CONNECTIONS

Electrical Engineering Department • Cal Poly College of Engineering • Fall 2019

INSIDE THIS ISSUE

- New room-scale microgrid to serve future Solar Systems Lab
- Computational intelligence course grows in popularity
- Donors fund department improvements, including: new courtyard, air conditioning for EE labs and speedier equipment checkout

CAL POLY
Electrical Engineering
COLLEGE OF ENGINEERING

MESSAGE FROM THE CHAIR

Dennis Derickson

Greetings from the EE department at Cal Poly. While I have had the pleasure to greet 170 first-time college students and 40 transfers this fall, I am also proud to share the significant impact thoughtful supporters have had in the past year, each gift making a difference in the lives of our students.

Among other things, donations have enhanced our labs, which students and faculty are using to work on innovative projects that will make a difference in California and beyond. A couple of lab projects (which are also sponsored) that you'll read about here include a microgrid that will allow students to test emergency and alternative power sources and a project that seeks to detect wildfires at an early stage.

Both of those projects have the potential to save lives, and they would not be possible without donor support.

We hope to continue funding important projects like this, which not only give students valuable experience for their futures but also enhance Cal Poly's reputation as a hands-on learning institution that contributes to safety and quality of life.

Speaking of the labs, our new REC Solar Power Systems Laboratory outdoor research area is still going through the facilities approval process. This facility will cost about $350,000 to complete, the funds coming primarily from corporate donations with REC Solar in the lead.

The 2,000-square-foot outdoor lab will allow our faculty and students to build experimental power network subsystems and connect them to our private EE high voltage distribution system that interconnects our five power system labs inside Building 20. The outdoor research area will be key to our Building 20 microgrid project that will be part of our curricular offerings for students. We are also working on a room-scale microgrid in advance of the REC Solar lab (see story on following page).

We now have six new laboratory rooms that have cooled water temperature regulation, making the labs more comfortable,. You might recall that on some warm days in the fall and spring quarters several of our laboratory rooms heat up, making for a less than perfect learning environment for both faculty and students.

During a Building 20 renovation in the 1990s, the Big E was plumbed to bring in cooled water and warm water into our labs to regulate

Funded by donations from Electrical Engineering Department alumni and friends, a 3,000 square-foot courtyard next to the "Big E" (Building 20) has begun to host student, faculty and club events. For more on the courtyard, see Page 13.

temperature. For unknown financial reasons, the university did not complete the cooled water connections, so they sat idle for 20 years. The EE department finally used some of our donor funds to finance our facility department to complete the connections. This was pretty expensive but the results are absolutely wonderful on a hot fall day. We have another six rooms to go and we hope to gather the funds to complete the cooling of all of our labs in the next few years. (See the pipes on Page 14).

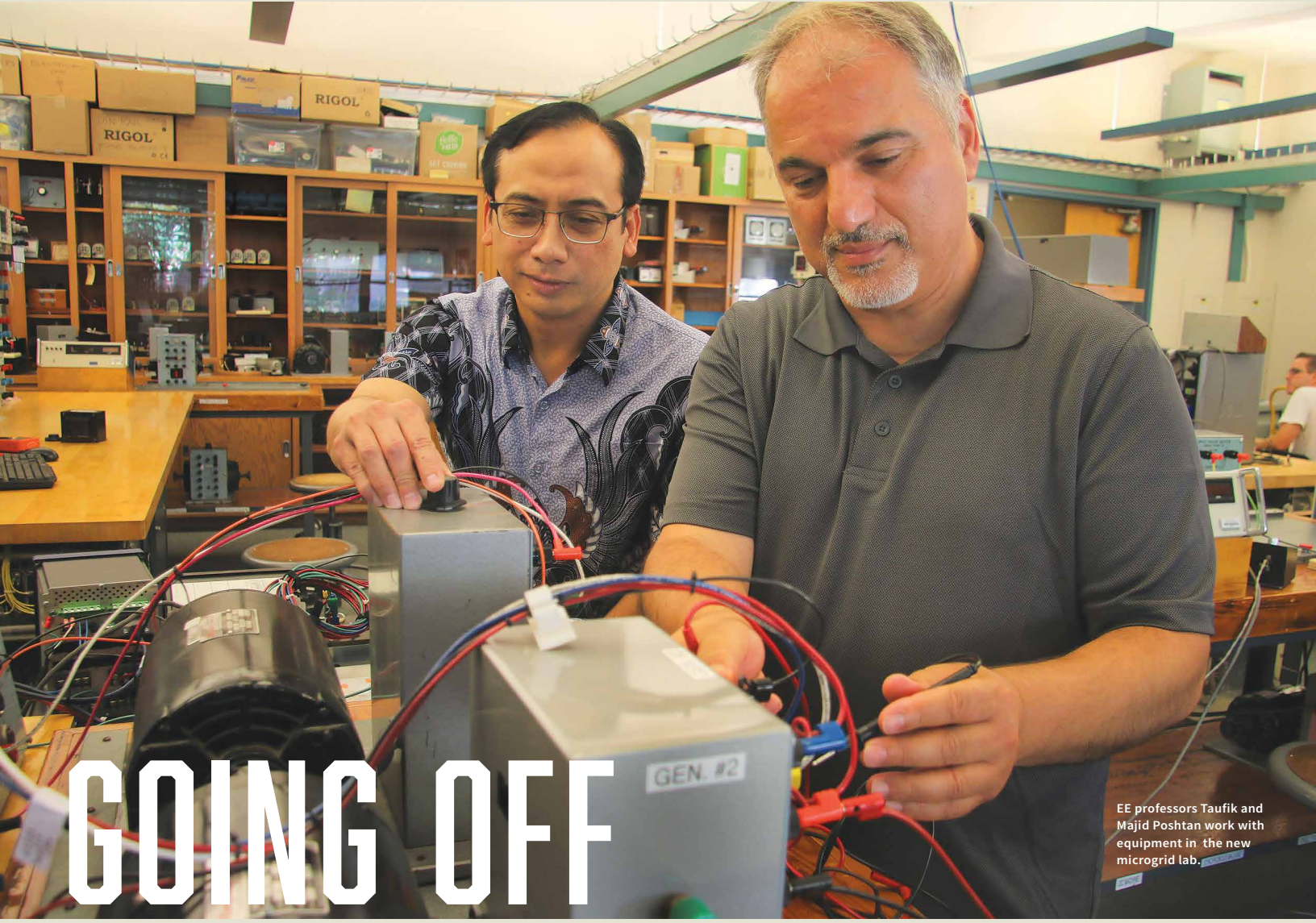
In other donor-related news, the EE department, in conjunction with the College of Engineering, just opened up its EE outdoor courtyard in one branch of the "Big E" building headquarters. The outdoor courtyard has 3,000 square feet of area for students to study/interact or for faculty to hold outdoor office hours. It is also turning into our outdoor celebration and party area for EE clubs. This was all made possible by generous donations from our alumni and friends. Thank you on behalf of everyone in EE. Please stop by and we will have a meeting out in the EE courtyard.

