



CU ENGINEERING

FALL 2019

WE HAVE LIFTOFF

IDEA GENERATOR

CU Engineering
has gone all-in on
entrepreneurship

PAYDAY PIONEER

Alumnus' platform
aims to help those living
paycheck-to-paycheck

Education and innovation take
flight at new aerospace building



University of Colorado **Boulder**



First-year students attend the 2019 Engineering Launch in August.



Meet CU Engineering's Class of 2023!

Students enrolled 947	Female students 45%	Underrepresented students 25%	First-generation students 20%
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Census numbers for the fall 2019 first-year class.

MESSAGE FROM THE DEAN



@DeanBobbyBraun

Dear CU Engineering Community:

When Karen and I moved to Boulder three years ago, a lot of folks told us that the College of Engineering and Applied Science was among the best-kept secrets in the nation. It didn't take me long to verify the veracity of this statement and the caliber of the college. Now, it's clear the word is getting out.

We continue to rise in *U.S. News & World Report* rankings, with three of our graduate programs in the top 10 and seven in the top 20. Five of our undergraduate programs are among the top 20 nationally. In three years, four of our faculty have been elected to the National Academies, joining nine other active faculty with this distinction. Overall, the college has risen to the No. 16 spot among public universities.

Telling our story is a determinant factor in our growing reputation. The importance of enhanced communications was evident as a driver across each pillar in our strategic vision. To become our best, we knew we needed to engage all sectors of our community.

To that end, we ramped up our communications efforts, reaching out to alumni, supporters, industry partners, parents, students, faculty and staff. We've engaged nationally with research sponsors from Washington, D.C., to Silicon Valley. We launched an annual state tour to connect the people of Colorado with the college, and strengthened partnerships with universities across our state so that more Coloradans could have access to a quality engineering degree.

Following through on our vision, we're beginning to look like our state. The 2019 first-year class includes 45 percent women and 25 percent underrepresented

minorities. Twenty percent of this class is first-generation college students. This is the most scholastically talented and most diverse class our college has admitted to date.

By establishing regional alumni networks in Denver, Houston, San Francisco, Seattle and Southern California, we are reaching out to our alumni in new ways and developing opportunities for our alumni to get involved with the college. A simple way to stay connected is through this magazine, which we now publish twice a year, in the fall and spring. There are so many good news items to share, we couldn't wait a year to tell you about them.

You are an essential element in our continued success. As an ambassador for our college, you have the opportunity to spread the word about the people, partnerships and research that make up CU Engineering. Find a story in this issue that interests you, and make a point to share that with someone else.

I have greatly enjoyed getting to know so many of our outstanding alumni, industry partners, faculty, staff and students. It has been an honor to work with you in setting a new course for the college's future and in weaving that course into the campus strategic plan. Together, we have made great strides in improving the economic competitiveness and security of our state and nation and the quality of life for all Coloradans. While I am returning to the aerospace sector in 2020, I look forward to watching the college continue along this trajectory for years to come.

All the best,

Dean Robert D. Braun

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Startup Success

A new minor and dedicated entrepreneurship space are just two of the ways we're supporting dreamers and doers.

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Liftoff

New aerospace building is already having an impact on students and researchers.

 /cuengineering

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@DeanBobbyBraun

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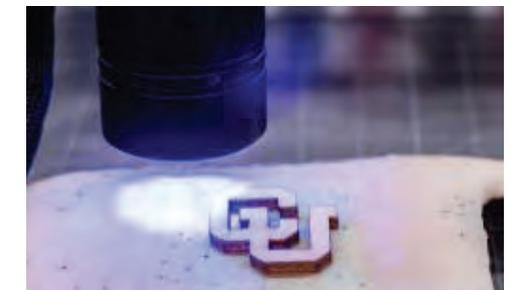
Leading Edge

Check out brief updates on some new CU Engineering research advances.



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CUENGINEERING ONLINE

 colorado.edu/cuengineering/fall2019



PayActiv CEO Safwan Shah (MSEIEngr'90,
PhDAeroEngr'94), Page 30



Snowy Spring Graduation

Nothing says "Colorado" quite like a snowstorm during spring graduation! It may have been unseasonably chilly in Boulder, but it didn't deter the more than 900 undergraduates and 450 graduate students who celebrated their commencement on May 9.

[flickr.com/cuengineering](https://www.flickr.com/photos/cuengineering/)



Dean Bobby Braun (left) hosts Kristina Johnson at the College of Engineering and Applied Science Dean's Speaker Series.

Johnson returns to her roots

FOR THE SECOND INSTALLMENT OF THE DEAN'S SPEAKER SERIES, Bobby Braun sat down for a chat with Kristina Johnson, chancellor of the largest university system in the nation (State University of New York) and a former Obama appointee in the U.S. Department of Energy. The two discussed her experiences as an entrepreneur, her leadership philosophy and much more before an engaged crowd of students, faculty and alumni on May 1.

Johnson, who is a former faculty member in the Department of Electrical, Computer and Energy Engineering at CU Boulder, also took time to visit her old stomping

grounds during a meet-and-greet with the Women in ECEE student group, in addition to sharing her experiences with students during lunch in the BOLD Center.

During her chat with Braun, she looked back on some of her accomplishments at CU Boulder, including co-founding the Optoelectronics Computing Systems Center in the late 1980s. She said she still remembers how it felt to be well-established as a researcher for the first time.

"Today I was asked by a faculty member, 'What was the best part of your career?'"



“ Keeping your eye on becoming an engineer and facing that initial barrier and being resilient and persistent – after that, you can do anything. ”

she said. "And I have to say, it was 1993–95, after we got the labs up and running, and we had graduate students. I got tenure, and I just really embraced it and ran with it."

During the Q&A portion of the evening, an undergraduate student asked Johnson how she remains so versatile as an entrepreneur, educator and leader. She credited her engineering education.

"Engineering is hard – at least I found it hard," Johnson said. "So keeping your eye on becoming an engineer and facing that initial barrier and being resilient and persistent – after that, you can do anything."

VIDEO: KRISTINA JOHNSON
colorado.edu/engineering/kristina-johnson



Lobby named in recognition of couple's scholarship gifts

The Engineering Center holds fond memories for CU Boulder alumni Ashok Srivastava and Lynn Waelde. The couple met while working on their PhDs and spent hours writing their dissertations together over coffee in the lobby. So it's fitting that, in recognition of the couple's recent gift to the College of Engineering and Applied Science, the lobby was designated the Srivastava-Waelde Engineering Lobby on April 25.

The gift from Srivastava (EEngr'91, M'93, PhD'96) and Waelde (MPsych'91, PhD'95) will support scholarships for students in aerospace, electrical and mechanical engineering or computer science who are involved in organizations promoting a diverse student body. Waelde is a professor at Palo Alto University and an adjunct clinical professor at Stanford University School of Medicine. Srivastava is a senior vice president and chief data officer at Intuit, where he is responsible for leading efforts in large-scale machine learning and AI across the enterprise.



Student team takes cybersecurity concept to national pitch competition

CU Boulder was among only six universities invited to present an innovative network security concept in June as part of Starts H4D, a pitch competition for cutting-edge national security solutions.

The group presented at Founders Fund, a leading venture capital firm in San Francisco, alongside teams from Stanford, the University of Southern California and Duke on projects including image recognition of drones, GPS jammer detection, innovative learning platforms and IoT security.

The CU Boulder team included computer science graduate student Trevor Stanley, Leeds School of Business student Chris Coffey, applied mathematics master's student Will Shand, Technology, Cybersecurity and Policy program master's student Cory Cranford, and mechanical engineering master's student Gerano Montoya.

Their team, CharIoT (Characterizing the Internet of Things), developed a new machine learning approach for identifying different kinds of internet-enabled devices on a network.



New space for entrepreneurial collaborations is underway

Business and engineering leadership, students and friends celebrated the official groundbreaking on June 5 of a \$45 million addition that will physically connect the two CU Boulder academic and research powerhouses.

