engineering news
School of Engineering
SPRING 19
SANTA CLARA UNIVERSITY

Interim Dean's Message

Spring quarter and the excitement on campus is palpable! We are delighted that Dr. Elaine Scott will be our next dean of the School of Engineering, and we look forward to working with her to make her term wildly successful.

More excitement—where once stood the Engineering Center is now a massive construction site, birthplace of the Sobrato Campus for Discovery and Innovation—a landmark STEM facility slated to open in fall 2021. Construction crews took down the old engineering buildings with mind-boggling efficiency, and teams of experts began dissecting the ground that, pre-dating the Mission Campus, once held a tannery. Now, archeologists and chemical experts comb the earth, maintaining our history and safety in preparation for the building to come.

Getting us to this point has been hectic as we moved into newly remodeled facilities, but this transitional period allows us to prototype facilities for the STEM center, and we are discovering what's working and where improvements can be made. Students quickly made these spaces their own, and the labs, classrooms, and collaboration areas are alive with activity.

Our seniors are especially busy as they prepare to present their capstone projects on May 9. Senior Design is a culmination of all that our undergraduates have learned. It is a chance for them to show how the disparate courses they have taken over the past four years come together to create a functioning engineer. In this edition, you will find some of their inspiring stories. Enjoy!

Ronald Danielson, Ph.D.
Interim Dean
School of Engineering

Meet Our New Dean, Dr. Elaine Scott!

With great excitement, the School of Engineering welcomes Dr. Elaine Scott as Dean, beginning August 1, 2019.

Dr. Scott brings a wealth of leadership experience to SCU. Most recently, she served as the founding Dean of the School of Science, Technology, Engineering and Mathematics at the University of Washington in Bothell. There, she focused her energy on charting the school's mission and vision, hiring and supporting distinguished faculty scholars, developing innovative degree programs, growing enrollment, and engaging the broader community. Among her many accomplishments, Scott tripled both undergraduate and graduate enrollment over the course of six years, doubled the amount of extramural research funding, and mentored dozens of faculty, three of whom earned the prestigious Presidential Early Career Award from the National Science Foundation. She has also garnered success in the public arena by developing strong relations with industry partners.

"As the founding dean of the School of STEM at UW Bothell, Dr. Scott brings extensive and innovative leadership to Santa Clara and the Sobrato Campus for Discovery and Innovation," said SCU President Michael Engh, S.J. "She will be a welcome addition to the University community at this transformative time for our campus."

Prior to her work at the University of Washington in Bothell, Dr. Scott helped establish the Virginia Tech–Wake Forest School of Biomedical Engineering and Sciences and its related graduate degree programs in 2001. Through this initiative, she brought together two universities, three colleges, two graduate schools, and 10 departments to build a transformative multidisciplinary academic unit that bridges the biomedical sciences, biomedical engineering, and real-world applications to enhance the quality of life.

Photo: Courtesy of Santa Clara University

Dr. Scott earned her bachelor's and master's degrees in agricultural engineering from the University of California, Davis, as well as doctoral degrees in mechanical engineering and agricultural engineering from Michigan State University. She has served as a professor of mechanical engineering at Virginia Tech, Seattle Pacific University, and the University of Washington, Bothell.

"Santa Clara University's unique location in the heart of Silicon Valley, its talented faculty and staff, and its Jesuit Mission provide a unique opportunity to educate and inspire engineers and leaders," she said. "I look forward to partnering with the university community to develop the next generation of mission-oriented leaders."

Mind Your Music

Computer engineering seniors Rachel Goldstein and Andy Vainauskas are musical. She plays cello, he plays violin. In addition to their rigorous engineering coursework, they were both members of SCU's orchestra, and he was also a member of the chamber singers. Over the years, their ability to make music helped them manage the stress of university life and gave them an outlet for their creativity. So, for their senior capstone project the pair is helping bring that capability to non-musicians through Mind Music, a tool that uses EEG technology and a musical improviser system to allow users to create music using their own brain activity.

Advised by computer engineering Assistant Professor Maya Ackerman, a leading researcher in artificial intelligence and machine learning and opera singer, the pair is also working with Robert Keller, professor of computer science at Harvey Mudd University and accomplished jazz musician. "Dr Keller created software that allows users to play the piano and improvise with the computer program. Instead of a piano, our system uses a Muse headband—a device currently on the market that provides EEG biofeedback to enhance meditation," said Andy. "A big milestone in our project was connecting the Muse as hardware to Dr. Keller's software," Rachel explained. It's been a huge undertaking to understand how everything works together. First, we had to get the Muse talking to the software, then figure out how the biofeedback fits into the actual code—which module is listening, and which is interpreting the data; and finally reading those values and generating music."

