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ARIZONA ENGINEER

COLLEGE OF ENGINEERING • VOLUME 44 • NUMBER 1 • SUMMER 2021

EXPERIENTIAL LEARNING

INSIDE THIS EDITION

9 **LUNAR ARK:** A Modern Global Insurance Policy

PLUS

6 Smartphone-Based COVID-19 Test
Researchers call on personal experience

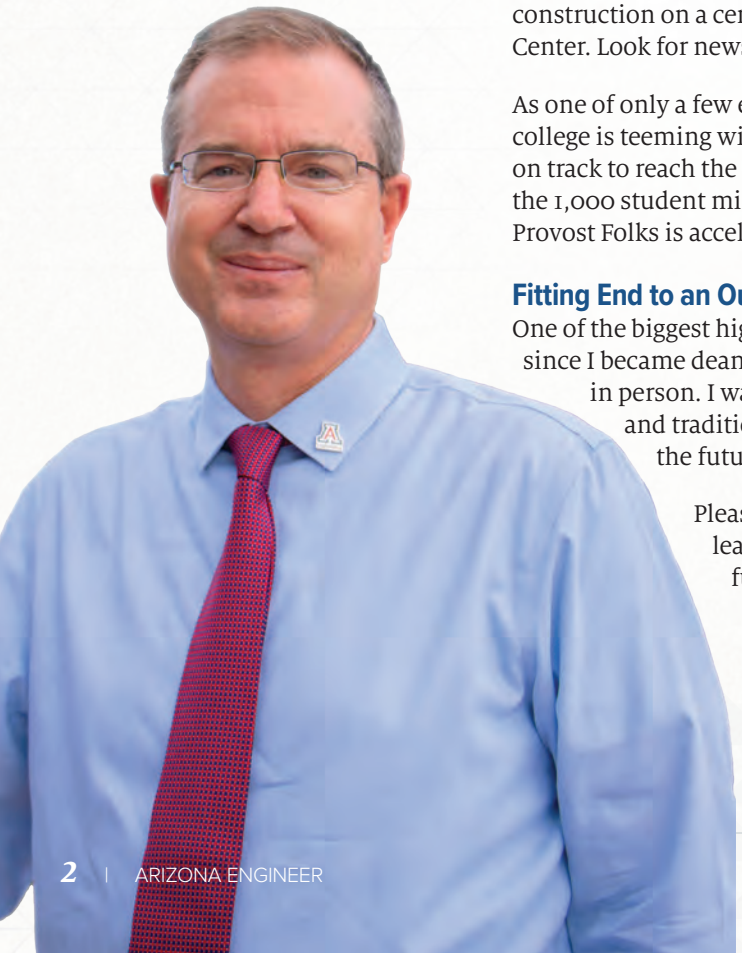
10 Craig M. Berge Design Day 2021
Wind turbine surveillance robot takes top prize

14 Clubs Build Skills & Friendships
Students roll up their sleeves and get to work

THE UNIVERSITY OF ARIZONA

Keeping Students First and Making Growth a Priority

The college is expanding experiential learning and giving students an edge every step of the way.



I HOPE YOU all are enjoying your summertime activities and family vacations.

What a whirlwind this school year has been. Everyone has taken the pandemic challenges head on and stayed true to the college's priorities – namely, students first!

In fact, this issue of the alumni magazine is all about the importance of experiential learning. In a year when face to face, much less hands on, education was difficult to manage, students, faculty and staff got creative and engineered solutions. With adaptations to courses, competitions, design projects, club activities, internships and high-profile research, students still had plenty of opportunities for real-life experiences.

I couldn't be more proud of all that has been accomplished in the last year. We reimagined Craig M. Berge Design Day with students presenting their findings via video. The college launched a new software engineering BS degree. Our new mining and mineral resources school was established, building on our global leadership in the field. And we named the first director of the Craig M. Berge Engineering Design Program, home of the senior design course. Our alumni have been a big part of making all that happen, and more. And we are grateful for your support!

Change Parallels Economic, Community Needs

There were many partners and friends of the college who provided instrumental assistance in designing the mining school and software engineering degree. Thanks to them, these programs are solidly in sync with industry needs and economic development. Numerous alumni also helped make this year's Design Day a success. With grit, determination and the backing of mentors, sponsors and judges, 99 teams of seniors completed impressive capstone projects, including the top winners, a wind farm autonomous rover and habitat enrichment items for jaguars at the Reid Park Zoo.

The college's commitment to community needs and entrepreneurialism will remain paramount as the Craig M. Berge Design program incorporates more and more projects into existing and new courses. And we keep reaching even higher, as we move closer to construction on a central engineering home for all of these activities – the Student Design Center. Look for news about expansions in the coming months.

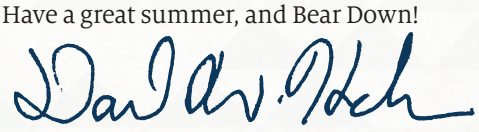
As one of only a few engineering colleges at land grant institutions with medical schools, the college is teeming with possibilities for growth and multidisciplinary research. In fact, we are on track to reach the goal of 700+ incoming students in 2021-2022, and we are striving to hit the 1,000 student milestone within the next few years. The support of President Robbins and Provost Folks is accelerating our plans.

Fitting End to an Outstanding Academic Year

One of the biggest highlights for me was the spring 2021 commencement. For the first time since I became dean two years ago, families and friends came together to celebrate graduation in person. I was thrilled to take part in the special recognitions, the reading of the names and traditional hooding of those earning doctoral degrees. It was a celebration of all the future holds for the college and its graduates.

