mellon team, including a key member from Oregon State University, is one of six teams that will receive up to $4.5 million from DARPA to develop the robotic platforms, sensors, and software necessary to accomplish these unprecedented underground missions.

The robots will be tasked with rapidly mapping, exploring, and exploiting complex underground environments, ranging from spaces so small that humans can only crawl through them to areas big enough to accommodate an all-terrain vehicle. The challenge is designed to provide warfighters and first responders with the capabilities they need to accomplish a variety of missions in caves, tunnels, or urban underground facilities, such as subway stations.

"Successfully completing these missions will require multiple robots, including both drones and ground vehicles," said Sebastian Scherer, who will lead the team with Matt Travers, both of CMU's Robotics Institute. "Our team has a wealth of experience in operating robots in mines, enclosed spaces and the wild, and in coordinating the activity of multiple robots."

Travers, a systems scientist in the Robotics Institute, said the CMU team will leverage its expertise in modularity — developing robots that can be rapidly built and reconfigured to adapt to widely varied environments.

"We can't be sure that a four-wheeled platform will always be the right robot for every job, so we need to be ready to add wheels or substitute tracks or even legs," says Travers. "In some environments, small robots might be our only option, while others may demand larger, more robust robots."

Scherer, a senior systems scientist, said communications will be a major challenge underground, and that getting robots to work cooperatively to ensure a space is comprehensively mapped is critical. Geoff Hollinger, an assistant professor of mechanical engineering at Oregon State and a CMU robotics alumnus, has been recruited to the team for his expertise in multirobot systems.

CMU's team also includes Howie Choset, the Kavčić-Moura Professor of Computer Science; Sanjiv Singh, research professor of robotics; Anthony Rowe, associate professor of electrical and computer engineering; and a number of undergraduate, graduate, and post-doctoral researchers.

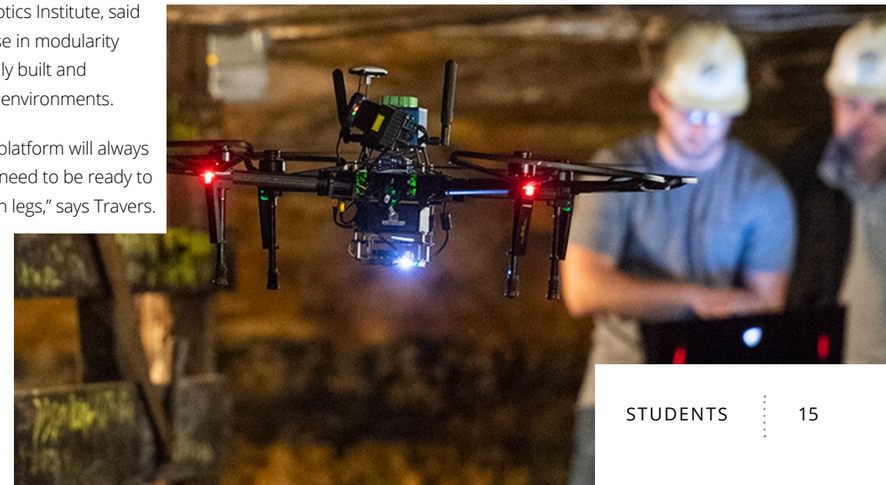
"Creating robots that can work in subterranean environments will expand the potential application of robots both underground, such as in mines, and inside structures, such as buildings, ships, and aircraft," says Scherer. "The constraints robots encounter in these confined spaces are enormous, so we have our work cut out for us."

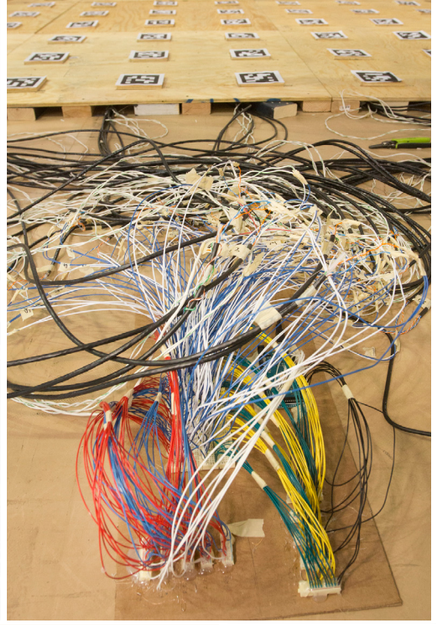
In addition to DARPA funding, the team is receiving support from Boeing and from Near Earth Autonomy, a spinoff of the Robotics Institute. The team also is seeking additional commercial and foundation sponsors.