Photo: Heidi Williams

Not surprisingly, it's difficult to interpret brain data. To determine if their system was working, Rachel and Andy ran tests on something more familiar to them. Using an accelerometer to monitor head movement, they tested the software by assigning quarter notes and eighth notes to left and right head tilts. Once satisfied with those results, they began extracting actual brainwave data from the Muse outputs and figured out how to turn differing values of brainwave signals into categories that could be used to create a grammar, or set of rules, to tell the software what to do in different situations. "We had to decide how we want music generated based on the specific type of brain activity—assigning shorter, faster notes to certain values, and longer, slower notes to others," Rachel said.

And that's where the fun comes in. "Now, we're taking the brain data and being more creative," said Andy. "We have lots of choices in how we interpret brain activity. We're looking at fun ways to interpret the biofeedback and translate it into music." Catching his excitement, Rachel added, "There are so many different qualities in music you can change—dynamics, volume, tempo, pitch, high or low register—but ideally, when the user puts on the Muse headband, there should be a connection between their perceived mental state and the music that is being produced. If they try to calm down, they should hear that reflected."

Rachel and Andy imagine their system being a boon for people currently restricted from producing music due to disability or lack of training. "I just envision someone coming home and creating a piece that reflects their day, celebrating good news or helping them cope with stress or anger or sadness. It's what you do with an instrument," said Andy.

ENGINEERING A HELPING HAND

Jamie Ferris ’19 doesn’t let many opportunities pass her by. As a Presidential Scholarship recipient, the honors program senior is double majoring in mechanical engineering and philosophy. She also runs cross country and track, participated on SCU’s Ethics Bowl team, worked on SCU’s winning Tiny House Competition team, is president of the student chapter of the mechanical engineering honor society Pi Tau Sigma and vice president of the engineering honors society Tau Beta Pi, and has spent two summers helping advance faculty research through the Kuehler Undergraduate Research program.

Following her sophomore year, Jamie stayed on campus assisting Associate Professor Panthea Sepehrband in investigating how ultrasonic bonding occurs at the atomic level. “I loved working with Dr Sepehrband. She gave me room to grow and to learn how to research independently, and guide my own thoughts,” she said. Some of those thoughts led to the realization that she would rather be working in robotics, so she reached out to Christopher Kitts, director of the Robotics Systems Laboratory (RSL) and professor of mechanical engineering. “He asked what I wanted to be involved in, and I off-handedly mentioned it had been my dream since high school to do something in prostheses. Turns out, he’d just had a meeting with a potential partner to design a prosthetic hand, and he said I’d be perfect to work on it. I was trying not to freak out, but I was so excited.”

Working in a partnership with the Jaipur Foot Foundation, a nonprofit providing free prostheses in India, Asia, Africa, and Latin America, Jamie and other undergraduate and graduate students from bioengineering, biology, mechanical engineering, and public health sciences are developing the HELP Hand, a Human-centered Electric Prosthetic, to be produced in India. “It’s been a journey figuring out exactly who our target user would be,” she noted, “but we decided to focus on urban blue- or white-collar workers in India, as this is a large population best suited to the sort of electric device requested by Jaipur Foot.” Furthermore, the device is being designed for use on the nondominant hand. Jamie explained that after amputation, dominance of the hand switches within three to four months. “In India, many have lived with amputation for years before being fitted with a prosthesis, so the device we’re designing will perform a supporting, rather than dominant, role.” The undergraduates are working on a pulley tendon system as their senior design project (advised by Kitts and Prashanth Asuri, bioengineering associate professor and BioInnovation and Design Lab director); the graduate group is tackling a gear-based transmission.

Photo: Heidi Williams

(From left) Michael Mehta, Jamie Ferris, Evan Misuraca, and Shiyin Lim are designing a prosthetic hand for a nonprofit in India for their senior design project.

The technical design of the prosthesis is just one part of the project, Jamie said. “We have to take into account what will work best with the Foundation’s process in India, what charging options are available, what will be accepted aesthetically by both prosthetists and users, and we have to be sure we are fitting the needs of our customer base.” To ensure they are staying focused, the engineers regularly check in with their teammates from public health sciences, asking them to question and double-check decisions being made along the way.