Please enjoy this issue of the Arizona Engineer focused on experiential learning. The know-how and diversity of our students is key to a better future for all.

Have a great summer, and Bear Down!



David W. Hahn
Craig M. Berge Dean, College of Engineering

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A Wildcat Formula Racing team member gets ready for a vehicle test.

CONTENTS

FEATURED STORY

9 **Lunar Ark: a "Modern Global Insurance Policy"**
The ambitious project aims to preserve humankind – and animal-kind, plant-kind and fungi-kind – in the event of a global crisis.

IN EVERY ISSUE

2 Dean's Message
17 Class Notes
19 Thoughts on Philanthropy

IN THIS ISSUE

6

Smartphone-Based COVID-19 Test — Students draw on personal experience in designing and building the simple, affordable and portable device.

10

Craig M. Berge Design Day 2021 — Seniors showcase their efforts to make crops healthier, humans safer and the future brighter.

14

Building Skills & Friendship in Clubs — From race cars and underwater robots to prosthetics and air quality sensors, students dive deep into projects.

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Some articles in this print magazine are edited for length. Please visit **news.engineering.arizona.edu** for more stories, photos and videos.

Hispanic Senior a First in NIH Oxford Scholars Program

'My plan is to represent my community in research, science and engineering wherever I go.'

JOCELYNE RIVERA IS the first Hispanic woman to be accepted to the National Institutes of Health Oxford-Cambridge Scholars Program, an accelerated doctoral training program for students committed to careers in biomedical research.

The 2021 biomedical engineering graduate and first-generation college student, who grew up in Hermosillo, Mexico, will spend two years at Oxford University.

"My plan is to represent my community in research, science and engineering wherever I go," she said.

International Influences

Rivera's childhood dream was to become a doctor. However, when she was 15, a team of biomedical engineers built her cousin a customized prosthetic leg so he could walk after contracting a rare bone disease. That was when she decided to pursue engineering. After a year abroad learning German and some time in community college, she transferred to the UA to work with biomedical engineering researchers, including Philipp Gutruf and Minkyu Kim.

'We are so proud of Jocelyne,' says her mom, Sandra (left).

"Jocelyne stood out as a quick learner and extremely hard worker," said David Knoff, a graduate student in the Kim Research Group. "Beyond her intelligence and work ethic, though, it is Jocelyne's passion and curiosity that always stood out to me."

Rivera's diligence and smarts weren't the only things that set her apart. In some of her classes, she was the only woman, or only Hispanic woman, in the room. When she did encounter other Hispanic women, like a researcher from Colombia she met in Kim's lab who also spoke Spanish and English, it meant a lot.

"You can't imagine how important it is to have that diversity," she said. "We were both interested in the same thing, and I felt that I belonged there."

Summer Setbacks and Forward Leaps

Rivera, who was involved with the Society of Hispanic Professional Engineers, the Society of Women Engineers and the National Society of Leadership and Success, isn't one to falter in the face of obstacles. She was devastated when the prestigious 2020 summer program at Johns Hopkins University to which she'd been accepted was canceled due to COVID-19. But she quickly began looking for a new position.

Next stop for **Jocelyne Rivera**, 2021 biomedical engineering graduate, is the Oxford-Cambridge Scholars program.

She made it into the Multi-Scale Systems Bioengineering and Biomedical Data Science REU at the University of Virginia, a virtual program for computational modeling. The field was new to her, but she found a way to connect it to her passion. She began creating simulations to validate the experimental results in Kim's lab. She even brought together Kim and her mentor at the University of Virginia in an ongoing research partnership.

"If you really want to do something, just do it," she said. "Being a woman shouldn't stop you from studying engineering or going into science. Nothing should stop women."

Her family isn't surprised that Rivera's work has led to the NIH Oxford-Cambridge Scholars Program, which has an acceptance rate of 10%.

> "Being a woman shouldn't stop you from studying engineering or going into science. Nothing should stop women."
>
> **JOCELYNE RIVERA**
> *Oxford-Cambridge Scholar*

"As a child, Jocelyne was sweet, but very dedicated, always achieving what she set out to do," said Rivera's mother, Sandra, in Spanish, with her daughter translating. "We are so proud of her."

Building a VR Platform for NASA

MITCHELL KIRSHNER HAS always been driven by his passions. As an undergrad, he triple majored in integrated science, earth and planetary sciences, and integrated engineering studies. He studied Martian lava flow for his chemical and biological engineering MS thesis, then went on to collect geochemical data from the Canary Islands.

Now, he's a systems and industrial engineering PhD student and research assistant in the Architecture Driven Systems Laboratory at the University of Arizona. He spent spring 2021 interning at NASA Langley Research Center, where he helped build a way to combine data from different mission segments. But instead of a library of files, documents or images, the system Kirshner worked on will be in virtual reality, allowing scientists to interact with the data in a 3D space.

"This sort of thing has never been done before," Kirshner said. "Let's say you have satellite data. In the software prototype I helped to build, you would be able to not only visualize the 3D motion of that satellite, but to apply algorithms to your data, compute results and visualize them as well. You can even walk right into the middle of your data for a viewpoint that is hard to acquire through traditional 2D visualizations."

Kirshner's internship was focused on analyzing data about space weather that can affect Earth. For example, increased solar radiation correlated to sunspot activity can cause errors in GPS navigation on Earth. By manipulating the space weather data in VR, scientists can improve their understanding of solar weather and predict how it may behave in the future.