Our EE vision document talks about "Preparing Our Students for a Data Intensive World." On Page 6, we feature Dr. Helen Yu and the computational intelligence classwork and research that she has pioneered at Cal Poly. Her graduate course in neural networks is the most popular grad course in the last two years. There are so many fields being impacted by machine learning and we are helping our EE students keep pace with this rapidly changing field.

Please stop by the EE department often or give me a call so I can help you understand all of the great things we have going with our Electrical Engineering Learn by Doing environment here at Cal Poly. New students and parents, please make sure and contact the EE Department for a private tour when you are on campus. We are happy to show you around as we are extremely proud of our facilities, students and offerings.

Dennis Derickson

Professor and Chair, Electrical Engineering



EE professors Taufik and Majid Poshtan work with equipment in the new microgrid lab.

GOING OFF THE GRID

MICROGRID LAB WILL ALLOW STUDENTS TO EXPERIMENT WITH CRUCIAL ENERGY PRODUCERS

"We want to have a microgrid lab where students can actually experiment or play with equipment in microgrids. We'll do different types of microgrid experiments without worrying about turning off a building."

— Taufik, EE Professor

On the north end of campus, a solar farm with thousands of panels produces a stunning visual — and enough energy to power roughly a third of Cal Poly. But while students work with the microgrid powered by those panels — which saves Cal Poly money and helps combat climate change — they can't conduct experiments on it.

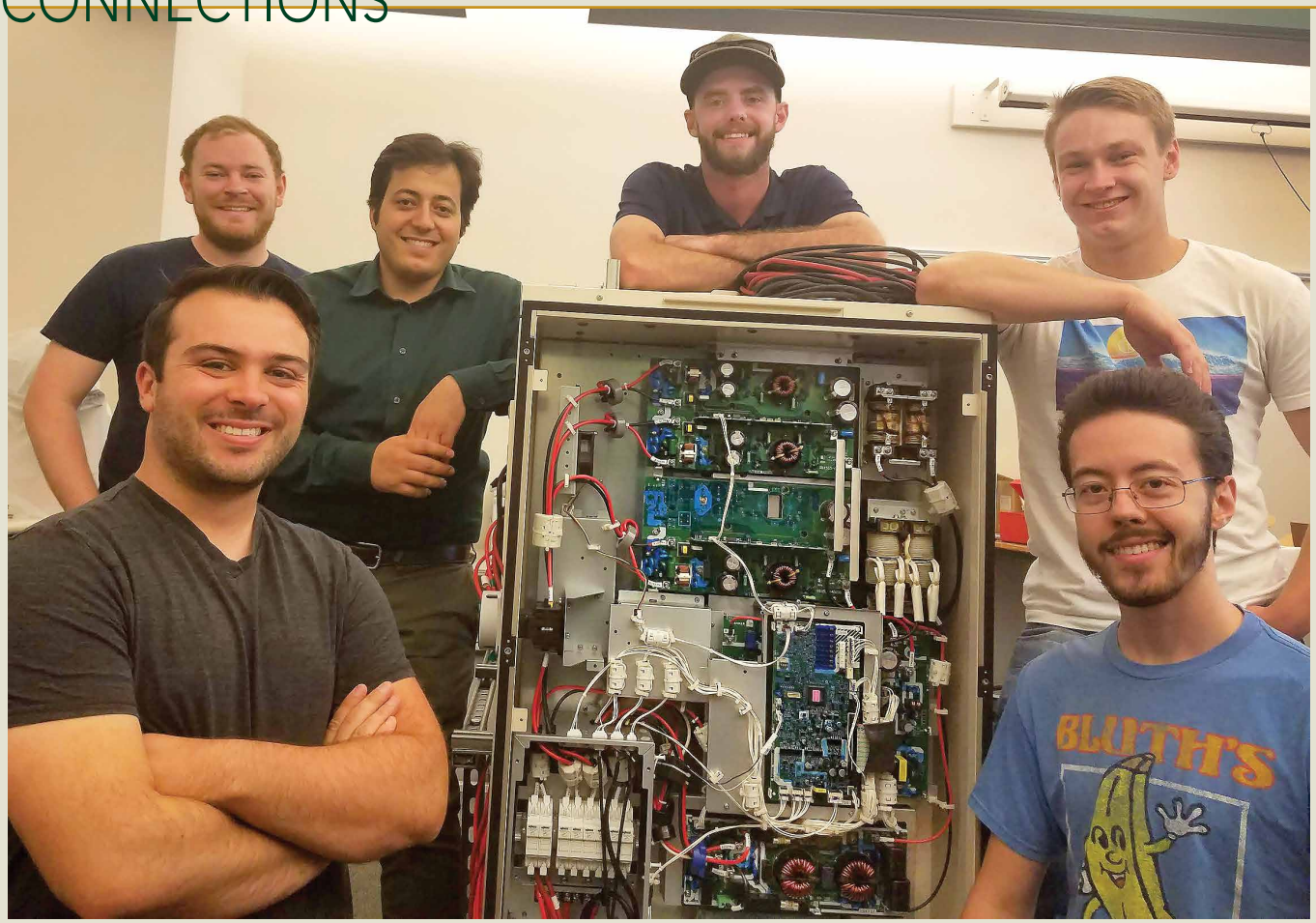
However, a new microgrid lab in the Electrical Engineering Department will allow students to learn to work with microgrids, creating simulations with actual energy-related devices.

"We want to have a microgrid lab where students can actually experiment or play with equipment in microgrids," said Taufik, electrical engineering professor and director of the Electric Power Institute on campus. "We'll do different types of microgrid experiments without worrying about turning off a building."

A microgrid is a local energy grid with control capability, according to the U.S. Department of Energy, meaning it can disconnect from the traditional grid and operate autonomously. The grid connects homes, businesses and other buildings to control power sources. Microgrids, which can be powered by distributed generators, batteries, or renewable resources such as solar panels, generally operate while connected to the grid, but they can break off and operate on their own in the event of an outage.