It’s a multi-year project, she says. “At the end of this year, we hope to have a functional prototype that can be refined by the next group, evolving into a great product that can ultimately be manufactured in India. The Jaipur Foot Foundation envisions this prosthesis as creating an industry, providing jobs and helping more than just those receiving the prostheses. We have the possibility to have deep, long-lasting impact if we do a good job."

Following graduation, Jamie will continue prostheses research; she has already been accepted into one Ph.D. program and is awaiting notification from others. “Santa Clara has been such a great fit for me, but without the funding I received, I would not have been able to come here. I’m so grateful for the opportunities I’ve had to pursue my interests in engineering, philosophy, and athletics. At a Jesuit institution, it’s all about furthering education and bringing people together to build knowledge. Being here has helped me become a better person.”

DESTIGMATIZING ASTHMA

Photo: Heidi Williams

From left: Murray Bartho, Megan Nolte,Michael Breshock

In the United States, more than 6 million children under the age of 18 have been diagnosed with asthma, according to the Centers for Disease Control, and that number has been increasing since the 1980s. Treatment for the disease often includes regular use of a nebulizer—a device that changes liquid medication into a fine mist that is more easily delivered to the lungs. The problem with this therapy is that nebulizers are loud, big, bulky, and require sessions of up to 20 minutes just sitting in one place, breathing the medication in through a mask. Kids don't like to sit still for that long, and teens don't like to feel different from their peers, so compliance becomes an issue.

Looking for a solution to this problem, Dr. Niki (Amita) Saxena, a local pediatrician, reached out to Prashanth Asuri, director of SCU's BioInnovation and Design Lab and associate professor of bioengineering. A patient's parent had suggested a nebulizer disguised as an e-cigarette lookalike might take some of the embarrassment out of treatment. Of course, a pediatrician is never going to advocate smoking of any kind, especially for kids with asthma, but the idea of a hidden nebulizer intrigued Murray Bartho, Michael Breshock, and Megan Nolte, who were looking for a challenge. The team set out to create a prototype of some kind of undercover nebulizer as their senior design project.

They started off by getting a handle on the market. Over the summer, Asuri assigned the team readings on needs finding. "The readings were not intended to be a means to finding a solution, but rather to help define the different types of customers, understand customer needs, and convert this information into product requirements," he said. To further define the direction of their project, the team created a survey which Dr. Saxena sent to her patients. To reach a larger audience, they also posted a survey on Facebook and LinkedIn.

Survey results confirmed their suspicions that portability and ease of use were important design constraints. More research was conducted on how they might shrink current components to suit their needs. A jet nebulizer, the most common and cheapest to produce, would be difficult to make small enough to be portable. Ultrasonic mesh nebulizers are efficient and portable, but expensive. The team wanted to prototype a device sized and priced to compete with what is currently on the market. They decided to make a nebulizer that people could take camping, or use in the car, or have in their backpack. But what should it look like? It had to appear as something so ubiquitous it would go unnoticed.

"We asked ourselves, 'what's something people have with them all the time, that's easy to carry, and not noticed at all?'" said Megan. It hit them—they could hide their device inside a water bottle or hydroflask! "The mouthpiece is already there, it has portability, people can use it wherever they are," Murray said. "They can carry it on their backpack; there's already a holder there, so it fits into the existing infrastructure."

Their bioengineering background was strong. Among the three of them they have all the major's tracks covered: biomolecular/ biotech, pre-med, and medical devices. So the team was well equipped to design the prototype. But with limited mechatronic experience, building the actual device was a stretch, so they enlisted the help of sophomore mechanical engineering students. Asuri notes that the projects hosted by the BioInnovation and Design Lab are interdisciplinary in nature, both by design, but also due to the complex nature of the projects offered by its industry partners. "One cannot imagine running a project like this without first establishing collaborative, interdisciplinary teams," he said. Another tenet of the Lab is achieving vertical integration on projects. Asuri explained: "An open-ended project like this is appropriate for seniors, but might be too much for sophomores and juniors to take on. Having them work on small pieces of the project gives exposure to real-world customer experiences and is suitable for their level of education. Scaffolding bits of the work also mimics how teams work in industry, and in this case, it enabled the seniors to implement a pump into their design," he explained.