"What I've done so far at the UA was exactly what I needed for this specific internship," he said. "I don't think I could have been prepared better elsewhere."

Mitchell Kirshner collects geochemical data in the Canary Islands.

Roberto Furfaro (left) guides graduate student **Enrico Schiassi**.

Roberto Furfaro Becomes 2021 da Vinci Fellow

ROBERTO FURFARO CAME to the UA as a visiting student in 1998 to do his master's thesis. The professor of systems and industrial engineering has been here ever since. Now, he is the College of Engineering's 2021 da Vinci Fellow. Each year, one exceptional engineering faculty member is selected as a da Vinci Fellow and receives a one-time grant of $10,000, funded by donors to the da Vinci Circle.

"Since I got my PhD here, I've considered this my home," Furfaro said. "It is one of the most meaningful awards I've received, because it's a recognition of what I'm doing and that I've been here a long time. I'd like to thank the University of Arizona not just for this prize, but for the opportunity to have a career here."

Furfaro's focus is on using machine learning and artificial intelligence to build or improve space systems. He's helped develop an autonomous lunar greenhouse, designed a mission to explore shadowy areas of the moon, helped build multimillion-dollar cyberinfrastructures, and contributed to NASA's OSIRIS-REx mission. There is even an asteroid named after him: 133474 Roberto Furfaro.

Biomedical engineering professor **Jeong-Yeol Yoon** and his team show UA President **Robert C. Robbins** and Provost **Liesl Folks** around the Biosensors Lab.

Team Develops Smartphone-Based COVID-19 Test

Personal experience inspires students working on the device.

RESEARCHERS AT THE University of Arizona are developing a COVID-19 testing method that uses a smartphone microscope to analyze saliva samples and deliver results in about 10 minutes.

The team, led by biomedical engineering professor Jeong-Yeol Yoon, is combining the speed of nasal swab antigen tests with the high accuracy of nasal swab PCR, or polymerase chain reaction, assay. The researchers – who published their findings in a 2021 Nature Protocols Paper – are adapting an inexpensive method they originally created to detect norovirus, the microbe famous for spreading on cruise ships.

> "It's really cool to be working on a detection platform that can get fast results that are also accurate."
>
> **KATIE SOSNOWSKI**
> *biomedical engineering doctoral student*

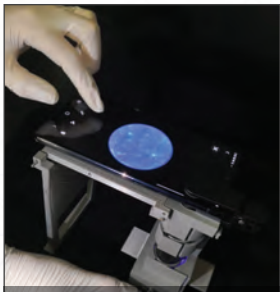
"We've outlined it so other scientists can basically repeat what we did and create a norovirus-detecting device," said Lane Breshears, a biomedical engineering doctoral student in Yoon's lab. "Our goal is that if you want to adapt it for something else, like we've adapted it for COVID-19, you have all the ingredients you need to basically make your own device."

Yoon – a BIO5 Institute member and professor in multiple departments – is working with a large group of undergraduate and graduate students to develop the method.

"I have a couple of friends who had COVID-19, and they were super frustrated because their PCR results were taking six or seven days, or they were getting false negatives from rapid antigen tests. But when they got the final PCR tests, they found out they had been sick, like they'd suspected," said Katie Sosnowski, a biomedical engineering doctoral student. "It's really cool to be working on a detection platform that can get fast results that are also accurate."

Cheaper, Simpler Detection

Traditional methods for detecting norovirus or other pathogens are often expensive, involve a large suite of laboratory equipment or require scientific expertise. This test consists of a smartphone, a simple microscope and a piece of a wax-coated paper that guides the liquid sample to flow through specific channels. The portable, easy-to-use setup costs about $45. Users introduce antibodies attached to fluorescent beads to a potentially contaminated water sample. If enough particles of the pathogen are present in the sample, several antibodies attach to each pathogen particle. Under a microscope, the pathogen particles show up as clumps of fluorescent beads which can be counted. The test takes about 10 to 15 minutes, and Yoon says a nonscientist could learn to do it just by watching a brief video.



Researchers demonstrate smartphone COVID-19 test.

The newer version features a 3D-printed enclosure for the setup and employs a method called adaptive thresholding. Rather than setting a fixed value for what quantity of a pathogen is dangerous, it uses artificial intelligence to set the danger threshold and account for environmental differences, such as the type of smartphone and quality of paper.

The team members have tested their technique on samples from a small number of consenting UA students. In the coming months, they expect to publish findings about the efficacy of the method for testing both mouth gargle samples and air samples.

EMPOWER STEM Creates Student Pathways to Jobs in National Labs

UNIVERSITY OF ARIZONA associate professor Erin Ratcliff was fascinated by the work she did as a faculty fellow at the Naval Research Lab in 2017 and again in 2020. She wanted her engineering students to see the possibilities of similar positions.

"NRL has cutting-edge, amazing equipment and capabilities, and they have a lot of it," said Ratcliff, an associate professor of chemical and environmental engineering. "They're doing all kinds of highly classified science and technology development – from fundamental concepts to things that almost seem like science fiction."

Ratcliff and a team of engineering researchers have created a unique program at the university that builds a bridge between students and government research jobs. EMPOWER STEM, funded by $748,000 from the Office of Naval Research, gives students opportunities to learn about the engineering behind the latest technologies in the Department of Defense and Department of the Navy. In return, government labs gain access to a well-prepared, diverse pool of potential employees. The team hopes the program will serve as a model for other universities.