"In the case of power blackout or in the case of power outage or power shortage, the neighborhood or area can provide its own electricity,"

Continued on next page



Electrical engineering students working in the microgrid lab include, back row from left, Jacob Sussex, professor Ali Dehghan Banadaki, Derek Seaman and William Dresser; front Row: Owen McKenzie and Jonathan Wharton.

Below: Professor Ali Dehghan Banadaki demonstrates lab equipment to EE student Shaun Weber.

said Majid Poshtan, an associate professor, who will be instrumental in the operation of the lab.

Because they can use renewable sources, microgrids also offer to mitigate the impact of climate change.

"According to the EPA, most of the greenhouse gas emissions from human activities in the United States are from burning fossil fuels for electricity, heat, and transportation," said Ali Dehghan Banadaki, a lecturer in the department, who worked on microgrid modeling and control for his Ph.D.

While climate change has also brought about more dangerous storms and fires, microgrids offer power options during catastrophes, he added. That's especially important for powering, say, a hospital.

"It will secure power for our needs on the one hand, and on the other hand, it will help the planet by producing fewer greenhouse emissions, which will hopefully make fewer wildfires happen in the future."

Cal Poly's microgrid, powered by solar panels, is expected to contribute to the 2020 goal of having 33 percent of the campus's annual electricity needs met by clean energy. Students can collect data from the microgrid, but because it is a working power source, they can't conduct experiments with it.

A microgrid lab, however, allows students to conduct hands-on work, even creating power failures they can respond to.

"We have real equipment but on a smaller scale," Poshtan said. The lab is primarily located in room 101 of Building 20 — a room previously used for power-related senior projects, master's thesis and industry-sponsored projects. Students have already used the lab for a senior project, a summer undergraduate research project and more. And this spring, the department plans its first course that will utilize the lab.

"This class will function as a great technical introduction as well as a resume builder for EE's looking to enter the power system field," said Vincent Tham, one of three students who used the lab as part of a senior design project. "As far as we know, there are very few power system laboratories in California and hands-on experience with industry standard devices will put Cal Poly students ahead of other job candidates." ■

POWER PLAY

SURP TEAM SUGGESTS MEASURING THE TEMPERATURES OF POWER LINES FOR FIRE DETECTION

Confronted with the probability that California will continue to face deadly wildfires, a team of electrical engineering faculty and students has suggested that power lines can be used for early detection of fires.

As part of an undergraduate summer research project, the team wrote a paper, "Using Power Infrastructures for Wildfire Detection in California." That paper notes that since the early 1900s, the US Forest service has utilized outposts to observe remote areas.

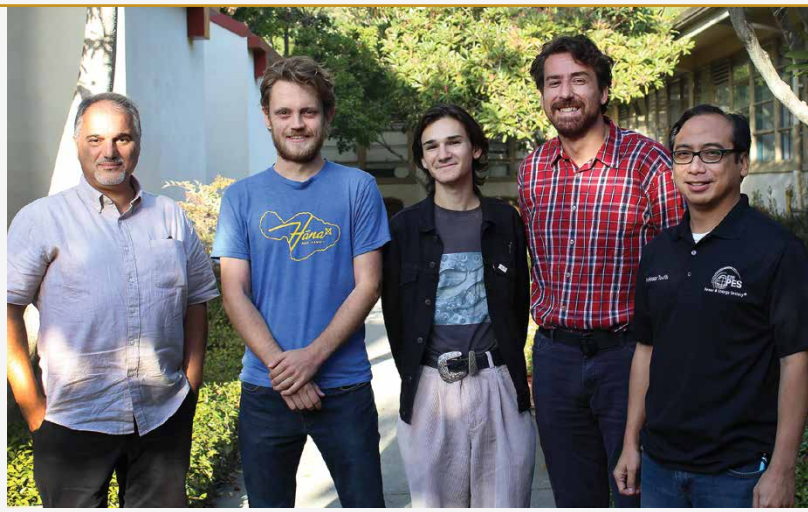
Meanwhile, conventional wildfire detection today is typically based on satellite imaging systems, airplanes/drones and fixed cameras. Yet those systems are limited in accuracy and expensive.

But there is existing technology, the team argued, that can be used to identify fires — including ones in remote areas.

"Our approach is based on the observation that radiated heat from fires quickly results in changes in transmission line temperatures and sag," said Joseph Callenes-Sloan, one of the faculty members involved in the project. "As the transmission line temperature increases from radiated heat from a fire, the line also expands in length, resulting in sag."

By monitoring line temperatures and sag, he said, early onset wildfires can be detected in less than a minute up to 120 meters from the transmission line.

The team included students Emil Erickson and Reed Slobodin, along with faculty Majid Poshtan and Taufik.



The Summer Undergraduate Research Program team investigating the use of power line temperatures in fire detection included, left to right, professor Majid Poshtan, electrical engineering students Emil Erickson and Reed Slobodin, and professors Joseph Callenes-Sloan and Taufik.

In 2018, 87 people were killed as a result of wildfires, which cost the state $16.5 billion. Ironically, the Camp Fire — the deadliest fire in the United States since 1918 — was caused by a downed transmission line, and the state's three largest utilities have ignited more than 2,000 fires in the past four years.

But because power lines react to heat, they can be used for fire detection of any kind, the team concluded. Meanwhile, even remote areas are often covered by power lines, offering more coverage.

In California, the paper noted, there are 150,000 miles of transmission and distribution lines, which translates to roughly 11 million acres of land that can be monitored. That would cover 30 percent of California's forest areas. ■

RIDING THE AI WAVE

XIAO-HUA (HELEN) YU'S COMPUTATIONAL INTELLIGENCE CLASS IS ONE OF EE'S MOST POPULAR GRADUATE COURSES

While proposing a 2-month workshop to study "thinking machines," an assistant professor of mathematics at Dartmouth College coined the term "artificial intelligence" in 1955.