In 2020, the Koelbel Building, which houses the Leeds School of Business, will be physically connected to the Engineering Center. The 45,000-square-foot addition will feature a 200-seat auditorium and an innovation and entrepreneurship hub, where students from any discipline can collaborate with faculty and local business leaders to explore new ideas.

Engineering Dean Bobby Braun said a permanent hub to support entrepreneurial collaborations will help create the jobs of the future.

“Our students need more than technical knowledge to impact today’s increasingly complex society.”

“Our students need more than technical knowledge to impact today’s increasingly complex society,” Braun said. “Our recent growth in entrepreneurial activities, built upon expanding partnerships across campus and the state,

demonstrates the value of well-rounded students with critical thinking skills and hands-on expertise.”

MORE ABOUT THE PARTNERSHIP

colorado.edu/business/business-engineering-expansion

Regents approve new biomedical engineering degrees

Good news for students looking to pursue careers in the biomedical industry: New undergraduate and graduate degrees in biomedical engineering could launch as early as fall 2020.

The CU Board of Regents approved the new degrees in the College of Engineering and Applied Science in June. Through these bachelor's, master's and doctoral degrees, students will have the chance

to pursue classes from across the university, across engineering, and in biology and mathematics. The goal, organizers say, is to tap into a medical world that increasingly gears treatments to individuals and depends on rapidly evolving technologies.

The degrees are the first of their kind in the CU system, and no other university in the state offers a stand-alone undergraduate degree in biomedical engineering.



Herbst celebrates 30th anniversary with new name

Thirty years ago, a gift from Clancy and Linda (Vitti) Herbst created the Herbst Program of Humanities in Engineering. Since then, the program has been committed to helping students develop a personal sense of responsibility as the basis for lifelong private and professional integrity.

After deliberations among the Herbst faculty and stakeholders, the program has decided to update its name to better reflect its scope and mission. The program will now be known as the Herbst Program for Engineering, Ethics and Society.

Herbst courses challenge students to apply intellectual rigor to the ethical and social complexities of being engineers. In the past, the program was known by the humanities, whose rich and varied works have helped



Herbst House

students explore these complexities. The new program name reflects those complexities themselves: the nexus of engineering, ethics and society.

Ball Corp. gift will support scholarships, new aerospace building

Two recent gifts from Ball Corp. and its foundation will support the new Aerospace Engineering Sciences Building and scholarships for diverse students through the BOLD Center.

“Ball Corporation is a leader in so many ways in our community, and we’re thankful for their partnership in developing the workforce of the future,” Dean Bobby Braun said. “Ball embodies the term ‘good corporate citizen.’ In addition to its generous financial support, the company’s leadership and employees are committed to volunteering, and advising our students and faculty.”

CU partners with Ball in many ways across the campus,

including with senior engineering design. The company also has a strong recruiting and professional development presence on campus, including career and internship fairs, networking events, activities during National Engineers Week and a mentoring program through the BOLD Center.

“We are pleased to support a strengthening and expansion of aerospace engineering sciences and look forward to the impact it will make for the students, faculty and the pipeline of talent for industry,” said John Hayes, Ball chairman, president and CEO. “We are committed to working with CU to develop this talent through our scholarship support and mentoring of students by Ball employees.”



An aerospace student works in the PILOT lab in the new Aerospace Engineering Sciences Building on East Campus.



NASA Administrator Jim Bridenstine visits new Aerospace Engineering Sciences Building



NASA Administrator Jim Bridenstine visited CU Boulder in August to tour the new Aerospace Engineering Sciences Building and LASP, and to hold meetings with university leadership, local industry and government representatives. He also hosted a Q&A session with CU Engineering students in the aerospace building.

VIDEO: JIM BRIDENSTINE Q&A
colorado.edu/engineering/bridenstine

STARTUP SUCCESS

By Kellen Short

COLLEGE GOES ALL-IN ON ENTREPRENEURSHIP

AN ENTREPRENEUR'S JOURNEY MIGHT NEVER BE PAINLESS. But CU Engineering is going all in to ensure that its graduates are ready to tackle the challenges of launching and scaling a startup.

Since naming entrepreneurship a priority in its Strategic Vision and hiring its first entrepreneurship director in 2018, the college has redoubled its efforts to keep innovation and entrepreneurship top of mind for students and faculty.

With a new entrepreneurship minor and expanded course offerings, increasing ties to campus accelerator programs, and dedicated spaces for dreamers and doers, we are weaving entrepreneurial skills into the fabric of the CU Engineering student experience from the time they set foot on campus. At the same time, homegrown startups are enjoying a banner year.

“We’ve been blown away by the ambition and progress of our CU Engineering student and faculty ventures,” said Kyle Judah, director of entrepreneurship. “And there’s still overwhelming demand and interest in more entrepreneurship programs and resources. So we’re rapidly creating resources in and out of the classroom to support founders at every step of the journey.”

Entrepreneurship minor launches

We launched a 15-credit entrepreneurship



minor this fall to better equip students curious about starting their own venture.

With core courses in Entrepreneurial Product Design and Tech Ventures & Marketing, plus entrepreneurial capstone courses and a growing list of electives, students can immerse themselves in the ecosystem without losing progress toward graduation. They can explore topics that capture their interests, including blockchain, civic innovation, sustainability and big data.

The minor is available to students in any engineering department or the Bachelor of Arts in Computer Science major offered through the College of Arts and Sciences. And the individual courses are open to students from any major, allowing collaborations that mimic the real world.





Engineers win NVC

Now in its 11th year, CU Boulder's New Venture Challenge trains participants to develop a business venture from scratch, connect with customers, create a product and craft a compelling pitch for investors.

For the first time this spring, NVC offered a hardware track, sponsored by CU Engineering, to specifically support teams focused on creating physical products.

The winning group, Stride Tech, created a device that attaches to seniors' walkers to track gait problems before they result in dangerous falls. They emerged from the new hardware track to win the grand prize: \$100,000 to move from idea toward reality.

The team, which formed out of the mechanical engineering senior entrepreneurial capstone course and the Design for America student group, included Engineering Plus students Tim Visos-Ely, Max Watrous and Humsini Acharya, and mechanical engineering student Andrew Plum.

Catalyze CU accelerator expands

Engineers turned out in droves for the Catalyze CU startup accelerator, which expanded from 10 to 12 weeks in 2019 and included skill-building workshops, mentoring sessions with local entrepreneurs and up to \$5,000 in equity-free financing for each team.

For the second consecutive year, at least half of the full-time participants were women. Each student founder also received \$3,000—provided by CU Engineering and the Caruso Foundation, led by philanthropists Dan and Cindy Caruso of Zayo Group—to cover summer living expenses so they could concentrate on establishing their ventures.

Bigger spaces for bigger dreams

The addition that will connect the Leeds School of Business and the Engineering Center will include entrepreneurship space. But while it's under construction, the college also established a "pop-up" entrepreneurial space in the recently vacated aerospace wing to support student founders.

"We didn't want to wait until the connector's done to start supporting our student entrepreneurs," Judah said. "We want to build that energy, that density of entrepreneurial talent, so when the new E-Ship space opens in 2020, we'll have momentum in our favor."



Get involved!

Contact Kyle Judah at kyle.judah@colorado.edu or [@KyleJudah](https://twitter.com/KyleJudah) on Twitter.



ENGINEERING STARTUPS IN THE NEWS

Emergy Foods

In July, the innovative food company, focused on sustainable, plant-based protein, announced \$4.8 million in venture funding and another \$1.3 million in grants from the National Science Foundation and others. The startup, founded by CEO **Tyler Huggins (PhDCivEngr'16)** and CTO **Justin Whiteley (PhDMechEngr'16)**, has established a new headquarters and an expanded production facility in Boulder.