The initiative, which includes paid bootcamps and professional development seminars, is focused on teaching students about printable electronic devices, such as solar cells and biosensors. These electronics provide lighter and more affordable alternatives to existing technologies.

Ultimately, Ratcliff wants any interested students to be able to participate, but the team is concentrating first on student veterans, who have prior experience with the DOD. In a September 2020 survey of UA veteran undergraduates, over 50% indicated an interest in DOD science positions.

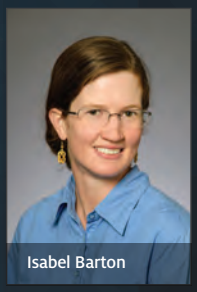
The university is nationally recognized for serving student veterans. In U.S. News & World Report's 2021 Best Online Bachelor's Program rankings, Arizona Online ranked No. 5 overall and No. 4 among public universities in its bachelor's program offerings for veterans.

"This grant creates a much-needed bridge to better position and align our veteran population for future STEM-specific employment opportunities within the DOD and the DON," said Cody Nicholls, assistant dean of students, military and veteran engagement at the UA.

Anna Rich, a chemistry and biochemistry PhD student, works on printable electronic materials under associate professor **Erin Ratcliff.**

CAREER Awards Advance Geometallurgy & Quantum Resources

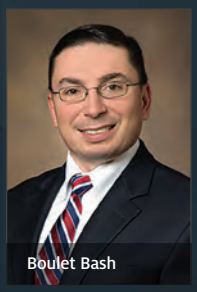
The College of Engineering announced two CAREER Award recipients this semester: Isabel Barton in mining and geological engineering, and Boulat Bash in electrical and computer engineering.



Isabel Barton

Barton, who has a background in geometallurgy, is on a mission to make mining processes more efficient by breaking down silos between geologists, who are experts on ore deposits, and metallurgists, who know how to extract the metals from rock. She's also focused on public outreach, currently teaching a course on mining and anthropology that explores nonrenewable resources through a historical lens.

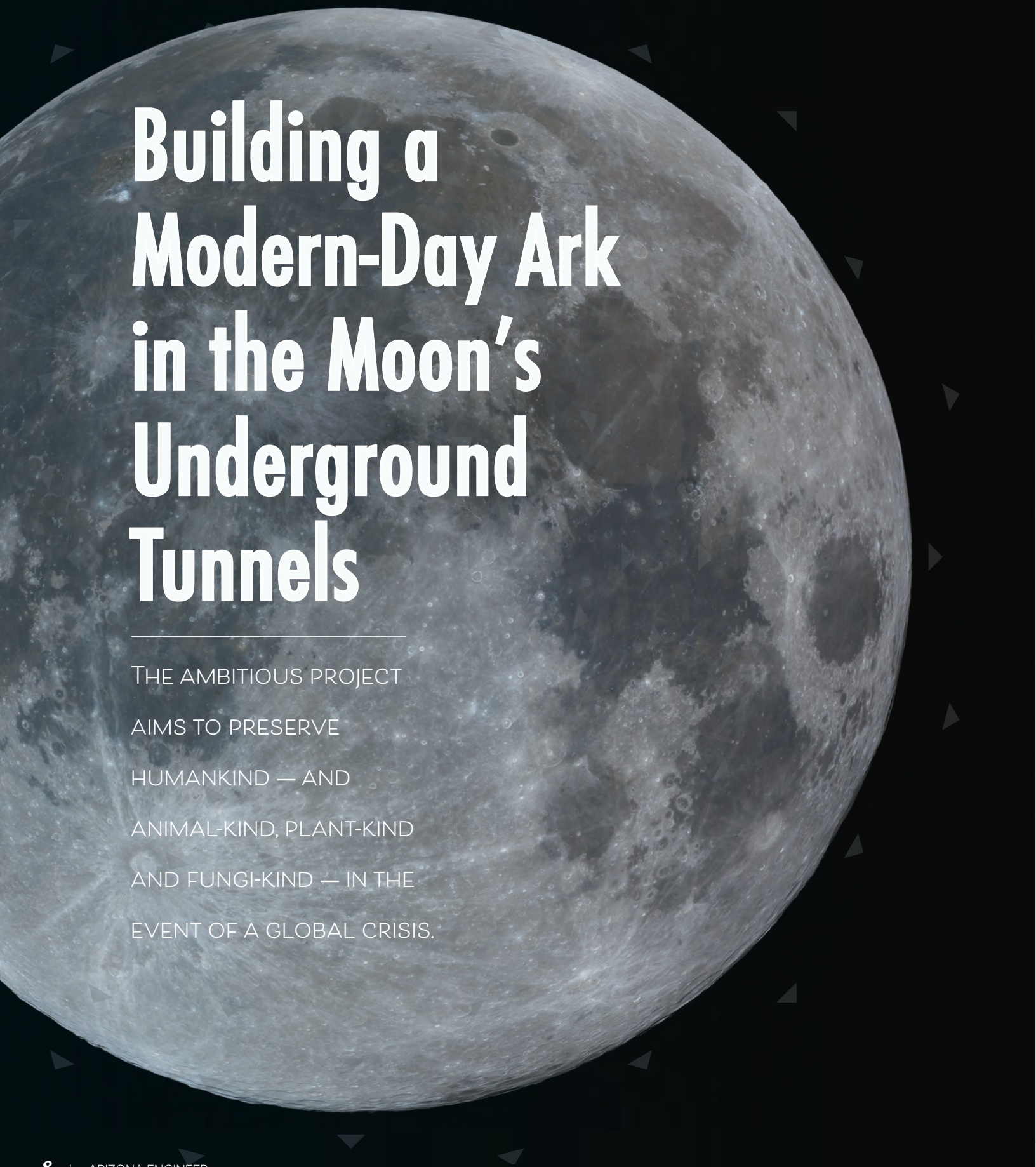
"Putting together this course was an opportunity to showcase how much mineral resources have had to do with civilization as we know it," she said.