Megan, Murray, and Michael have found working with a real customer for their senior design project very rewarding. "We're not imagining what might be useful," Michael said. "We're addressing specific needs and putting things together to address a real problem. When we talk with people about the project, they get excited. That confirms to us this type of product is useful and needed."

Restoring Paradise

On November 8, 2018, a wildfire turned firestorm ripped into the town of Paradise, California. Within just 90 minutes, the town was engulfed. When the fires were extinguished 17 days later, the human and economic tolls were devastating: 85 lives lost, 240 square miles scorched, 18,800 structures destroyed, $16.5 billion in damages. The townspeople were bowed and heartbroken, but not defeated; residents quickly regrouped to plan rebuilding.

On February 12 and 22 of this year, three civil engineering seniors, Sedona Leza, Karin Komshian, and Brianna Eremita, joined the resilient citizens at Paradise town planning meetings. The students were moved by the suffering caused by the disaster. The team (advised by civil engineering Associate Professor Reynaud Serrette, founder of the Light Gauge Steel Research Group) chose to take on the challenge of modeling a house to better mitigate fire damage and to research municipal strategies to minimize future loss.

When the team drove into Paradise the first time, they were shocked by the devastation. "We'd been reading articles and looking at pictures online, but when you see the rubble, it is so emotionally heavy," Sedona said. "The scale of destruction was incomprehensible. The only things left standing were metal or masonry."

At the planning meetings, the team got a feel for how the residents were planning to rebuild. "We wanted to see if there was an opportunity to put in ideas or help," Karin said. "We learned the town is still looking to build with timber, but wood fuels a fire. Firefighters I spoke with said the fire spread so quickly because it jumped from house to house, becoming an urban firestorm. Timber construction did nothing to constrain the spread, so we're proposing using cold-formed steel for construction instead. It's a bit more expensive, but the fire resiliency makes it more affordable in the long run."

In addition to designing with fire-resistant building materials, the team is also investigating how homes could be better sealed against an external fire. "There's a tradeoff, though," Brianna explained. "If a fire starts inside, sealing will make it worse. Balancing both scenarios is a challenge in the construction phase."

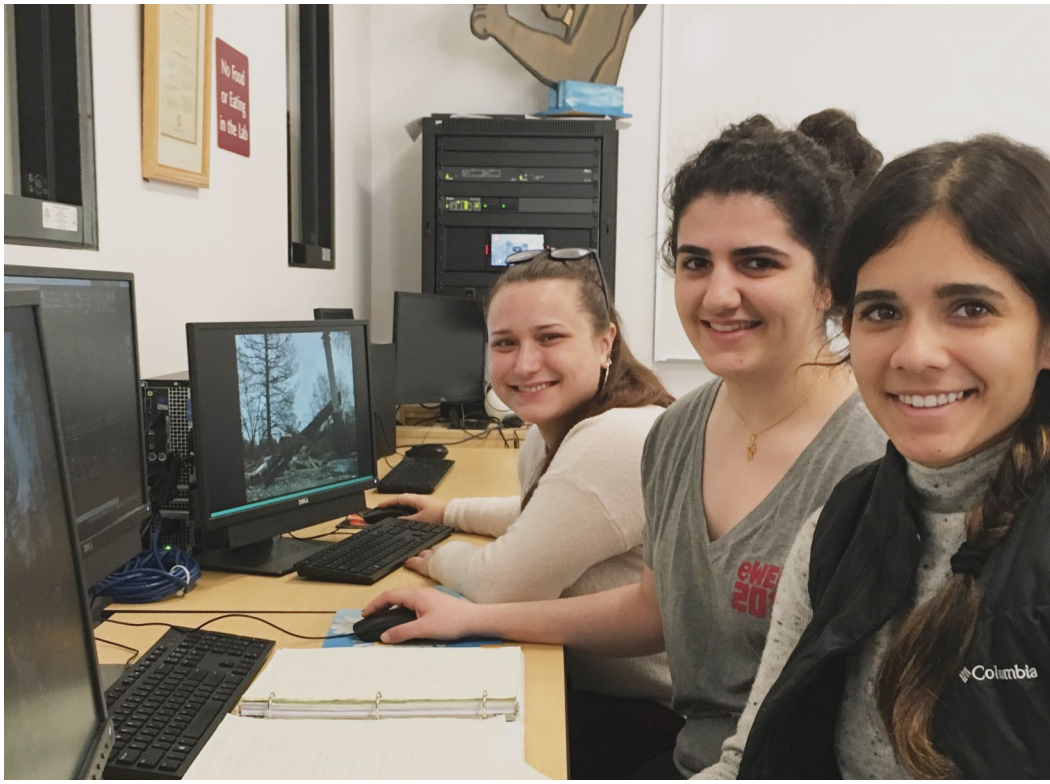
They are also looking at ways to combat the problem of pine needles and debris collecting on roofs and acting as kindling during a fire.