Pana

Pana aims to make corporate travel seamless through a combination of smart technology and real humans. **Devon Tivona (CompSci'14)** announced in May that the company earned more than \$10 million in venture funding

to scale up the chat-based travel concierge service. Pana originated at CU Boulder in 2014, when Tivona and his team competed as Varsity, a higher-education social network, in CU Boulder's New Venture Challenge and tied for first place. After further vetting from startup mentors and going through Boulder's Techstars accelerator, Varsity was scrapped in favor of Native, a travel-assistant app designed to take the hassle out of trip planning. It rebranded to Pana in 2015.

Halp

Formerly called BubbleIQ, the startup announced \$2.6 million in seed funding in April 2019 under the leadership of cofounder **Fletcher Richman (EICompEngr'14)**. The software integrates IT help



Fletcher Richman, Halp



Stateless



Devon Tivona, Pana



Solid Power

tickets with messaging systems like Slack and zendesk to modernize workplace customer support and move away from typical email-based help desks. While a student, Richman participated in New Venture Challenge and Catalyze CU, and helped create Spark Boulder, the state's first student incubator and coworking space, before joining CU Boulder's TechStars accelerator.

Stateless

Building on Boulder's excellence in networking technology, Stateless aims to reinvent network connectivity to provide greater security, visibility and control. In February, the company announced \$11.33 million

in funding to expand its operation. Founded in 2016 by **Murad Kablan (PhDCompSci'17)** and Associate Professor Eric Keller, the startup also participated in Catalyze CU and the New Venture Challenge.

Drovr

Drovr created the first smart electric fence that can be controlled via cell phone, aiming to prevent livestock overgrazing and associated climate change. In June, cofounder **Zoe Welz (EngrPlus'18)** was selected from more than 4,000 applicants to pitch at the GIST Catalyst competition at the Global Entrepreneurship Summit in the Netherlands. Sharing the stage with Ivanka Trump, U.S. CTO Megan

Smith and Prince Constantijn of the Netherlands, Welz won in the food and agriculture category.

Solid Power

Solid Power aims to create safe, energy-dense, all-solid-state batteries using lithium metal anodes that will revolutionize transportation, industry, aerospace and defense. The spinoff was founded in 2012 by mechanical engineering professors Se-Hee Lee and Conrad Stoldt, who developed the underlying technology in campus research labs. In May, Ford Motor Co. became the latest to invest in the Louisville-based company, following Samsung Venture, Hyundai, BMW Group and more.



Leading With Impact

By Josh Rhoten

Panelists Dan Massey (from left), Bobbie Bastian and Nolen Scaife

Alumni event puts spotlight on cybersecurity

THE COLLEGE HELD ITS FIRST LEADING WITH IMPACT alumni speaker series events this spring in California's Bay Area, focusing on a hot topic: cybersecurity.

"There is a lot of energy in that field here at the college right now because of the newly reorganized and named Technology, Cybersecurity and Policy program," said Kevin Lobdell, the college's director of alumni engagement. "This event tapped into that, showing the interdisciplinary nature of the work and showcasing how the college is leading in many ways."

Lobdell's team organized the event, which brought together alumni, faculty, staff and friends over the course of two evenings in Palo Alto and San Francisco in June. While there were built-in networking opportunities, the event featured a panel discussion on how CU Boulder researchers are anticipating and preventing cybersecurity risks, and how the TCP program is addressing a shortage in the cybersecurity workforce.

Panel speakers included TCP Program Director Dan Massey, incoming computer science Associate Professor Nolen Scaife, and Colorado Computer Science Teachers Association President Bobbie Bastian.

Manasa Suresh, a 2019 graduate of the TCP program, said she really enjoyed the event.

"It was a great opportunity to meet folks who are experts in the field of networking and security," she said.

Lobdell said the college will host other Leading With Impact events with different themes in the coming year. While locations are still being confirmed, one likely location is Denver.

"There are lots of alumni watch parties for games, but this is an educational way to complement and share the impact the college is having in the world right now and build connections between alumni," he said.



Drovr



BUILDING BETTER SPACE SITUATIONAL AWARENESS

Marcus Holzinger is investigating ways to track objects in orbit, and his team is taking full advantage of the new aerospace engineering sciences building to do it.

“This building is world class, and I was hired before the blueprints were finalized, so they were able to add something—pouring an extra thick concrete pad on the roof in one area to add an 18-foot dome for telescopes,” Holzinger said.

Holzinger, an associate professor and Smead faculty fellow, researches space situational awareness (SSA), which involves monitoring satellites and debris orbiting the Earth.

It’s a field that got a boost in public awareness from the film *Gravity*, in which debris from a destroyed satellite sets off a chain reaction of crashes and failures.

While *Gravity* was fiction, the principle behind it is not. The risk of a cascade failure in orbit has been a concern of space scientists since the late '70s.

Today, the Air Force and NASA maintain tracking networks, keeping tabs on everything in orbit larger than a grapefruit. Holzinger’s work is about improving those tracking systems and designing systems so satellites can avoid obstacles autonomously.

The dome Holzinger was able to place on the roof houses three robotic telescopes that focus on nearby space-based objects.

Drones lift a ‘Cut Before Flight’ ribbon to Ann Smead (left) and Brian Argrow at the Aerospace Engineering Sciences Building grand opening ceremony on August 26, 2019.

Liftoff

AEROSPACE HAS A NEW HOME AT CU BOULDER

By Jeff Zehnder

The Ann and H.J. Smead Department of Aerospace Engineering Sciences has moved into its new dedicated building on East Campus.

Eighteen months after construction began, the four-story, 175,000-square-foot structure was completed over the summer. Classes and research are underway inside.

“This new building celebrates a bright and vibrant future in aerospace for the university, our students, the state of Colorado and our nation,” said Bobby Braun, dean of the College of Engineering and Applied Science.

Discussions with faculty and students influenced the design of the facility. It will allow for expanded course

offerings, facilitate new research collaborations and cement CU Boulder as the hub of Colorado’s aerospace industry, which is ranked first in the United States in private employment concentration.

“This building allows us to bring together all of our aerospace research enterprises and teaching enterprises in one beautiful location that we can showcase to the world,” said Brian Argrow, chair of Smead Aerospace. “Colorado is a leader in this field, and having a facility like this demonstrates our generational commitment.”





Engraved pavers at the northeast entrances of the aerospace building

DONATION WILL FURTHER FUEL AEROSPACE INITIATIVES

An anonymous alumnus is providing \$1 million to endow two funds for project-based learning: The K.D. Wood Student Scholar Fund and the K.D. Wood Projects Scholar Award.

Karl Dawson “K.D.” Wood was a pioneer in plane and spacecraft design who founded the aeronautical engineering department at CU Boulder in 1946 and served as the department’s first chair.

As a professor, he emphasized project-based learning, which had a lifelong impact on the donor, said Erin Gage, director of development in the Office of Advancement.



Karl Dawson “K.D.” Wood
Credit: Carnegie Library for Local History/Boulder Daily Camera Collection

“This alumnus thrived in that environment, and it’s what he’s done in his career. As a donor, his intention from the beginning was to honor Professor Wood,” Gage said.

Wood died in 1995 at age 96. His son, Bob, an aerospace engineer who graduated from CU Boulder, said the gift is a fitting honor.

“My father always stressed the importance of doing things hands-on. That’s how he learned while working for the airplane companies, and so he taught the same way to students,” Wood said.

K.D. Wood officially retired from CU Boulder in 1967, but remained an active instructor in the department, continuing to teach into his 80s.

The Student Scholar Fund will support scholarships for graduate students interested in industry careers. The Projects Scholar Award will be used to recruit additional industry professionals to serve on the faculty.

AEROSPACE WALK OF FAME

A special outdoor feature at the new building was created to illustrate the state’s bright and active aerospace industry in a concrete way—literally.

The brick walkway leading to the northeast entrance of the building has engraved pavers with the names of every aerospace company that has operations in or calls Colorado home.

“There are 462 companies named,” said Doug Smith, associate dean for programs and engagement. “We did fairly serious research internally and with the Colorado Space Coalition to make the list. We wanted to include everyone.”