Boulet Bash

Bash's CAREER funding will support his work applying quantum resources to sensing in covert channels. Quantum resources are powerful, but complex, meaning they aren't suitable for every situation. Bash's research will focus on a sweet spot where quantum benefits outweigh their drawbacks. He also hopes to generate interest among the next generation of engineers through the Arizona Science Engineers and Math Scholars program.

"The goal is to bring this information to students who might not think about this as being available to them, or as something they can succeed at," he said.



Building a Modern-Day Ark in the Moon's Underground Tunnels

THE AMBITIOUS PROJECT AIMS TO PRESERVE HUMANKIND — AND ANIMAL-KIND, PLANT-KIND AND FUNGI-KIND — IN THE EVENT OF A GLOBAL CRISIS.

JEKAN THANGA IS taking scientific inspiration from an unlikely source: the biblical tale of Noah's Ark. Rather than two of every animal, however, his solar-powered ark on the moon would store cryogenically frozen seed, spore, sperm and egg samples from 6.7 million Earth species.

Thanga and a group of his undergraduate and graduate students outline the lunar ark concept, which they call a "modern global insurance policy," in a paper presented the 2021 IEEE Aerospace Conference.

"Earth is naturally a volatile environment," said Thanga, UA professor of aerospace and mechanical engineering. "Because human civilization has such a large footprint, if it were to collapse, that could have a negative cascading effect on the rest of the planet."

Climate change, he added, is another concern: If sea levels continue to rise, many dry places will go underwater. Thanga's team believes storing samples on another celestial body reduces the risk of biodiversity being lost if one event were to cause total annihilation of Earth.

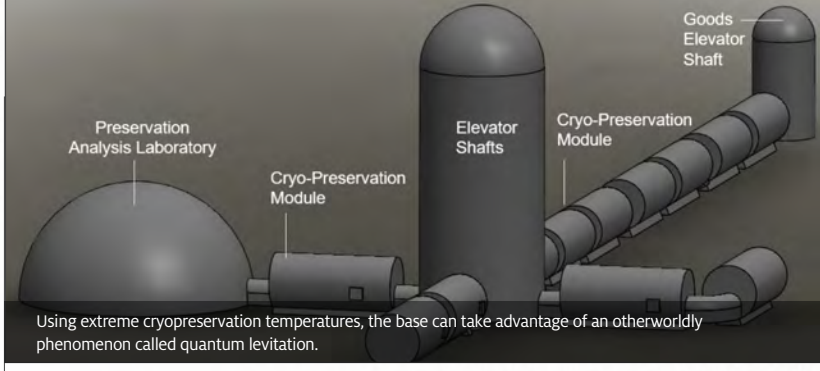
Totally Tubular

Scientists discovered a network of about 200 lava tubes just beneath the moon's surface in 2013. These structures, about 100 meters in diameter, formed billions of years ago, when streams of lava melted their way through soft rock underground. Untouched for an estimated 3 billion to 4 billion years, they could provide shelter from solar radiation, micrometeorites and surface temperature changes.

The idea of developing a lunar base, or a human settlement on the moon, has been around for hundreds of years, and the lava tube discovery renewed the space community's enthusiasm for the concept. But the moon isn't exactly a hospitable environment where humans can spend extended periods. There isn't water or breathable air, and it's about minus 25 degrees Celsius, or minus 15 degrees Fahrenheit.

On the other hand, those same features make it a great place to store samples that need to stay very cold and undisturbed for hundreds of years at a time.

Building a lunar ark is no small undertaking, but Thanga says the project is not as overwhelming as it sounds. Transporting about 50 samples from each of 6.7 million species would require about 250 rocket launches. It took 40 rocket launches to build the International Space Station.



Using extreme cryopreservation temperatures, the base can take advantage of an otherworldly phenomenon called quantum levitation.

"It's not crazy big," he said. "We were a little bit surprised about that."

Cryogenics & Quantum Levitation

The team's model for the underground ark includes a set of solar panels on the moon's surface for electricity. Two or more elevator shafts lead down into the facility, where petri dishes are housed in a series of cryogenic preservation modules. An additional goods elevator shaft transports construction material to expand the base.

The fact that the lava tubes are so cold, and the cryopreserved samples must be even colder, means there's a risk that the metal parts of the base could freeze, jam or even cold-weld together.