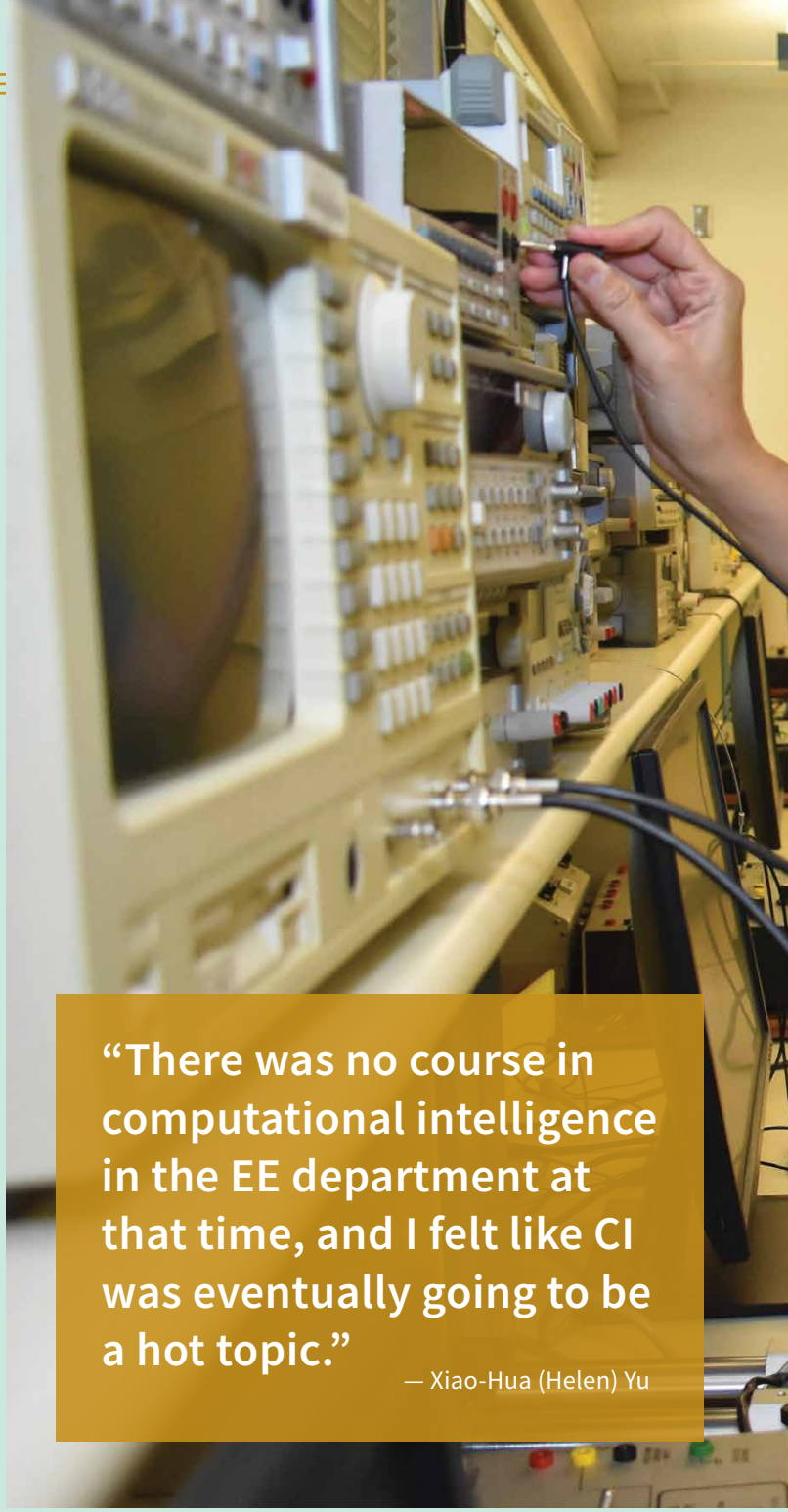
Yet, even though it's been nearly 65 years since John McCarthy introduced the term into the lexicon, today artificial intelligence is seen by many as an emerging, hot field. And in 2003, the Institute of Electrical and Electronics Engineers Computational Intelligence Society was established to advance nature-inspired computational paradigms in science and engineering.

"Right now everybody is talking about this new technology," said Xiao-Hua (Helen) Yu, whose EE 509 course, Computational Intelligence, is one of the most popular graduate courses in the Electrical Engineering Department.

Inspired by biology and the study of human behavior, computational intelligent systems refers to a class of "sophisticated" systems that can solve problems that normally require the intelligence of a human being. Yu's course, which she designed from scratch, covers the theory, design and applications of biologically motivated computational paradigms, including artificial neural networks, evolutionary computing and hybrid intelligent systems.

While the technology that makes the course possible has come a long way, most of the progress has been more recent. The concept of thinking machines even predates the Dartmouth conference, when pioneering computer scientist Alan Turing wrote a 1950 paper speculating about the concept. Yet, after that promising start, pessimism eventually grew, and the so-called "AI Winter" occurred — a long period of academic letdowns resulting in debilitating cuts to artificial intelligence funding. But faster processing power in the 2000s, along with the ready availability of data, aided AI's comeback.

Yu was quick to get onboard, starting with an experimental class in 2009.