Colorado has the second-largest aerospace economy in the country, employing more than 190,000 people in space-related jobs.

IN THE YEAR 2071

A time capsule containing aerospace artifacts is buried in front of the new aerospace building. The capsule will stay buried until September 2071 on the 125th anniversary of the founding of the aerospace department.

CU BUFFS BASEBALL HAT

Flew on a space shuttle mission with a certificate of authenticity

ALTIMETER BOARD

Used for ASEN 2004 Vehicle Design and Performance lab, where students used engineering knowledge to design and build an optimized water bottle rocket. An award was given to the group that had the most accurate MATLAB predictions for its rocket’s performance. Student workers designed and built these boards completely in-house.

“THE SILVER BULLET”

This water bottle rocket was named for its paint job and spin stabilization. It was designed by students attending a summer high school outreach program. The students successfully angled the fins so the bottle would spin during flight.



TEXTBOOK

Introductions to Flight is the cornerstone of our ASEN 2002 and 2004 courses

ROLLING SPIDER QUADCOPTER

Used for ASEN 3128 (Aircraft Dynamics). This class taught students the mathematics behind aircraft controls. The rolling spiders were used to demonstrate concepts including proportional derivative (PD) controllers and flight stability. Students would design their own PD gains and implement them on the rolling spider.

GYRO

This physical rate gyro was created for the lab to the course ASEN 3200: Orbital Mechanics, Attitude Dynamics and Control. This box was created with a motor, springs, 3D-printed housing, and a battery box. (It takes two AA batteries ... if those still exist in 2071.)

TEST SPECIMEN

Aluminum slotted tube used for ASEN 3112: Structures class to conduct a torsional test in which test specimens were placed into an Instron torsion machine. Then the torsional extensometer was placed onto the specimen to test open- and closed-wall theory of structural analysis.

PROJECT TORUS

By Josh Rhoten



Drones get inside look at supercell storms

Researchers from CU Boulder flew drones into severe storms this spring for project TORUS, one of the largest and most ambitious drone-based investigations of meteorological phenomena ever, with students leading much of the work.

Project TORUS—or Targeted Observation by Radars and UAS of Supercells—is a partnership between CU Boulder, the University of Nebraska-Lincoln (which is leading the work), Texas Tech University, the University of Oklahoma and the National Severe Storms Laboratory, and it will continue into 2020. The goal of the project is to collect

data to improve the conceptual model of supercell thunderstorms—the parent storms of the most destructive tornadoes – to help with future forecasting. Better forecasting means more warning time and fewer false alarms, potentially saving lives in the future, said Professor Eric Frew, who was a PI on the project.

“What was really exciting about what we were able to accomplish was that these drones were designed, fielded and operated by students,” Frew said. “I had sophomores and juniors on this team accomplishing something that had never been done before.”

CU’s portion of the project was led by faculty from the College of Engineering and Applied Science through the Integrated Remote and

In Situ Sensing initiative (IRISS). The team was responsible for piloting up to three drones simultaneously around the storms to measure temperature, pressure, humidity and wind speeds. Drones are a critical component of the overall TORUS project because they sense data from inside the storm, data that cannot be obtained without physically being there to take the measurements. In all, the CU team totaled over 40 hours of air time on 51 flights, including seven tornado-producing storms over the nearly monthlong deployment throughout the Great Plains.

The college has been using drones for this type of work since 2010 and was the first to do so in the world. The lessons learned over the years informed the design of the new unmanned aircraft used this spring. Built

from lightweight yet high-strength foam from RiteWing RC, the drones include an avionics system and many other aspects custom-built by the team. They are also modular in design, allowing for fast and easy repairs in the field.

Aerospace engineering senior Danny Liebert pilots one of the drones for the team and said he loves how rugged it is compared to the previous “TTwistor” model.

“The TTwistor drone we used was great but just not as durable. These new aircraft are awesome. They take it like a champ out there,” he said.

IRISS Engineering Manager Steve Borenstein said the opportunity for hands-on experience for students through the project is unrivaled.

“Our field campaigns challenge the entire team every day in terms of solving logistical problems and technical troubleshooting. Every student has a critical role in the preparations and mission deployments, including pilots, operators, and ground support,” he said. “Deployments are a tough three weeks, but the students leave with experience and memories that will last them forever.”



Podcast

Smead Aerospace Professor Eric Frew talks about drone-based storm research, airborne scientists and the movie *Twister*.

colorado.edu/engineering/torus19podcast



Leading Edge

With more than \$630 million in research funding on campus last year, our faculty are on the forefront of technological advancements with the potential to solve some of today's most pressing challenges. Here's a brief look at just a few of their projects.

Health monitoring in an 'earable' package

Tam Vu | Computer Science

Vu founded and directs the Mobile and Networked Systems lab, where his team is developing new wireless and mobile devices called earable computers. These small devices are worn on, in or near a user's ears and can be used for unobtrusive monitoring of health conditions, such as sleep quality, or for hands-free control of computers for people with disabilities. Most existing head-based sensing and stimulation methods are cumbersome, intrusive and expensive—suitable only for stationary and short-term use in clinics or hospitals. Placing these devices on the ear in a small package would make them significantly easier for users to fold into their daily lives. Vu recently received an NSF CAREER award to support this research, and preliminary work was supported by NSF and a Google Faculty Award.

Filters, cookstoves are making a difference

Evan Thomas | Civil, Environmental and Architectural Engineering

A recent study found that a large-scale program to deliver water filters and portable biomass-burning cookstoves to Rwandan homes reduced the prevalence of reported diarrhea and acute respiratory infection in children under 5 by 29% and 25%, respectively. The results suggest that similar programs can provide an interim solution for rural populations that lack access to safe drinking water and rely on traditional fires for cooking. "Until now, there has been limited evidence of the effects when these products are delivered at scale," said Thomas, a co-author on the study and director of the Mortenson Center for Global Engineering. "The study demonstrates the viability of bringing water filters and cookstoves to vulnerable households and will help inform future national initiatives."



Breaking the limits on superconductivity

Charles Musgrave | Chemical and Biological Engineering

Sean Shaheen | Electrical, Computer and Energy Engineering

Engineering faculty are beginning interdisciplinary research that could one day bring lossless power transmission lines, quantum computing and levitating trains closer to reality in everyday life. Those advancements can be achieved through superconductivity, which today is only possible through extremely cold temperatures and high pressures. Those aspects limit potential applications due to cost and logistics, but Musgrave and Shaheen—along with Daniel Dessau in physics—are working to develop organic, solid-state materials that exhibit superconductivity at conditions closer to room temperature and standard pressure. The research is being funded through a \$1 million grant from the W.M. Keck Foundation.

Using plants to study social networks

Orit Peleg | Computer Science

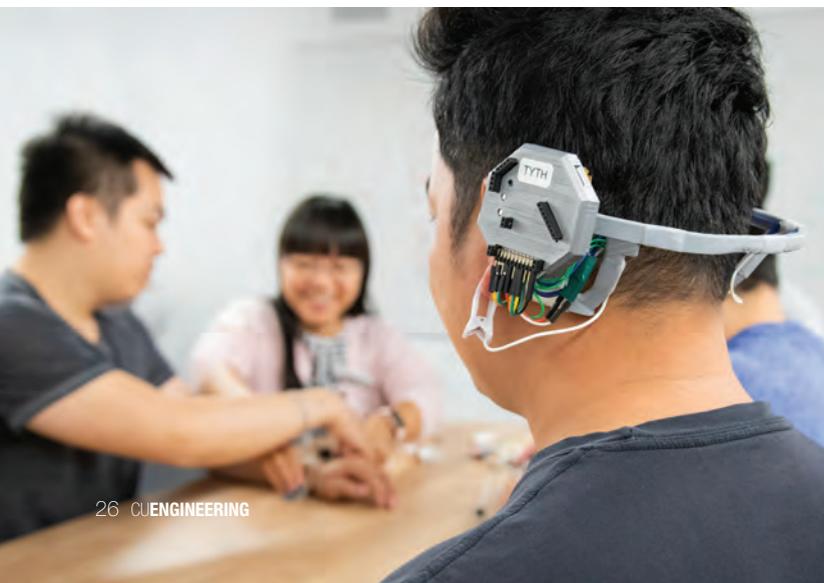
Humans interact in social networks every day around the office coffee pot or online with Facebook. The structure and connections within these networks shape how information is shared. That in turn defines much of our modern life and collective behavior, though little is known about how or why these processes work. That's because it's difficult to study how these systems, with so many inputs and variables, actually work. Peleg is leading an international team of researchers trying to untangle this question by studying social systems in sunflowers. That plant is ideally suited because it adjusts its flowers and leaves to earn maximum sun exposure, throwing shade on nearby plants, which also adjust — creating a network. Peleg's team is in charge of computer modeling for the project, which could also have agricultural implications related to maximizing planting space.