Beyond home design and construction modeling, the civil engineers are also making recommendations for defensible space and homeowner maintenance. Even more, they are exploring the feasibility of an early-action system that would release water in the area surrounding Paradise to saturate potential fuel and slow wildfire progression as it approaches town. Sedona described the team's thinking: "We're looking at creating a buffer zone around the town—parkland or community vegetable gardens, or a solar farm—that would minimize vegetation and create a fire break. We have to be cognizant of the town's perspective, though. They are very concerned that in rebuilding they maintain the feel of the community they love; they don't want to feel like a suburb of Chico. They are a close-knit community. We want our recommendations to beautify their town and foster a sense of community."

The team has a deliverable to present a set of recommendations to the town council later this spring. "There are a lot of moving parts to this project," said Brianna. "We're learning so much about cold-formed steel construction, building codes, power line safety risk, municipal planning, evacuation routes, and more. Some of our recommendations will be very detailed, others will be presented as considerations, not fully fleshed out. It's been challenging, but Dr. Serrette encouraged us to look 10 years into the future, and it is rewarding to help the people of Paradise."

Sedona, Karin, and Brianna agree that seeing the resilience of the community and witnessing their fighting spirit helps motivate them. "There's no question this town will rebuild and be better than ever. We're happy to be able to put our education to use for them in any way we can," said Karin.

Photo: Heidi Williams



From left: Sedona Leza, Karin Komshian, Brianna Eremita

Switching Things Up

You may not know it, but tucked within the innards of your cell phone, your microwave, and virtually every electronic item you own, lurks a voltage converter—a component that acts as a go-between, reducing the amount of power drawn from the power supply source (a plug in the wall, a battery, or a solar cell) to the amount of power your device actually needs to do its job. Your phone, for instance, requires different amounts of power to operate the camera, apps, and signal search, to name just a few of its functions. For decades, standard voltage converters served the population well, but with the proliferation of the Internet of Things (IoT), in an increasingly connected world in which technology is embedded in our everyday objects, a smaller and more energy efficient voltage converter is needed.

For their capstone project, electrical engineering seniors Bradford Kidd and Anne Hsia have stepped up to address the challenge of stepping down the regulation of power in IoT devices. The pair have designed a device that reduces the physical footprint and the power consumption of traditional voltage converters. They started by reading stacks of academic journals and Ph.D. dissertations to gain insight into how to proceed.