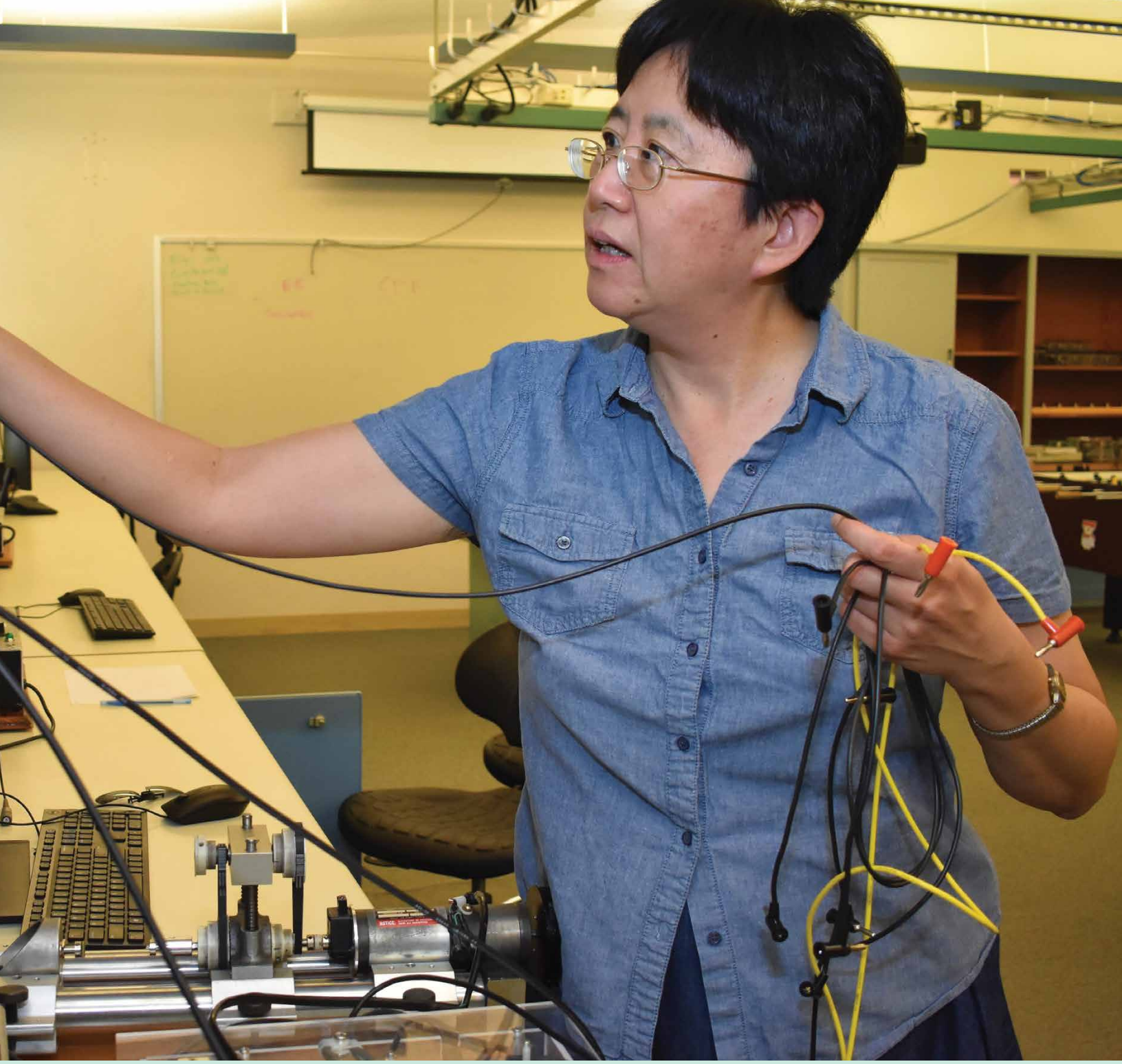
> **"There was no course in computational intelligence in the EE department at that time, and I felt like CI was eventually going to be a hot topic."**
>
> — Xiao-Hua (Helen) Yu

"There was no course in computational intelligence in the EE department at that time, and I felt like CI was eventually going to be a hot topic," she said.

She was right — student demand was there. In fact, she has had students from several departments, including various engineering majors and students from business, math and physics.

"I've even had one from philosophy," she said.

Computational intelligence has many applications, such as medical diagnosis, document recognition, automatic driving, and gaming, to name a few.



Yu and her research team have pursued a variety of projects, including noise reduction for heart signals, medical image processing and robot path planning, as well as neural network controllers.

She and her students have presented and published many papers at international conferences and journals.

"That's something I feel I can really be proud of," Yu said. "The work I present is our students' work."

One of her past students, Nicholas Kimball, said the class provided a much more rigorous understanding of neural networks than he had previously known.

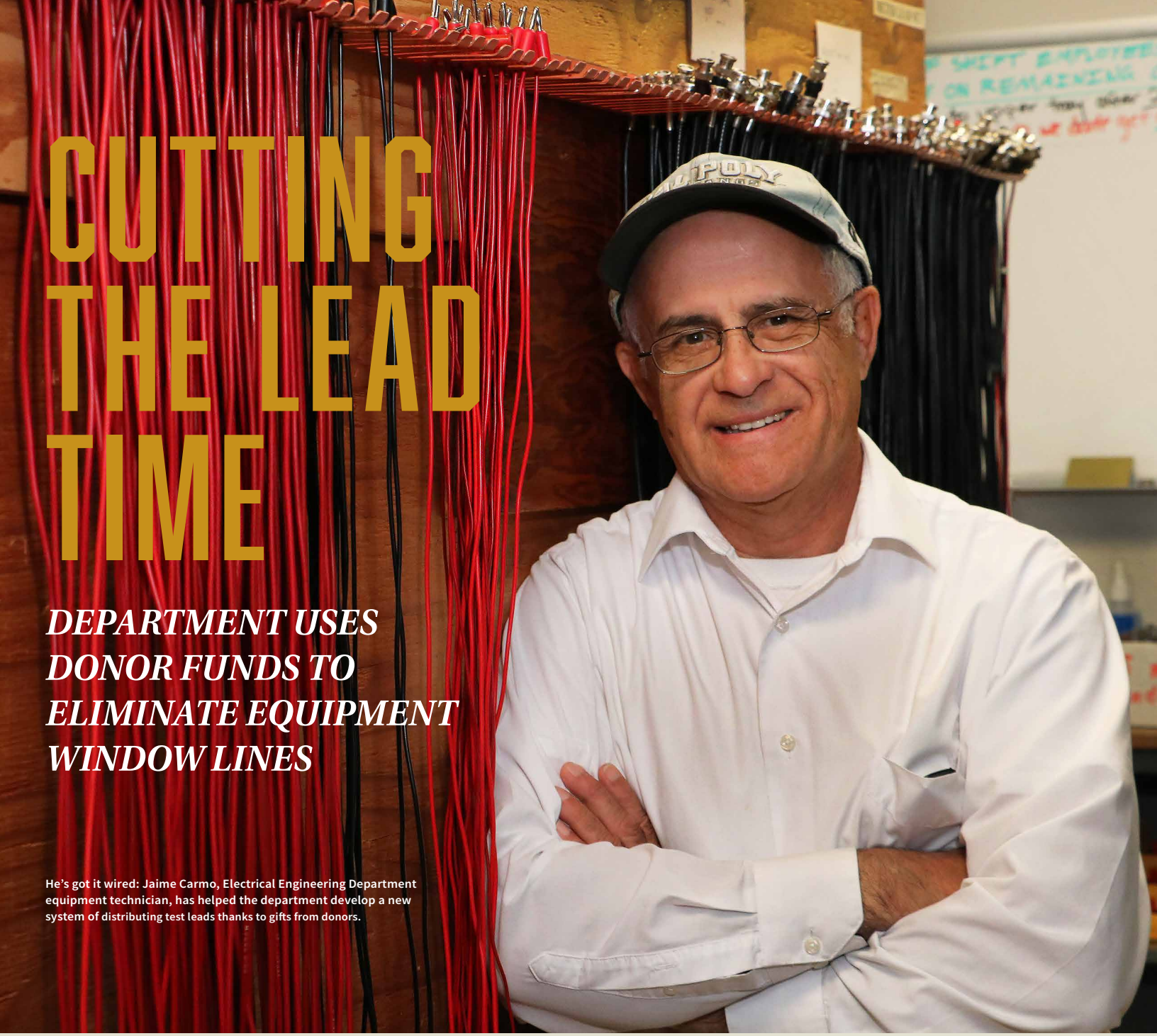
"I was also introduced to many other machine learning algorithms and concepts, such as the least mean squares algorithm, support vector machines and swarm intelligence," he said.