Wind turbines that mimic nature

Lucy Pao | Electrical, Computer and Energy Engineering

Pao is overseeing testing on a new "morphing," two-bladed wind turbine at the National Renewable Energy Lab. The new blades are much lighter and more flexible than traditional versions and bend like palm trees in the wind, making them ideal for offshore use. The rotors are also positioned downwind, meaning they bend away from the structure. This allows them to be built larger without risking damage should a strong wind push them into the tower. Finally, the two-blade design means less total material needed in construction.





Super 'FAST' response to disease outbreaks

Anushree Chatterjee | Chemical and Biological Engineering

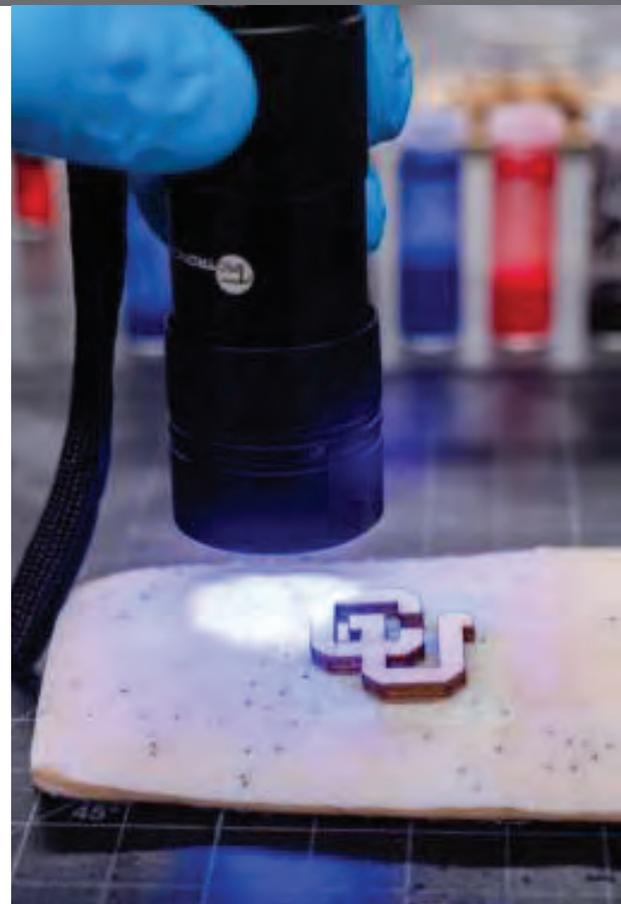
When outbreaks happen, response time is crucial. Unfortunately, developing custom therapies as countermeasures through traditional channels is often a slow and arduous process. But with Chatterjee's Facile Accelerated Specific Therapeutic (FAST) platform, the process of drug discovery to synthesis and creation of a

new therapy can be completed in less than a week. The platform can produce therapies for any system or disease—from highly adaptive microbial super bugs to radiation poisoning in astronauts—by targeting genes and gene expression.

Tattoos to prevent skin cancer

Carson Bruns | Mechanical Engineering, ATLAS

Bruns is developing tattoos that are both beautiful and functional. In his recent TEDxMileHigh talk, he said, "Tattoos will soon be able to give us information about what's going on inside our bodies." Bruns is experimenting with loading microcapsules with UV-sensitive, heat-sensitive and conductive dyes. With UV-sensitive dyes, he has been able to create and test what he refers to as "solar freckles," small tattooed spots that appear when exposed to the sun. He hopes they will help protect against the 5 million preventable cases of skin cancer in the U.S. each year. Beyond sun exposure, Bruns sees a future where tattoos measure body temperature, blood sugar levels and blood alcohol content; make skin less likely to wrinkle; and help the skin of burn victims protect internal organs from being more severely damaged.



Self-healing, fully recyclable e-skin

Jianliang Xiao | Mechanical Engineering

Xiao and Wei Zhang of chemistry are developing a new kind of material for electronic skins that may also have the ability to shapeshift. Their completely recyclable, self-healing and flexible e-skin has applications in human health, robotics, prosthetics and beyond. Xiao's focus has been on improving the e-skin's mechanical performance. He and his research group are developing an antenna that can change shape, enabling an autonomous change in characteristics. When exposed to a stimulus, the material transforms. When the stimulus is removed, the elasticity of the device leads it to morph back into its original shape. This technology may also be used as a way to monitor a person's vital signs, improve robotic interactions with human environments and increase capabilities for prosthetic devices.

The softer side of robotics

Christoph Keplinger | Mechanical Engineering

For many decades, people have dreamed of robotic solutions for a variety of tasks. While progress has been made in robot brains, their bodies have seen few advancements. Because they are typically made with rigid materials like metal and traditional rigid electric motors, robot capabilities are limited. The materials also make human interactions with robots less safe and make it difficult for robots to adapt to unpredictable challenges. "Soft robotics will enable a new generation of more lifelike prosthetics for people who have lost parts of their bodies," Keplinger said. "With soft robotics, we will also be able to enhance and restore agility and dexterity, and thereby help older people maintain autonomy longer." Drawing inspiration from soft and deformable materials found in nature, like muscle and skin, Keplinger is researching and building artificial muscles or soft actuators, which will advance what robots can do.



Mini-microscope for deep brain imaging

Juliet Gopinath | Electrical, Computer and Energy Engineering

Victor Bright | Mechanical Engineering

A team of researchers from the University of Colorado Boulder and University of Colorado Anschutz Medical Campus have demonstrated a microscope that fits on the head of a freely behaving mouse and can peer deeply inside the brain.

The microscope, known as the 2P-FCM, uses an electrowetting lens being developed by Bright and Gopinath. The scope is mounted on the head of a freely moving mouse, where a high-powered, fiber optic light can view and control neural activity as it happens. The lens is liquid and can change shape when electricity is applied. The device enables deep brain imaging and better understanding of animal behaviors, such as spatial navigation, sleep and social interactions.

Wage Warrior

By Kellen Short

Alumnus tackles financial inequality through mobile technology

For the roughly 100 million Americans living paycheck-to-paycheck, the financial services industry can be confusing, burdensome or downright exploitative. Late fees, overdraft penalties and predatory payday loans can turn a temporary setback into a crippling cycle of despair.

But what if you could access your own earned money before payday—seamlessly, confidentially and at little to no cost? That's the promise of PayActiv, a 5-year-old company led by founder and CEO Safwan Shah (MSEIEngr'90, PhD AeroEngr'94).

Shah said the venture was driven not by an entrepreneurial impulse but by the perennial calling of an engineer: to solve problems.

"Entrepreneurship was entirely accidental," Shah said. "An entrepreneur, to me, is a person who sees an unmet need. When you know that you have to solve this problem, you become an entrepreneur in that moment. When problem-solving is pursued with laser focus, entrepreneurship ensues."