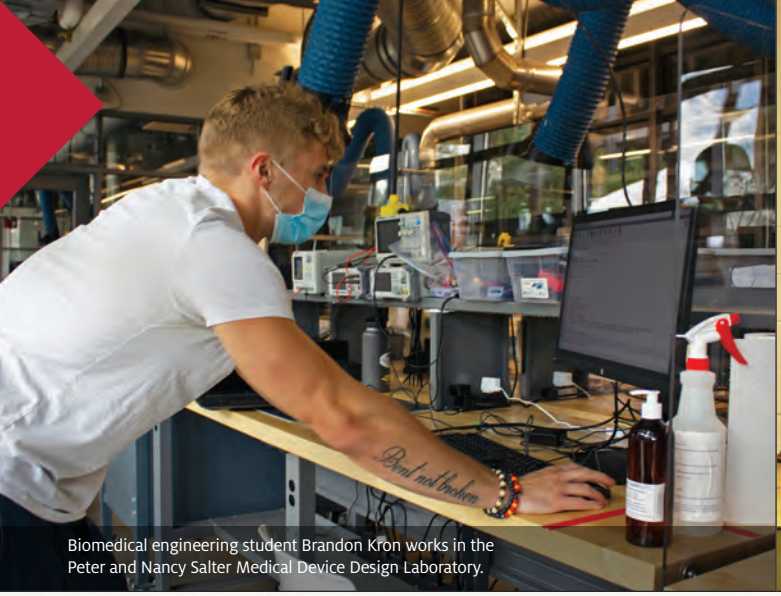
> "Projects like this make me feel like we are getting closer to becoming a space civilization, and to a not-very-distant future where humankind has bases on the moon and Mars."
>
> **ÁLVARO DÍAZ-FLORES CAMINERO**, *aerospace engineering PhD student*

However, there's a way to take advantage of the extreme temperatures by using an otherworldly phenomenon called quantum levitation. In this process, a cryo-cooled superconductor material – or a material that transfers energy without losing any heat, like a traditional cable does – floats above a powerful magnet. The two pieces are locked together at a fixed distance, so wherever the magnet goes, the superconductor follows.

"It's like they're locked in place by strings, but invisible strings," Thanga said. "When you get to cryogenic temperatures, strange things happen. Some of it just looks like magic but is based on tried and laboratory-tested physics principles."

The team's ark design uses this phenomenon to make the shelves of samples float above metal surfaces, and robots navigate through the facility above magnetic tracks.

"What amazes me about projects like this is that they make me feel like we are getting closer to becoming a space civilization, and to a not-very-distant future where humankind has bases on the moon and Mars," said Álvaro Díaz-Flores Caminero, a UA doctoral student leading the thermal analysis for the project. "Multidisciplinary projects are hard due to their complexity, but I think the same complexity is what makes them beautiful."


Biomedical engineering student Brandon Kron works in the Peter and Nancy Salter Medical Device Design Laboratory.


Students test out 3D-printed shock isolators they developed for capstone sponsor Northrop Grumman.

Students Net $46,000 in Prizes at Craig M. Berge Design Day 2021

MEMBERS OF THE Class of 2021 spent their entire senior year in a pandemic. But, through a combination of virtual communication, safe in-person meetings and pure grit, 99 teams completed capstone projects that are a testament to the power of an engineering education. In place of an in-person ceremony, students created videos of their projects and were honored in the online Craig M. Berge Engineering Design Day Awards Ceremony that included $46,000 in prizes.

"I want to congratulate our engineering students for your hard work and perseverance through a difficult senior year," said David W. Hahn, the Craig M. Berge Dean of the College of Engineering. "The Wildcat Engineering spirit in each of you has brought you to this culminating experience."

The student designs were as impressive as they were broad, ranging from a public outreach telescope to a virtual reality laboratory to mosquito traps that combat deadly viruses. The celebration, the dean's chair, and the college's four-year design program are all named for College of Engineering alum Craig M. Berge, who earned his BS in mechanical engineering in 1957 and was a supporter of the college throughout his life.

Oso Pequeño: Wind Turbine Watcher

Engineers build the future. So it's no surprise that the winners of the Craig M. Berge Deans' Award for Most Outstanding Project created a device to help with the production of wind energy. Tucson Electric Power's Oso Grande Wind Project is a 61-turbine, 24,000-acre facility outside Roswell, New Mexico, expected to generate enough energy to serve about 90,000 homes. Because the farm is more than six hours away from TEP's nearest technicians, the company tasked Team 21056 with developing a way to remotely monitor the facility. The result: Oso Pequeño, a solar-powered, autonomous rover that gathers video footage of the turbines and weather.

"Given the challenges of this past year, all of the teams did amazing projects," said Larry Head, inaugural director of the Craig M. Berge Engineering Design Program. "But this project was the best."


Peter Vollmer poses with his team's award-winning wind farm surveillance rover.

Modified from a quad all-terrain vehicle, Oso Pequeño has seven mechanical subassemblies, is capable of conducting up to three turbine inspections per week, and came in a few hundred dollars under the team's $4,000 budget.

"As a team, we learned the importance of taking roadblocks in stride; adhering to a set schedule and achievable milestones; utilizing our individual creativity and unique experiences to the advantage of the team; and engaging in consistent, direct communication important to teamwork and collaboration," said Torrey Peterson, an industrial engineering major and the team's project procurement lead.

Overcoming Obstacles, Entertaining Jaguars

Team 21095, whose members built an aircraft for the AIAA Design, Build Fly Aircraft Design Competition, received both the Honeywell Award for Excellence in Aerospace Mechanical System Design and the Steve Larimore Award for Perseverance and Recovery.

Their challenges ranged from COVID-19-related shipping delays and a pilot being out of town for a flight test to the aircraft being totaled after taking a 60-foot dive. During the final flight test at a remote control aircraft field, the team realized one of the servos – devices that help control aircraft movement – wasn't working. The backups the team had brought were having problems too.

"With no other options, we were ready to call it a day and head back empty-handed once again," said aerospace engineering major Roman Gonzalez. "That was when someone passing by noticed our dilemma and offered up two

Bella the jaguar at the Reid Park Zoo

of his servos. We integrated and tested them, and they worked perfectly, and our flight test was saved."