While he doesn't use machine learning directly in his job as a hardware engineer at Amazon Lab126, having a functional understanding of it helps him understand the complex systems that rely on machine learning, such as Amazon Alexa.

"As the use of machine learning becomes more ubiquitous, I feel like it will only become more important to understand how machine learning algorithms work under the hood." ■

CUTTING THE LEAD TIME

DEPARTMENT USES DONOR FUNDS TO ELIMINATE EQUIPMENT WINDOW LINES



He's got it wired: Jaime Carmo, Electrical Engineering Department equipment technician, has helped the department develop a new system of distributing test leads thanks to gifts from donors.

On a warm summer day, Brad Levin sat at a desk littered with red and black plastic segments — tiny tubes he had snipped from much longer ones.

While most students were far from campus, Levin was in the EE Department, making test leads his peers would use during the much busier fall quarter.

"I made around 750 BNC cables," Levin said later.

His efforts will save students considerable time. Because now, each EE lab will be stocked with dozens of test leads.

"The change came about from an urgency to reduce the long lines and time spent by the students waiting to obtain test leads and equipment from the EE Department checkout window," said Jaime Carmo, EE equipment technician.

When Carmo joined the department 31 years ago, most test leads could be found in individual labs, he said. But when Building 20 was remodeled in 1992, the test leads were moved to a single checkout window, where students were hired to assist in loaning them to peers.

Eventually, the equipment window became a place known for long lines, as students waited to fill out checkout cards and return their leads. Department Chair Dennis Derickson said many alums will remember those lines.

"I mentioned to Dennis how it was done in the 'old days,'" Carmo said, "And he asked me to come up with numbers and cost."

"This will make the students' who work at the checkout desks lives easier and cut down on line times, so students won't be late to their labs. It also helps the students who need to use equipment when the check-out desk isn't open."

— EE student Brad Levin

At top, electrical engineering student Brad Levin worked on BNC cables over the summer for the new in-lab distribution of test leads that fellow students Ellie Mitchell, David Heyer, Dani Lopez and Neal Sharma seemed to enjoy when they arrived at the newly-refurbished electrical engineering labs for fall quarter.

With support from donors — which also funded air conditioning in the labs — Derickson decided to make the change.

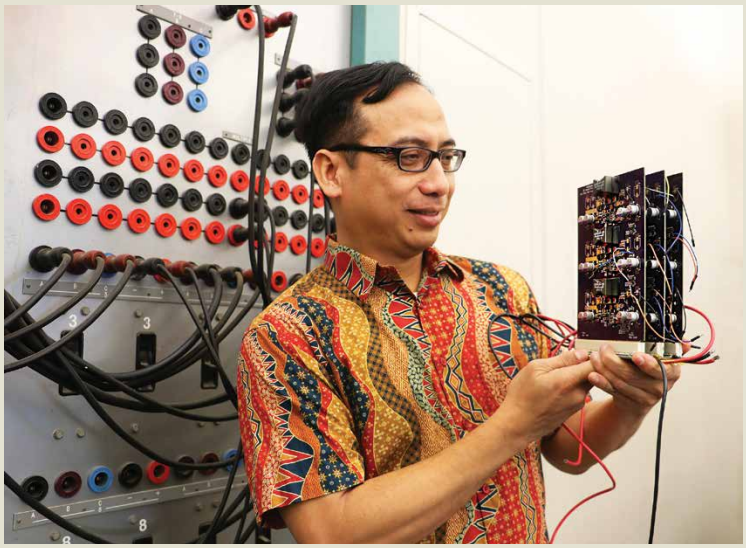
"We naturally had to make many test leads," Carmo said.

Which is where Levin came in.

"This will make the students' who work at the checkout desks lives easier and cut down on line times, so students won't be late to their labs," Levin said. "It also helps the students who need to use equipment when the checkout desk isn't open."

The checkout window remains, but now students working there can concentrate on special needs and technician-assigned projects.

"This is a good example of how donor money is being used to help students," Derickson said. ■



LIGHT FOR THE DEVELOPING WORLD

PROFESSOR TAUFIK RECEIVES PATENT FOR DEVICE THAT COLLECTS, CONCENTRATES DC POWER FROM MULTIPLE SOURCES

Cal Poly electrical engineering professor Taufik holds a prototype of his patented Multiple Input Single Output DC converter that could help provide light to the more than 1.6 billion people living far off the grid.

A newly patented device from Taufik could provide light to the more than 1.6 billion people living far off the grid.

The "Multiple Input Single Output DC-DC Converter with Equal Load Sharing on Multiple Inputs" — or MISO — makes it possible to combine the input of multiple low-power electricity sources into one stronger output source. It was developed by the professor and former student Owen Jong, who earned an electrical engineering bachelor's degree in 2012.

"MISO allows any type of low-power energy device — solar, wind, water in a stream, even human-powered generators like a bicycle — to be connected to one house," Taufik said. "It's collecting multiple little sources of energy into one bigger source. In the developing world, a little electricity goes a long way. Just keeping a light on at night is huge."

The U.S. Patent and Trademark Office recently issued the patent for MISO. The device looks like a circuit board and is small enough to hold in one hand — yet its impact could be profound, the professor said. MISO's ability to work with direct current (DC) electricity is the key to making it more efficient. Power converters will be needed, because the grid uses alternating current (AC) while renewable power sources, such as solar panels and small-scale wind turbines, produce DC power.

"Converters add to the expense and are less efficient by 15 to 35 percent depending on the load," said Taufik, who runs the DC House project on campus, which seeks to create a house in which electricity is provided by direct current, rather than the traditionally used AC power. "It makes no sense for people in rural areas that live off the grid to convert DC to AC. It's much more efficient to stay with DC power."

"It's collecting multiple little sources of energy into one bigger source. In the developing world, a little electricity goes a long way. Just keeping a light on at night is huge."

Taufik, who previously received a patent for a "Multiphase DC-DC Converter for Voltage Regulator Module" to supply power to microprocessors, worked with Cal Poly's Office of Research and Economic Development to secure the MISO patent.

"The research to get MISO started actually began in 2010, because it's a critical component in the DC House project, and the patent process took almost three years," he said. "Different ideas for MISO converters were attempted and improvements were continuously sought after until we believe we found the best — and unique — solution."