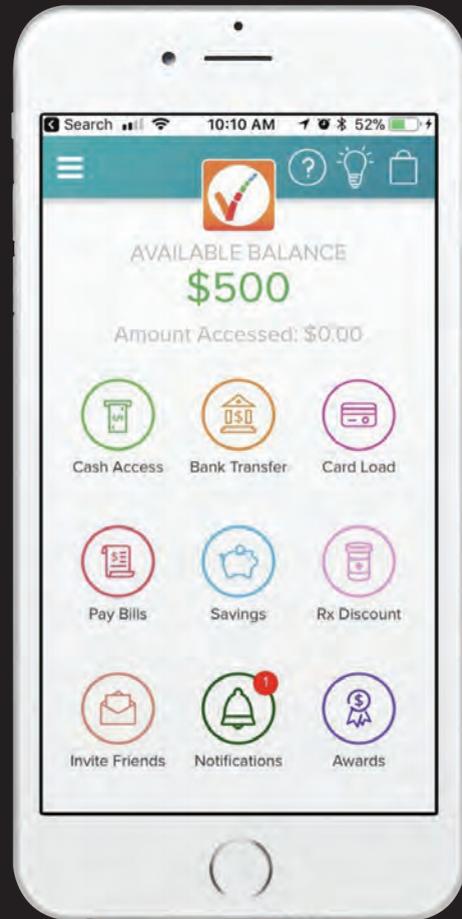
How PayActiv works

PayActiv connects with companies' payroll systems to offer hourly employees instant access to their already earned but unpaid wages before the designated payday via a mobile app, ATM or the web.

"An entrepreneur, to me, is a person who sees an unmet need. When you know that you have to solve this problem, you become an entrepreneur, in that moment."

Safwan Shah (MSEIEngr'90, PhD AeroEngr'94)

Safwan Shah, PayActiv founder and CEO



App features

- » Provides access to already earned wages for a nominal flat fee
- » Savings tools
- » Financial literacy resources

For \$5 per two-week pay period, employees can access a portion of their earned income at the click of a button without accruing any debt. Users can transfer funds to their bank account, load prepaid cards or PayPal, get discounts, make purchases on Amazon or use Uber within the same app. The platform also provides financial planning and budgeting tools, along with analytics for employers.

In many cases, employers subsidize the transaction fee as a benefit to employees, reporting higher job satisfaction, easier recruitment and lower turnover as a result. More than 500 companies large and small use PayActiv, including the world's largest private employer, Walmart, and nonprofits like Goodwill.

Today, almost a million people have used the service, and PayActiv has already facilitated more than \$2 billion. The concept also has proven attractive to investors, who have contributed \$37 million to date.

From aerospace to Silicon Valley

Developing a technologically sophisticated platform was a natural fit for Shah, who grew up in Pakistan with an engineer father who built power lines and dams across the nation. Attracted by the Western novels of Louis L'Amour, Shah arrived in Colorado in January 1989 to pursue a master's degree in electrical engineering.

Marvin Luttges, whom Shah considers his greatest benefactor, encouraged him to return after his master's for a PhD in aerospace engineering, and Shah joined BioServe Space Technologies, where he conducted several experiments in service to the U.S. space program.

After graduation, Shah moved to Silicon Valley, worked for a few years, dabbled in several companies and then in 1999 founded Infonox, a financial transaction company that became the backbone of the global gaming industry over the next decade by developing the world's first biometric ATM.

A year after selling the company to TSYS for \$90 million and retiring at 45, Shah began to wonder: What's next? Teaching MBA students at Berkeley and undergrads at UC Santa Cruz followed. He also earned an executive MBA from Stanford. All this while looking for his ultimate purpose, that one thing to which he could dedicate the rest of his life.

'He has enormous empathy'

While his time at CU Boulder built Shah's technical chops, it also exposed him to financial hardship that would later inform the mission of PayActiv. Already earning a graduate student's meager income and thousands of miles from home, Shah went through a divorce that



left him deep in debt.

That experience allowed Shah to appreciate the challenges so many face, said David Carlick, an investor and PayActiv board member.

"He has enormous empathy, and that empathy is a big part of how he selected the mission of PayActiv," Carlick said. "Safwan's mission, which I adore, is not only to loosen up the assets that you have, which is your own earned money, but also to ultimately provide people with access to low-cost, really fair financial tools."

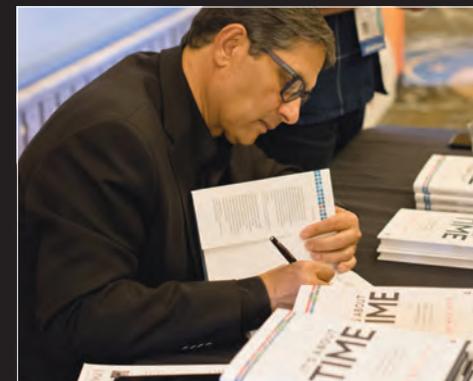
Engineers in Silicon Valley may not solve the root issues of wage stagnation or unfair lending practices, Shah said, but for lower-

income workers, PayActiv can go a long way toward providing security, savings and dignity.

This fall, Shah will accept the CU Boulder George Norlin Award, an acknowledgment of his achievements and recognition of his efforts to improve society.

But friends say personal satisfaction is far more important to Shah. Steve Simske, his graduate school colleague, said the person Shah most seeks approval from is himself.

"He doesn't need accolades. He doesn't need people telling him how great he's doing," Simske said. "He's very competitive, but it's a healthy competitive, because he's always comparing himself to who he was yesterday."



Extras

VIDEO: a short documentary about PayActiv at ItsAboutTimeTheFilm.com

BOOK: *It's About TIME: How Businesses Can Save the World* showcases his original ideas in short essays. ItsAboutTimeTheBook.com

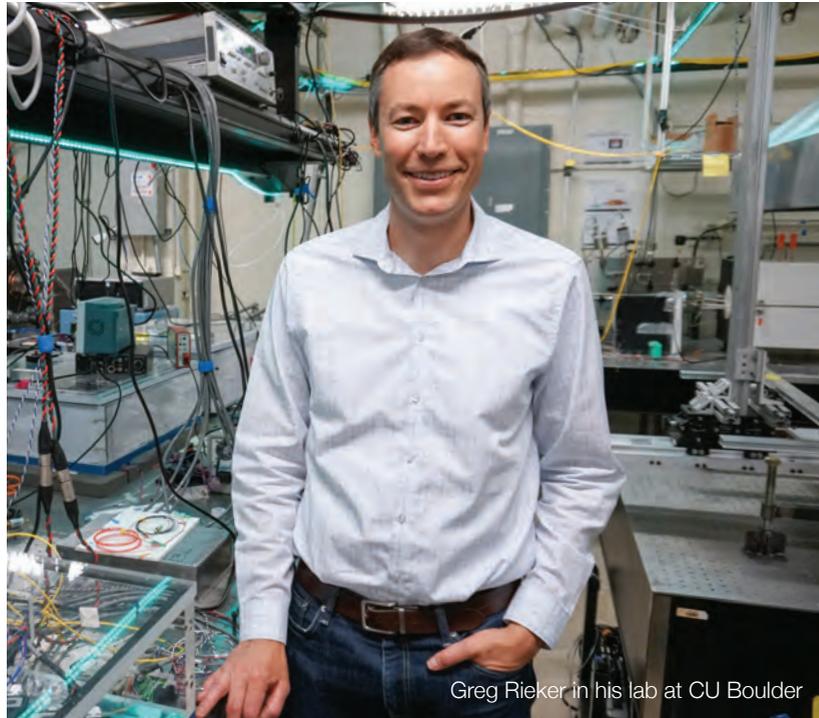
FACULTY AND STAFF AWARDS

Rieker receives top international award

Using lasers, mechanical engineer Greg Rieker can understand exactly how molecules react during the combustion process. When a laser is projected across a combustion environment, certain wavelengths are absorbed depending on which molecules are present at a given time.

For his excellence in combustion science, he was awarded the Hiroshi Tsuji Early Career Researcher Award in April. It's his second top international award in the past year.