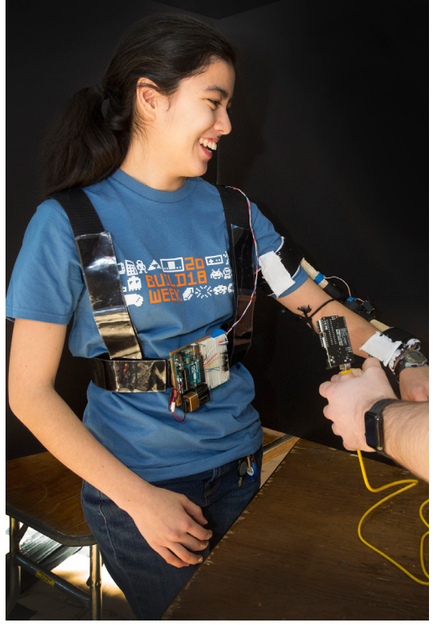
Beginning in the fall of 2019, DARPA will conduct a series of challenges, including one each in man-made tunnels, natural caves, and underground structures. A final event in the fall of 2021 will combine all three types of subterranean environments.

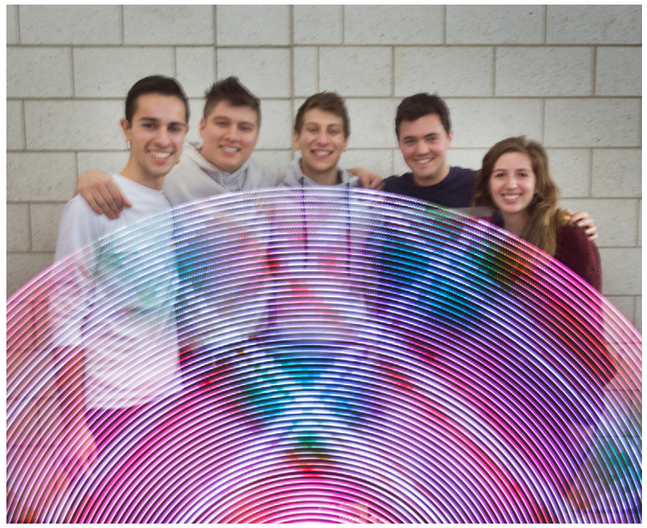
The DARPA competition takes place on two tracks: the systems track, in which teams such as CMU develop and demonstrate physical systems for live competitions; and a virtual track, in which teams develop software and algorithms to compete in simulated environments. DARPA will award $2 million to the winner of the systems track and $750,000 to the winner of the virtual track.

Carnegie Mellon teams won the 2007 DARPA Urban Challenge robot race and placed third at the 2015 DARPA Robotics Challenge for disaster response robots.









yush gupta

Honoring CMU alumnus Yush Gupta

By Krista Burns and Prachi Gupta

The Department of Electrical and Computer Engineering has lost a valued and respected member of its community. Alumnus Yush Pal Gupta (ECE '10) passed away on November 5, 2017. He was 29 years old. Known for his relentless curiosity, passion, and creative mind, Yush was the epitome of the type of student the university strives to attract.

Yush was extremely active in organizations during his time at Carnegie Mellon University. An avid runner, he joined Carnegie Mellon's cross country team as a freshman. Yush had a strong interest in robotics and joined the school's elite Google LunarXPrize team in its mission to build a private spacecraft. During his senior year, he expanded funding and membership for the department's annual hardware hackathon, Build18. He also served as vice president of Carnegie Mellon's Sigma Chapter of Eta Kappa Nu, a national honors society for electrical and computer engineering students. In 2010, he was selected as an Andrew Carnegie Society Scholar, an award given to a handful of CMU students who have excelled in academics and made significant contributions to their communities.

Following graduation, Yush worked as a software engineer at Intel. Not long after, he left to create an education startup, Pensieve, a name inspired by J.K. Rowling's "Harry Potter" books. Priya Narasimhan, professor of electrical and computer engineering, recalls how passionate Yush was about quality education being universally accessible.

"Yush was extremely intelligent, very entrepreneurial, one of our best and brightest," says Narasimhan. "He wanted to change the world, change how people were taught, and he had a plan for how he would do that. He had initiative, ideas, ambition, and the intelligence and ability to execute to that ambition."

Later, Yush also served as co-founder and chief technology officer of Bitcoin startup LibertyX before embarking on his latest venture, Haveli, a robotics company.