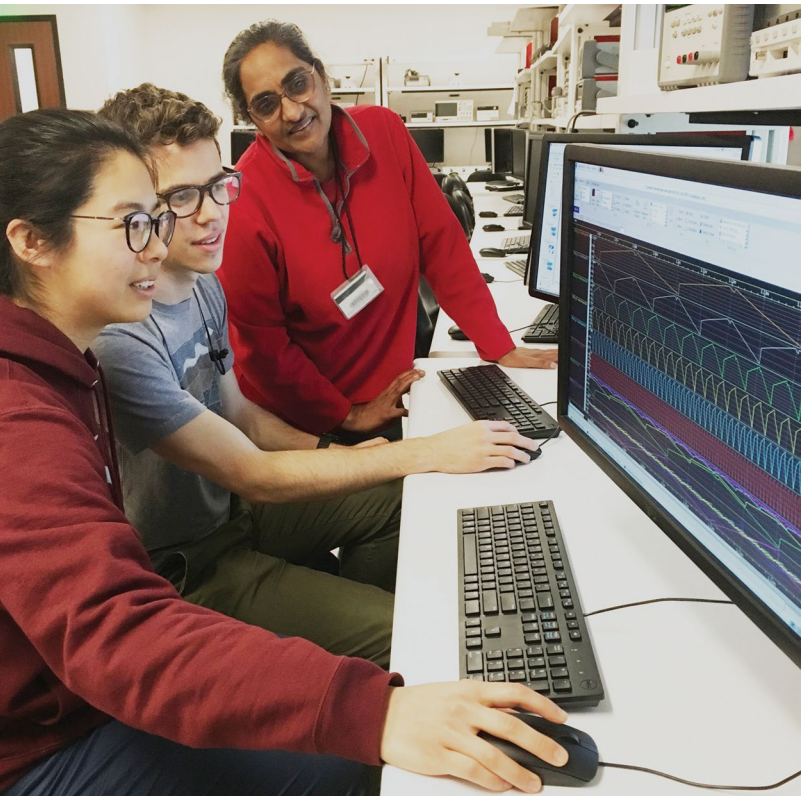


Photo: Heidi Williams

"We are doing something new that really isn't taught in school," said Brad. "We knew we needed something ridiculously small, less than one square millimeter, so we decided to create an integrated circuit design that uses switches and capacitors rather than inductors—which are inefficient, have a lot of noise, and are very large—to step down power input as needed." Their design reduces an input of 0.9–1.3V to 0.6V; perfect for IoT applications.

The design process consisted of, in Brad's words, "drawing a lot of rectangles"—laying out how their converter would be configured, deciding just how many switches and capacitors were needed, and how the chip would be manufactured. They also had to determine if the switch between frequencies should be linear or logarithmic, and they had to account for parasitics. Ummm… excuse me? Anne explained: "Parasitics are the things that eat away at efficiency. Friction is one problem, but we also had to consider loss from switches or capacitors not operating at 100 percent efficiency, 100 percent of the time." The pair used feedback flow charts to read which frequency to use and made dozens of graphs to judge how well things were working.

Turns out, their design works really well—operating at 90 percent efficiency for up to 30μA load currents. The team's advisor, Electrical Engineering Chair and Professor Shoba Krishnan, is thrilled with their work.

"This is good old-fashioned engineering design," she said. "Short of sending their design out to be fabricated, they are doing everything just like they would if they were working for a Silicon Valley company, and their design is actually being used by one of our electrical engineering Ph.D. students for his research."

The words bring a smile to Brad's face. "I was looking for a senior design project that was aimed toward where I'm going with my career. I've been interested in analog IC design and wanted to create a layout that a company could use in their chip," he said. Though he is enrolled in electrical engineering's combined five-year BS/MS degree program and will continue at SCU for another year, Brad has already landed a job with Adesto Technologies.

As for Anne, the classically trained pianist who is triple majoring in EE, mathematics, and music, she's keeping her options open for the time being. "Working with a teammate and being able to bounce ideas off each other while tackling a very technical project has been great. It was just what I wanted. And creating a design that will be beneficial to chip manufacturers is really fulfilling," she said.

GETTING "WEIGHSTED" FOR THE GOOD OF SCU

Sustainability is a big deal on the Santa Clara University campus. Regularly recognized as one of the nation's Top 50 Green Colleges (*Princeton Review*) and among the Sierra Club's Top 50 Cool Schools, SCU is dedicated to promoting a culture of sustainability among its students, faculty, and staff. Among other goals, the University has committed to a ten percent reduction in food waste by 2020, but to do so the Center for Sustainability needs a reliable system to measure progress. Enter a team of mechanical engineering seniors: Vince Heyman, Timothy Jaworski, and Tatianna Schleup stepped up to aid the effort.

Some measures were already in place—pre-consumption composting of scraps made during meal preparation, and leftovers packaged and delivered to a local soup kitchen. But heaps of food were still being tossed into dining hall trash cans. One problem, Tatianna explained, was that the Center for Sustainability had no clear idea how much food was being tossed out. "The collected data is not 100 percent consistent, and the Center has to rely on volunteers to do the work," said Tatianna.

For their senior design project, the team offered to create a standalone device for the Center for Sustainability to install in the dining hall. They started by surveying fellow students to gauge their willingness to spend an extra ten to fifteen seconds after a meal. "We got a lot of support for the project through the survey," said Timothy, "and we learned that students want to get a more personal view of their impact regarding food waste." Survey feedback influenced several design decisions, such as including an LCD screen providing real-time data on precisely how much food was being wasted and which station in the dining hall was creating the most waste.