"What makes these awards special is that I couldn't have done it anywhere else but CU Boulder," Rieker said. "The laser technology we've translated into combustion and other practical applications was first demonstrated on campus by Nobel laureate professor John Hall."



Greg Rieker in his lab at CU Boulder

Select national recognitions

Kristi Anseth

Chemical and Biological Engineering
National Academy of Arts
and Sciences

Penina Axelrad

Smead Aerospace
National Academy of Engineering

Taylor Barton

Electrical, Computer &
Energy Engineering
National Science Foundation
CAREER Award

Angela Bielefeldt

Civil, Environmental &
Architectural Engineering
American Society for Engineering
Education Fellow

John Falconer

Chemical and Biological Engineering
American Society for Engineering
Education Fellow

Jerome Fox

Chemical and Biological Engineering
U.S. Army Early Career Award
for Scientists and Engineers

Peter Hamlington

Mechanical Engineering
National Science Foundation
CAREER Award

Tomako Matsuo

Smead Aerospace
National Science Foundation
CAREER Award

Rebecca Morrison

Computer Science
Johnson & Johnson Women in
STEM2D Scholars Award

Hanspeter Schaub

Smead Aerospace
American Institute of Aeronautics
and Astronautics Fellow

Tam Vu

Computer Science
National Science Foundation
CAREER Award

Al Weimer

Chemical and Biological Engineering
National Academy of Inventors

Campus and college recognitions

Angela Bielefeldt

Civil, Environmental
& Architectural Engineering
CU Boulder President's
Teaching Scholar

John Mah

Smead Aerospace
John & Mercedes Peebles
Innovation in Education, Marinus
Smith Award

Shelly Miller

Mechanical Engineering
Campus Faculty Director
for Professional Development

Levi Perigo

Technology, Cybersecurity
and Policy
Marinus Smith Award, CEAS
Outstanding Faculty Advisor

Deb Renshaw

Chemical and Biological
Engineering
CEAS Outstanding
Undergraduate Staff Advisor

Kendra Thibeault

Engineering Management
Program
CEAS Outstanding Graduate
Staff Advisor

BOLD Faculty Fellows

Daniel Appelo

Applied Mathematics

Virginia Ferguson

Mechanical Engineering

Shaun Kane

Computer Science

Jana Milford

Environmental Engineering

NEW FACULTY



New faculty attending Faculty Orientation 2019

CU Engineering has hired 66 tenure-track faculty and more than 35 instructional faculty members in the past three years—a hiring rate almost unheard of in higher education.

"We're very excited to see how this new group innovates in research and teaching at CU Boulder," Dean Bobby Braun said.

Twenty-nine percent of the tenure-track hires were women, and 23% were hired at the associate professor level or above, meaning they already had a few years of teaching and research under their belts.

Faculty members have been hired for both department-level positions and in new interdisciplinary searches that represent focus areas where the college is looking to build capacity. This year, that included hypersonics, quantum information systems and imaging science.

The college's efforts to increase diversity among faculty and students has resonated with candidates, said Joann Silverstein, associate dean for faculty development. The opportunity

to innovate in teaching and the interdisciplinary nature of the campus and college was also a big draw.

Hope Michelson is joining mechanical engineering as an associate professor in 2020 after spending 20 years at Sandia National Laboratory. At Sandia, she said, most of her collaborations were with people outside her institution, so she's looking forward to more face-time with her fellow faculty.

"The department is extremely collaborative and super friendly," said Michelson, whose research focuses include soot formation evolution in the atmosphere. "I'm really looking forward to having those kinds of relationships at work."

While she will be relatively new to teaching, the ability to work with the next generation of engineers was part of the attraction to CU Boulder.

"I'm really excited about working with students and having that new, fresh energy and a different perspective on things," she said.

LEADERSHIP UPDATE



Ken Anderson

Chair, Department of Computer Science

Professor Ken Anderson has been elected by his colleagues to serve as chair of the Department of Computer Science.

Anderson joined the department in July 1998 and received tenure in 2005. He has served as an associate chair of the department, an ATLAS fellow and, most recently, as the associate dean of education in the College of Engineering and Applied Science. He was a participant in the first cohort of the National Center for Women & Information Technology Pacesetters program, a program designed to recruit more women to the field of computer science and encourage them to pursue their careers in technology. As part of his Pacesetters efforts, Anderson led the charge to create the Bachelor of Arts in Computer Science.

Anderson succeeds Professor Elizabeth Jessup, who has served as chair since 2017.



Angela Bielefeldt

Director, Engineering Plus Program

Professor Angela Bielefeldt is the new director of the Engineering Plus program, taking over for Jackie Sullivan and Derek Reamon, who began co-directing the program in 2013.

In 1996, Bielefeldt came to CU Boulder as a faculty member in the Department of Civil, Environmental and Architectural Engineering. From 2006 to 2010, she served as the Environmental Engineering Program director. Bielefeldt is an active member in the Accreditation Board for Engineering and Technology assessment and has served as chair of the college's First-Level Review Committee. Her research focus is on engineering education and sustainable water and wastewater treatment in developing communities.

Engineering Plus is a flexible engineering degree program that offers an engineering education through the combination of core engineering classes, an emphasis in a particular engineering field, and a selection of 18 concentration areas, including business, teaching and premed.



Shilo Brooks

Faculty Director, Engineering Leadership Program

After a national search, Shilo Brooks has been chosen to lead the college's Engineering Leadership Program.

Brooks has a doctorate in political science with research emphasis on political and cultural leadership. He has been teaching in the Herbst Program for Engineering, Ethics and Society since 2017. His vision for ELP is to introduce students to the fundamentals of ethical leadership using historical, literary and philosophic studies of character, ambition and decision-making.

The goal of the Engineering Leadership Program, founded in 2011, is to engage engineering students in learning about ethics, global leadership and communication. Brooks succeeds former Assistant Dean JoAnn Zelasko, who led the program until her retirement.



Rhonda Hoenigman

Associate Dean for Undergraduate Education

Rhonda Hoenigman, senior instructor in the Department of Computer Science, has been tapped to serve as the associate dean for undergraduate programs for the College of Engineering and Applied Science.

In this role, Hoenigman will focus on the quality and diversity of the undergraduate community, lead the college's approach to student success for all undergraduates and spearhead the enhancement of student climate with an emphasis on mental health and wellness.

Hoenigman, who has been on the computer science faculty since 2013, has led undergraduate programs in the department for the past three years. During that time, she oversaw revisions in the curriculums for the BS and BA degrees and the computer science minor. She also guided the undergraduate program through significant growth, the addition of the BA degree, and the planning of the CS partnership program with Western Colorado University.



Massimo Ruzzene

Associate Dean for Graduate Programs

Massimo Ruzzene, a recently hired full professor in mechanical engineering, has agreed to serve as the associate dean for graduate programs in the College of Engineering and Applied Science.

In this role, he will focus on the quality of the graduate program community, serve as the college champion for our graduate students and research professionals, and develop interdisciplinary thought leaders among the college faculty and staff. Ruzzene has significant experience in the growth and operation of successful graduate programs, and joined the CU team in August.



Fernando Rosario-Ortiz

Director, Environmental Engineering Program

Associate Professor Fernando Rosario-Ortiz has been appointed the new director of the Environmental Engineering Program.

Rosario-Ortiz is the first Latino director of environmental engineering. He was born in Puerto Rico and attended the University of Puerto Rico and the California Institute of Technology on his way to becoming a professor. His research focuses on water treatment, including wastewater reuse, advanced oxidation processes and environmental photochemistry. He teaches courses in environmental organic chemistry, analytical methods in environmental engineering and water chemistry.

Rosario-Ortiz takes the reins from R. Scott Summers, who has led the program since 2013.