After his passing, Yush's family and friends started a GoFundMe account in honor of Yush's legacy at Carnegie Mellon University. After successfully raising over $13,000, Yush's family decided to support a four-year scholarship for an electrical and computer engineering undergraduate student.

"Yush was proud to be an ECE graduate and believed that education was the key to improving the world," says Dr. Amit Gupta, Yush's father. "In every project he undertook, he insisted that it should make the world a better place, especially for the underprivileged. We hope that this scholarship will help future innovators improve the world as he always wanted to do."

As a physical memorial, the Department of Electrical and Computer Engineering named a studying alcove after Yush, located in the undergraduate wing of Hamerschlag Hall. The Yush Gupta Alcove will serve as a peaceful yet inspiring space for students to study and collaborate.

"The Yush Gupta Alcove will be an unwavering reminder of Yush's legacy in the Department of Electrical and Computer Engineering," says Leona Kass, director of student and academic affairs. "He was a believer in education and electronics, which is what we aim for all of our students to be passionate about."

From faculty to fellow students, Yush impacted everyone he met. He will be remembered for his infectious good nature, ambition, and drive. His legacy in the department will continue to inspire the electrical and computer engineering community.

Carnegie Mellon Racing has breakout season

By Daniel Carroll

Sam Westenberg and the rest of the Carnegie Mellon (CM) Racing team waited in anticipation as the final results of the 2018 Formula Society of Automotive Engineers (FSAE) Electric Vehicle Competition were announced.

The team was fairly confident they'd managed to carve out a third-place finish in the competition that pitted the electric car they'd built against cars and teams from dozens of other top engineering universities; it would be a stellar result for a team that had only fielded its first competitive electric vehicle the year prior. Yet when the final standings were read out, the team was shocked.

They'd won.

The team had taken not third, not second, but first place.

It wasn't the first time the team had taken gold with their newest car, 18e, either. Earlier this year, the team took first place in the electric vehicle category at Formula North in Barrie, Ontario. They also managed to capture first in both the event's Endurance category and the overall Dynamics category, which encompasses all the events related to vehicle performance.

The response from former team members could not have been more positive.

"The outpouring of support by our alumni once we announced that we had won was incredible," says Westenberg, a master's student in electrical and computer engineering and team president for the 2018 season. "They were all so excited that the race car platform they had worked on for several years previously was finally paying dividends and performing at a high level."

It was one of these alumni who had first introduced Westenberg to the team. While it was the technical challenge of building a competitive electric vehicle that drew him in, what truly impressed him was the skill and achievements of the students working at CM Racing.

He joined the team his sophomore year in 2015. At the time, the team had only recently made the switch to an electric vehicle and had yet to drive an EV competitively. In fact, the all-electric class of FSAE itself was only three years old. By the time Westenberg graduated with a degree in electrical and computer engineering, the team's EV would take first in both major North American Formula SAE Electric competitions.

Since graduation, Westenberg has been working in the automotive industry. He credits much of his interest and decision to enter the field to his involvement with the team, and the skills and connections that came with it.

"Most of our team members will say that the majority of their relevant engineering experience comes from participating in FSAE," he says. "Many potential employers see it as the most important field on a resume."

The team has developed strong relationships with a number of industry leaders, and members are often recruited by sponsors and friends such as UBER ATG, SpaceX, Tesla, Boeing, Hyliion, Blue Origin, Ford, and General Motors.

While graduating alumni of the team look to their future careers, those remaining with the team have another season of racing to look forward to.

Though still young in comparison to the internal combustion class of FSAE, the electric class is catching up in leaps and bounds. Teams that struggled just a few years ago to field an electric car that could even drive under its own power are now working to adopt advanced features that could put them on par with their gas-burning cousins in performance. While the competition is ultimately an innovation-driving win-win situation for university teams and industry partners alike, the CM Racing team will have to work hard to maintain their edge in an increasingly competitive environment.

But that is a task for future classes of engineering students. His time with the team now over, Westenberg will join the ranks of supportive alumni. He's handed over the reins to senior Katie Lam, confident that this year's team will be able to meet the high bar set by their predecessors.

"Now the minimum expectation is that the car will be competitive," says Westenberg. "The goal isn't just to drive—it's to win."

tech spark

Maker spaces make a difference

By Lisa Kulick

Walk through the new 40,000 square feet Tech Spark in Hamerschlag Hall and you'll hear a buzz, or perhaps a bang. You'll see students taking apart skateboards and building mousetrap cars. Or 3-D printing parts for a capstone project prototype. You'll bump into them as they bustle through the C-level hallway, sharing their latest ideas with classmates. You will feel the energy of this revitalized space.