The device would come in different sizes, each small enough to hold in one hand. Prototypes for the device cost between $50 and $80, though Taufik notes that prototypes are usually more expensive than mass-produced products.

Taufik shared the credit for the invention.

"The work toward this patent would never have been accomplished without the help of many of my former students who took on the challenges in the MISO converter project, and in the overall DC House project," he said. "I truly owe this patent to these hard working and bright students."

Having been born and raised in Indonesia, where he frequently returns, Taufik sees a worldwide market for MISO.

"Hopefully, we can market this to companies that deal with electrification in developing countries or even rural areas of the U.S. where people want to live off the grid," said Taufik, who has taught at Cal Poly since 1999. "We've had a lot of interest in it because, right now, the world is beginning to learn that residential DC power is more efficient — and cheaper." ■

ENGINEERING WELLNESS

NEW GRANT FROM THE NSF WILL HELP ASSESS AND IMPROVE CENG STUDENT WELLNESS

For engineering students, all-nighters and long hours in labs are sometimes seen as a badge of honor, said Andrew Danowitz, an assistant professor in the electrical engineering department.

But that drive to succeed is one of the many factors that can impact mental wellness.

"As an undergraduate and graduate student, I viewed academic success as a key part of my identity," he said. "And I witnessed many people — peers and myself — burn out trying to achieve academic perfection."

The National Science Foundation (NSF) recently funded Danowitz's proposal to study mental wellness in engineering — a project that Danowitz expects to lead to wellness action plan.

"We have funding for at least three years," Danowitz said, "and we expect to collect a wealth of data over that period."

While Cal Poly has collected data on student wellness, Danowitz was particularly interested in engineering students. So he collaborated with Kacey Beddoes, project director for San Jose State's Research Foundation and College of Engineering Dean's Office. Along with Geneva Reynaga-Abiko, director of counseling services at Cal Poly's Student Affairs, the trio will conduct research on engineering student wellness with surveys and in-person interviews over the next three years. Students are expected to assist with data collection, data analysis and publishing.

Andrew Danowitz

"As an undergraduate and graduate student, I viewed academic success as a key part of my identity. And I witnessed many people — peers and myself — burn out trying to achieve academic perfection."

The study will follow the same group of participants over that 3-year span, which will be incorporated with information gleaned from 10 partner institutions to see whether mental wellness significantly changes as students progress through their engineering programs. The researchers will also look to see whether mental wellness indicators, if any, are most closely tied to student retention and success.

Both Danowitz and Beddoes were awarded with separate budgets of $174,000 for the collaboration.

"Based on our findings, we plan to develop recommendations for university faculty, students and administrators to maximize mental wellness and student success for engineering students," Danowitz said. "We also plan to work our findings into a model of student retention in an effort to help guide future studies in the area of engineering education." ■

2019 HOOD ENDOWED PROFESSORS SELECTED

PRODANOV, TAUFIK ARE THE CHOICE OF THE ELECTRICAL ENGINEERING ADVISORY BOARD

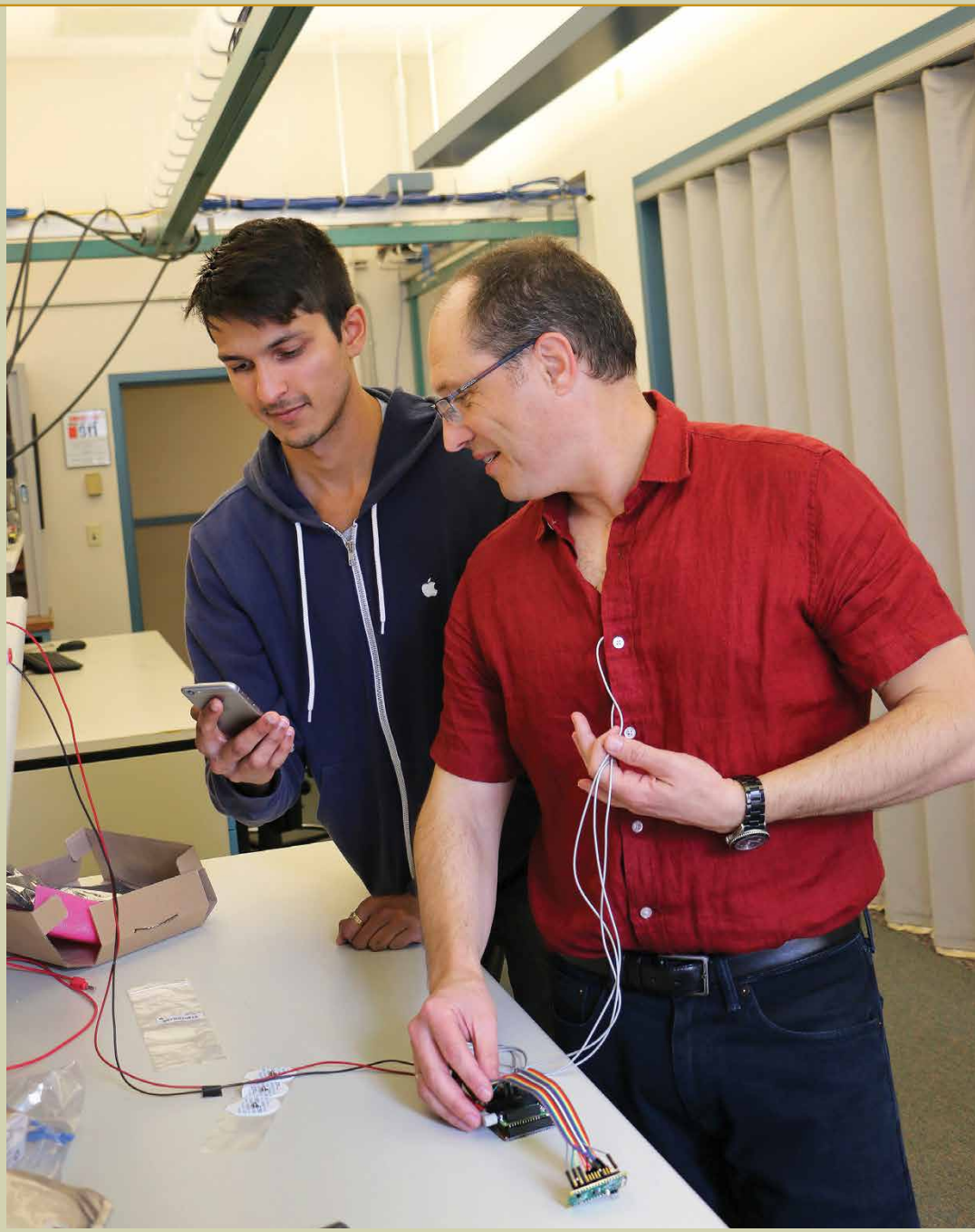
Vladimir Prodanov was named a Hood Endowed Professor for 2019, along with Taufik, who received the endowment for a second consecutive year.