HERITAGE SOCIETY: A LASTING LEGACY

Leaving a gift to the University of Colorado in estate plans or with a charitable life-income gift forever integrates your legacy with that of our transformative university. Your contribution provides the promise of a high-quality education to the next generations of students, empowering their success through outstanding teaching, learning, research, service and health care.

The University of Colorado established the Heritage Society to recognize and honor those who have shared their intentions to support CU through a planned gift, including provisions in a will or living trust, a beneficiary designation on a retirement account or with a life-income gift, such as a charitable gift annuity or charitable remainder trust.

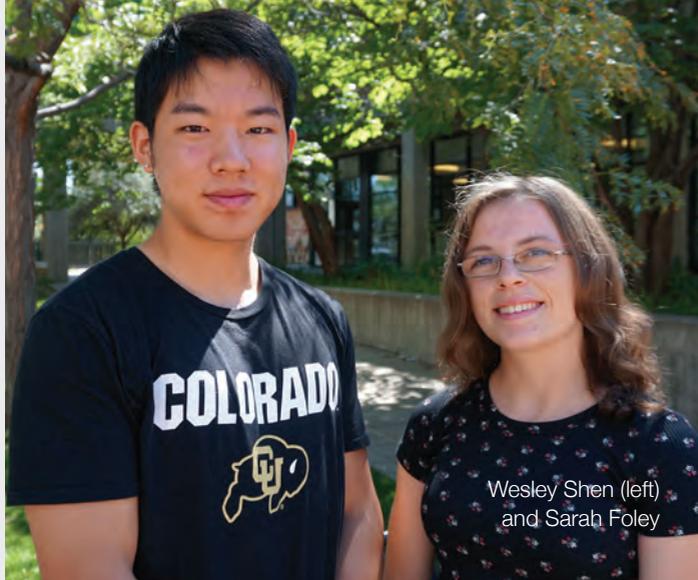
Our Heritage Society members provide CU Engineering with the long-term stability we need to provide scholarships to deserving students like Sarah and Wesley.

\$408,580

Realized dollars from planned gifts, 2019

\$14 Million

new gifts committed



Wesley Shen (left) and Sarah Foley

Legacy scholarships in action

“ This award allowed me to come out to Colorado to attend this excellent institution and study aerospace engineering. If it weren't for generous gifts like these, I would not be able to travel from my home in Massachusetts to Colorado, or be able to afford the out-of-state tuition. As a first-generation college student of Irish immigrants, every penny helps make it possible to become the first engineer in my family, and I could not be more grateful to have this opportunity. Coming to Colorado allows me the chance to work for companies in the space industry that I never dreamed I could, such as Lockheed Martin, SpaceX and many more. ”

Sarah Foley

M. Jeanne Place Scholarship recipient

“ Growing up in Taiwan then coming to this country was not an easy transition. Besides the language barrier and difficulties making friends, college tuition was also something to bear in mind. Receiving this award has made it much easier for me in the way that I don't have to be working whenever I wasn't doing schoolwork; I got to invest some of my free time in making new friends. Moreover, I got to participate in other extracurricular activities, such as being part of the Freshman Engineering Council and CU International.

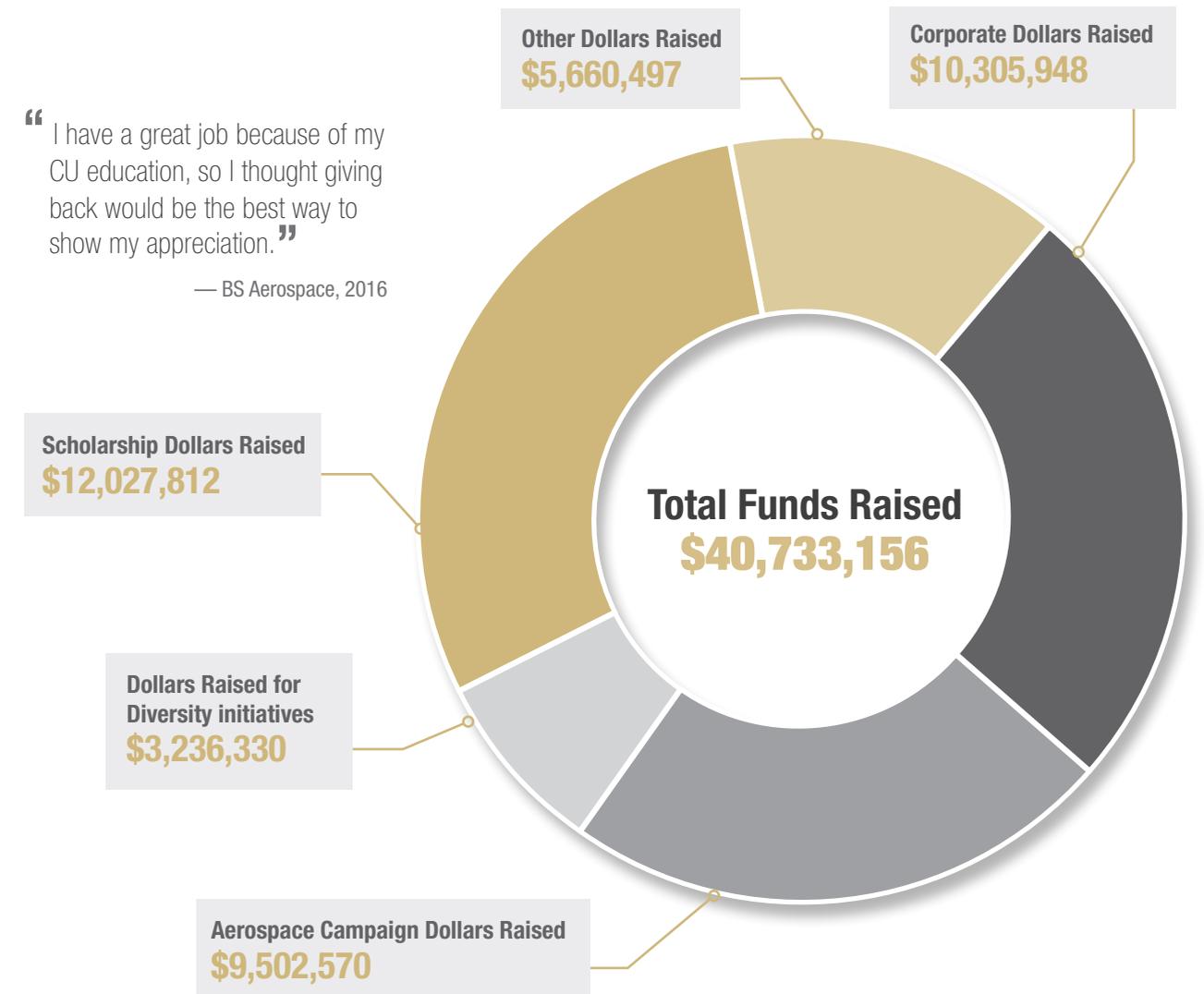
Upon receiving this award, I've thought about giving back to the CU community one day as well. This day can come as early as the age of 30 or it could be something that I'll leave behind, like how Eugene has done. ”

Wesley Shen

Eugene Carroll Scholarship recipient

GIVING: A YEAR OF GENEROSITY

The College of Engineering and Applied Science led the campus in fundraising efforts during fiscal year 2018. Thank you to all of our alumni, donors and industry partners for your continued support!



“ I have a great job because of my CU education, so I thought giving back would be the best way to show my appreciation. ”

— BS Aerospace, 2016

“ I give back to CU because CU gave so much to me. I don't do it for recognition—I do it to know that I am helping the college develop the next generation of leaders in engineering. ”

— BS Civil Engineering, 1967

Total Gifts – 2,843
Corporate Donors – 216
Non-Alumni Donors – 312
Young Alumni Donors – 208
Total Donors – 1,836

For more information on planned gifts or other giving opportunities, please contact Assistant Dean of Advancement Matt Young at 303-492-3883.



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#15 Chemical Engineering | **#15** Mechanical Engineering

#16 Civil Engineering

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In **ENGINEERING**