Advised by mechanical engineering Associate Professor Tim Hight and Center for Sustainability Director Lindsey Kalkbrenner, the team went through a slew of iterations before landing on their final design, which had to cost less than $1,500. "At first," Vince said, "we had an idea for a robotic arm that would scrape food onto a scale, from which a squeegee would push the food into the bin. That was too messy and too complicated. We decided to make the process as quick, simple, and close to what students were currently doing as possible. So we scrapped the robotics and moved the scale to below the wastebin, which reduces messiness."

Photo: Luis Acevedo

Timothy Jaworski, Tatianna Schleup, and Vince Heyman at work on Weighsted in the Machine Shop

The end result is "WeighstEd," an ADA-accessible, fully enclosed, Arduino-controlled, mobile receptacle that is about three feet high. A tablet installed atop the lid is preloaded with station offerings and meal information, allowing users to select the particular items they are discarding. The inputted data runs a code that opens the lid to allow users to scrape in their food, takes a scale reading, and feeds back information to Google sheets and forms to update trends on which meals and stations are creating the most waste.

"It was a steep learning curve with the computer coding we had to do," Timothy said. "This could have been an interdisciplinary project, but we all felt confident in our ability to learn what we needed to know." Rather than creating an Android app, they chose to use Google sheets and forms so Center for Sustainability staff could more easily use the data. "They will be able to see the trends," said Vince, "and let Dining Services know if they need to adjust portion sizes or change their offerings in other ways. Having this data available quarter to quarter will allow the Center to determine if SCU is reaching our goal of a ten percent reduction in food waste."

Tatianna summed up the team's motivation. "We all really wanted to work on something for our senior design project that would make an immediate impact. Working on this project for the Center for Sustainability has kept us motivated and invested, because we all care about sustainability at SCU and we are personally invested in it."

Learn more about sustainability at SCU:
scu.edu/missionsustainable

Santa Clara University
School of Engineering

Santa Clara University
500 El Camino Real
Santa Clara, CA 95053

Nonprofit
Organization
US Postal
PAID
Permit No. 22
Santa Clara, CA

The Jesuit University in Silicon Valley

Photo: Heidi Williams

GIVE TO SCU ENGINEERING
scu.edu/engineering/give

PRINTED ON RECYCLED PAPER

AWARDS – WE'VE GOT AWARDS!

An alumnus elected to the National Academy of Engineering and a student selected as a Fulbright Scholar?!? Here's the good news.

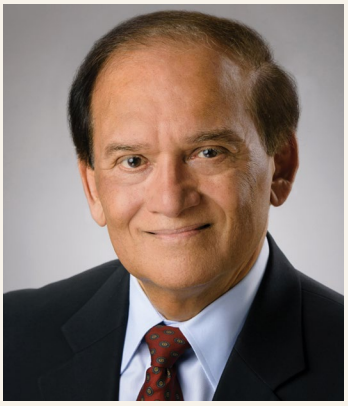


Photo: Heidi Williams

Hemant Thapar '73 MS '75, a pioneer in circuit-switched networking, data communications, and data storage, has been elected to the National Academy of Engineering. Its leaders cited Thapar's contributions to the "theory and practice of coding and signal processing for high-density magnetic recording." His groundbreaking research in data storage and retrieval was immediately adopted by industry and formed the foundation for follow-on work in the field of magnetic storage at universities and research laboratories.

Read more:
scu.edu/engineering/stories/thapar

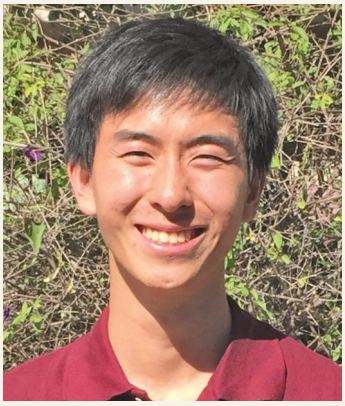


Photo: Heidi Williams

James Wang '19, has won a Fulbright Scholarship to research "hybrid-supercapacitors"—a new form of energy storage with potential benefits for renewable energy—in Paris, France. Wang spent his SCU years developing and exploring his passion for the environment while honing his engineering talent toward sustainable endeavors. He hopes to develop technologies to combat climate change and create sustainable and reliable energy, water, and food solutions for people in developing nations.

Read more:
scu.edu/engineering/stories/wang

Engineering News is published quarterly by the School of Engineering, Santa Clara University, Santa Clara, Calif.
Writer and Editor: Heidi Williams, hwilliams@scu.edu | Copy Editor: John Deever

FL-14262 04/2019 1,500