The Richard and Julie Hood Electrical Engineering Endowment was established to promote professional development. The Electrical Engineering Industry Advisory Board chooses recipients based on impacts applicants have as educators, initiatives, leadership, opportunities for student projects and more.

Taufik joined the Cal Poly faculty in 1999 and was recently awarded a patent for a device that could provide power to people living far off the grid.

Prodanov, who joined the Cal Poly faculty in 2009, worked with Maxim Integrated to launch an Internet of Things course.

Richard Hood, a 1973 electrical engineering graduate, founded Maxim Integrated in 1983. ■



Professors Vladimir Prodanov, above right, working with electrical engineering student Vikrant Marathe in his Internet of Things class, and Taufik, at left, were named the Hood Endowed Professors for 2019.

RETIREMENT

Art MacCarley

Every now and then students in Art MacCarley's classes will offer an appreciative round of applause after his final lecture of the quarter.

That's one of the things he fondly looks back on now that he's retiring.

A year after earning his doctorate from Purdue University, MacCarley landed his teaching position at Cal Poly in 1988. Among his many honors, he received both the Litton Research Award and the Northrup-Grumman Teaching and Research Award the same year. And his Electrical Vehicle Engineering Club took 4th (1997) and 2nd place (1998) in the EVTC Electric Car Races, beating more than 30 professional teams with multi-million-dollar budgets and professional drivers.

The former department chair has been an advisor to more than 250 senior projects through the years. He will continue to teach part-time through the Faculty Early Retirement Program at Cal Poly and summers at Munich University of Applied Science while working on some projects:

"My alternative fuel cars, solar systems, two textbooks, and renewing long-lost friendships," he said. "And I'm fortunate to have expert witness cases in automotive electronics that are very satisfying." ■

Professor Art MacCarley's work with the Electrical Vehicle Engineering Club had an impressive track record of success.

Electrical engineering students Jesus Morales and Agustin Poca enjoy the shade in the new EE Courtyard. The courtyard is located near the DC House and the Cal Poly Amateur Radio Club (CPARC) office in Building 20.

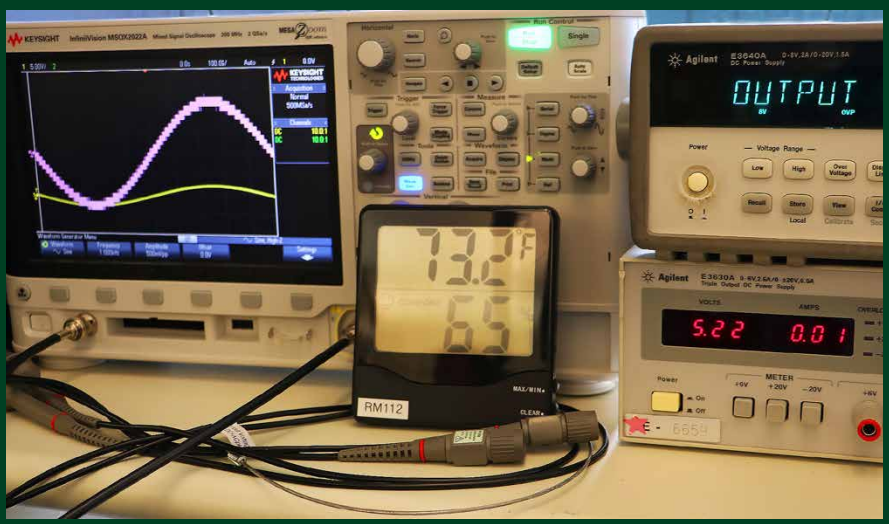
EE COURTYARD

We love our "Big E" electrical engineering building that was first operational in 1958. We have 3,5000 square feet of lab space for our students, which is unprecedented in the world of undergraduate EE education. It is very important for the Electrical Engineering Department to have spaces for our students to work on projects, gather together as students or to meet as clubs.

With that in mind, the department just finished a large EE courtyard construction project in one of the eyes of our Big E building last May. This 2,700-square-foot courtyard area is a place for students and clubs to gather in a shaded outdoor setting with tables, chairs, power and WiFi. This entire project was made possible by alumni donations from the College of Engineering and the Electrical Engineering Department. When you come for a visit, reach out to the department for a great conversation in the EE courtyard.

— Dennis Derickson, EE Chair

WATER-COOLED LABS



Thanks to financial donations from alumni and friends of the Electrical Engineering Department, a cold water temperature regulation system is now operating in six EE labs in Building 20 that were infamous for overheating on hot days during fall and spring quarters.

EE Chair Dennis Derickson, who calls the results so far "wonderful," said this marks the halfway point in a project that actually began in the 1990s. "We hope to complete the connections in the cold water plumbing in six more labs," he said. "It really makes for a better learning environment."

Above and left: Electrical Engineering Chair Dennis Derickson points out some of the cold water pipes that are now lowering the temperature of six EE labs into the 70s (73.2 on this hot September day).

CAL POLY
Electrical Engineering
COLLEGE OF ENGINEERING

College of Engineering
Electrical Engineering Department
1 Grand Avenue
San Luis Obispo, CA 93407

EE'S BAY AREA BOWLERS

The EE and CPE Bay Area Alumni group decided to so something a little different this year for our annual get together: We reserved lanes at the "Bowl Mor" bowling alley in Cupertino, California.

Our Apple alumni found this to be very convenient since it was right down the street from work. We had 35 bowlers in attendance with scores ranging from 35 to nearly 200.

Alumni in attendance ranged from just graduated to folks who have already retired.

A fun time was had by all, and planning is in place to have our follow on event in 2020. Please join us. Send a note to Lani Woods at llwoods@calpoly.edu to make sure we don't miss you at our next gathering.

POWER THE FUTURE

MAKE A GIFT TO SUPPORT ELECTRICAL ENGINEERING LABS, PROJECTS AND CLUBS

Click HERE to make a gift now, or contact Amy Blosser Spikes, assistant dean of advancement, at spikes@calpoly.edu or (805) 756-2163