Team 21034 kept to the ground with its animal enrichment automation system for the Reid Park Zoo's jaguar habitat. The project was supported with funding from the Craig M. Berge dean's endowment, as part of a new initiative to support community-focused projects. The final system, which uses motion sensors to allow animals to turn on features such as misters and visual displays, won the Raytheon Technologies Award for Best Overall Design.

"We were really excited to see the results," said Stephanie Norton, a Reid Park Zoo animal welfare specialist. "They were much better than we could have ever anticipated."

Honoring Trailblazers

The day also recognized changes to the Craig M. Berge Engineering Design Program and the Interdisciplinary Capstone Program. Don Newman, an alum and donor who has been the driving force behind Design Day planning for nearly a decade, and Gary Redford, the lead instructor of the Interdisciplinary Capstone 498 class, are both retiring.

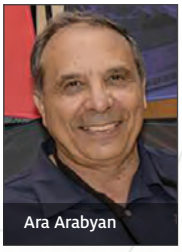
Don Newman

"It is thanks to Don's focus on long preparation times and attention to small details that we have been able to adapt with relative ease to these COVID times," said Ara Arabyan, director of the Interdisciplinary Capstone 498 Program, which is housed under the Craig M. Berge Engineering Design Program umbrella. "And Gary has mentored more than 70 ENGR 498 teams during his career with us, helping students produce some truly outstanding prototypes."

Jim Baygents, associate dean for academic affairs, recognized Arabyan, who is preparing to depart on sabbatical, for his invaluable contributions to the growth of the capstone program. Under his tenure, student enrollment in the program has doubled, projects have nearly tripled, and the budget has increased greatly.

"Ara keeps things working and running," Baygents said. "He's done it well, and he's done it with aplomb and devotion."

Baygents closed the day by thanking all the people who made Design Day possible, particularly the mentors. His final words were to the students.



Ara Arabyan

"You've shown that, when faced with challenging projects and challenging times, you're among the best and brightest in the state, if not the entire country. You represent the best of our university and our college, and we're proud of what you do."

Students meet in the AME courtyard to work on a catheter efficacy test setup for capstone sponsor BD.

Erik Knowles welds a piece for the Baja Race Car, as part of a capstone project sponsored by the Department of Electrical and Computer Engineering.

Three-Minute Presentation Puts Chemical Engineer on Top

MARWAN ABDULJAWAD, who recently graduated with his chemical engineering PhD, opened his presentation for the 2021 University of Arizona Grad Slam competition like this:

Marwan Abduljawad says his mother's battle with cancer continues to motivate him.

"Six years ago, my mom was diagnosed with cancer. I remember my sister calling me and telling me doctors wanted to perform an MRI so they would know exactly what was going on inside my mom's body. That interested me to learn more about MRI."

Abduljawad, who studied in the Biomolecule Bioengineering Nanotechnology Laboratory under Roberto Guzman, took first place at the competition. In Grad Slam, participants compete to show off their science communications skills by giving three-minute presentations about their research, using accessible language aimed at the general public.

In his video, he explains how clinicians inject patients with contrast agents, which make tumors or other areas of interest, such as blood clots, show up brightly in MRI scans. However, some contrast agents can stay in the body for long periods, and be especially harmful to patients with kidney failure. So Abduljawad created an alternative which discharges from the body quickly using gold nanoparticles coated in antibodies.

"These antibodies make the contrast agents smart," he explained. "So if we inject these particles through the vein, they're going to stick strongly to the tumor. And the tumor is going to light up like a Christmas tree."

His enthusiasm and clear language beat out 76 other participants in the multi-round competition for the grand prize of $3,000. He said his mother is his biggest inspiration.

Marwan Abduljawad

"Throughout the whole creation of my slides and oral presentation, she was at the forefront of my mind, and I felt encouraged to present this topic with the passion I felt in the lab," he said. "On April 10, I was proud to win this award and felt my mom would be too. Unfortunately, she succumbed to cancer on April 12, putting an end to her suffering. She will continue to motivate me."

Wildcats Win Big in SME Mine Design Competitions

UA STUDENTS WENT all out at this year's Society for Mining, Metallurgy, and Exploration/National Sand, Stone and Gravel Association, student design competitions. The senior design team, Aggregate Mining Solutions, brought home the gold against international participants – a first for the university.

Aggregate Mining Solutions takes home gold in the student design competition.

The Wildcat Junior Team earned third place in the Metallic Student Design Competition, which ran for the first time this year.

"The University of Arizona's mine design teams have been consistently ranking in the top three for the past several years. We have a tight-knit group of undergraduate students who are passionate about everything they do," said Moe Momayez, interim department head and David and Edith Lowell Chair in Mining and Geological Engineering. "The success of both the senior and junior mine design teams is also a reflection of the quality of our mining engineering program and the faculty in the department."

Their path to victory was paved with hard work. For example, the senior team visited local sand and gravel mines and spoke with the engineers who had designed them.

"This has been one of the closest teams that I have worked with, and I enjoyed every moment I got to spend with them," said MGE senior Will Peterson.

In addition to Peterson, the senior team members were Ryan Amos, Alexandra Contreras, Sarah Huggins-Hubbard, Nick Overleas and Nathan Syers. The junior team members were Kate Brown, Kerst Kingsbury, Schuyler Mangiafico, Victor Nieto, David Raihala and Tennyson Wilson.