The Tech Spark is a place where ideas are transformed. Enabling undergraduate and graduate student activities, research, and inventive hands-on learning, the Tech Spark is a cornerstone of the College's maker ecosystem. The space spans student facilities in a renovated wing of Hamerschlag Hall and brand new ANSYS Hall (to be completed in 2019).

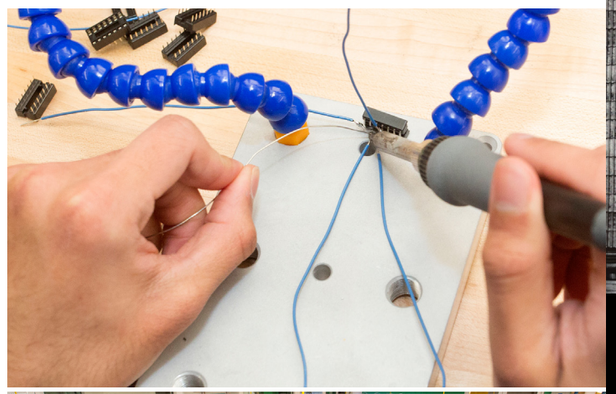
The Tech Spark will allow students to seamlessly immerse themselves into the College's learning-by-making culture. The state-of-the-art facilities, ranging from Hamerschlag Hall's design workshops to ANSYS Hall's large open bay facility, will enable new manufacturing technologies, creative processes, and innovative solutions that will stretch beyond our collective imaginations into the future.

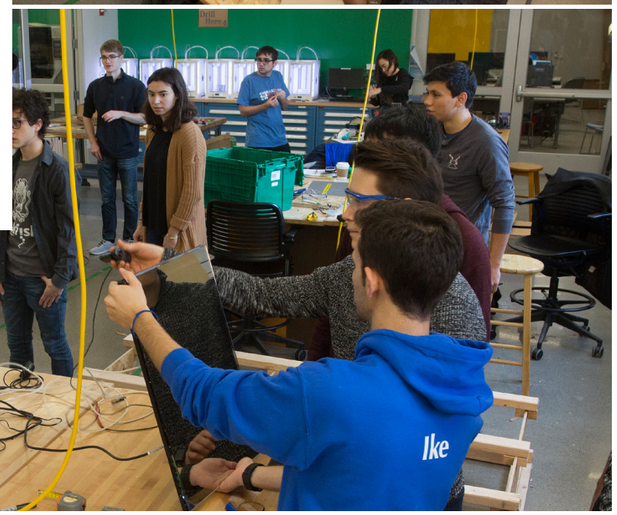
Integrated maker spaces for hands-on design and creation include a design workshop, electronic fabrication and rapid prototyping facilities, a student machine and teaching shop, a professional shop, advanced and additive manufacturing labs, a micro/nanosystems lab, clustered research areas, and more.

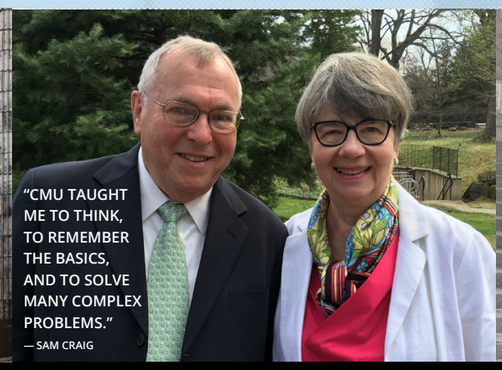
Want to see hands-on learning and real-world problem solving in action? One of the features is a series of large windows that flank the C-level hallway, connecting classroom and community. The next time you are on campus, stop by for a view of the future.

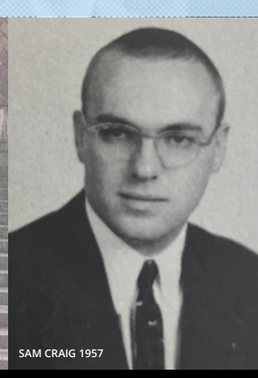
Tech Spark

A PLACE WHERE IDEAS ARE TRANSFORMED









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SAVE THE DATES

Build18 Build Week: January 14-18, 2019

Build18 Demo Day: January 18, 2019

Spring Carnival: April 11-13, 2019

ECE Day: May 3, 2019

Commencement: May 19, 2019