Undergrads Contribute to OSIRIS-REx Sample Analysis

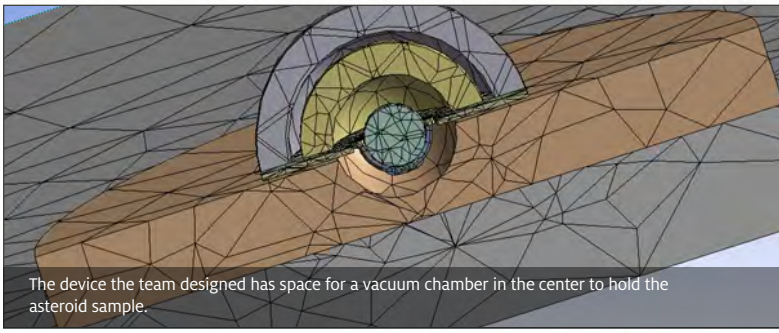
Seniors devise a way to measure thermal conductivity of precious cargo.

THE UNIVERSITY OF Arizona is leading NASA's OSIRIS-REx project, the first U.S. mission to return samples from an asteroid to Earth. After collecting samples from the surface of near-Earth asteroid Bennu, the OSIRIS-REx spacecraft began its two-year journey back to Earth in May 2021.

Scientists hope analyzing the samples will help answer questions about the makeup of the solar system and the origins of life as we know it.

In anticipation of the spacecraft's return to earth, a team of seniors has developed a method for testing the thermal conductivity of asteroid samples.

"I wanted to do this project because I'm really interested in astronomy," said mechanical engineering student Jinhua Ouyang. "As a Wildcat, I'm very proud of OSIRIS-REx."



The device the team designed has space for a vacuum chamber in the center to hold the asteroid sample.

Typically, measuring the thermal conductivity of a material means cutting it into a flat shape so two flat surfaces, similar to hot plates, can be mounted to the sample. But samples from Bennu are too precious to be modified – or even exposed to air.

"Sample protection is our No. 1 priority," said Zane Craddock, a systems engineering major and team lead. "Without theoretically touching the sample, we have to measure its thermal conductivity, which hasn't really been done before except in really limited ways."

This means the samples must remain in a vacuum chamber while they're being tested. Instead of the traditional method, the team devised a way to use radiation so heat is transferred through induction rather than direct contact.

When Lightning Strikes: Building Skills, Shocking Mannequins

GETTING STRUCK BY lightning is, famously, not very common. But in situations like hiking, golfing or repairing utility lines during a storm, the risk of getting hit by lightning is high – and so is the cost.

Team members get ready to work on Manny the Mannequin.

Dr. Dan Schlager, an emergency physician and clinical professor at the University of Arizona College of Medicine – Tucson, developed a patented lightning protection garment. Via his company, Zoltar Technologies, he sponsored a capstone project that tasked students with developing a mannequin to test the garment's efficacy.

"This project was my No. 1 pick," said biomedical engineering student Cassidy Mannier. "A lot of the other biomedical projects were kind of similar to the research I do in my lab. This just seemed like something I'd never heard of or experienced. And I wanted to try learning more about electrical engineering and try working more with industry."

The students modified a mannequin, which they dubbed Manny, by covering it in electrical tape to simulate the electrical resistance barrier of human skin. They also 3D-printed custom, non-metal joints and cut a hole in Manny's back so they could insert his "heart," a ceramic resistor installed with zip ties.

In March, the team visited the Lightning Simulation Laboratory at DNB Engineering in Anaheim, California, where they were able to dress up Manny in his protection garments and strike the mannequin with simulated lightning. They used a customized, Raspberry Pi-based system to gather data about how each strike affected the mannequin.

Members of the Wildcat Baja Racing team say cars, races and teamwork lead to better employment opportunities.

Building Skills, Machines and Friendships in Clubs

From race cars and underwater robots to prosthetics and air quality sensors, students roll up their sleeves and get the job done.

MANY STUDENTS TAKE their engineering knowledge to the next level in one of the college's dozens of student clubs. The college is home to several honors societies, professional groups and themed organizations, but hands-on groups were among those hit hardest by the pandemic. However, where there's a will, there's a way. And where there's an engineer, there's a will.

Baja Racing Team

The Wildcat Baja Racing team spends the school year designing, fabricating and testing a single-seat, Baja styled off-road car for Baja SAE, an annual collegiate competition.

"Baja really gives you something to stand out if you plan on going into industry," said Erik Knowles, a recent mechanical engineering graduate and 2019-2020 club president. "I had a Caterpillar internship at the proving ground two summers ago, and I would not have gotten that internship without Baja."

Knowles, who begins a full-time co-op at Caterpillar in summer 2021, said club members are in demand at the company because their skill sets stand out. Likewise, Emily Bauer, a 2021 mechanical engineering graduate who led a senior team designing the car, said the combination of unifying subteams into a whole team and turning physical parts into an entire vehicle helps prepare students for employment.

"It's both literally and figuratively a lot of different parts. We're taking a lot of different concepts we learn in class, like centrifugal force and centripetal force and acceleration, and applying them."

Micah Seiglaff, 2020-2021 president and rising senior in mechanical engineering, agreed that there's nothing like firsthand experience.

"You learn a lot of theory and math in classes, but it's not until you pull up SolidWorks and start running a part, and running simulations, and figuring out how you're going to put something together that you really see the whole picture," he said.

Wildcat Formula Racing

Like Baja, Wildcat Formula Racing is a design-build-compete group. Club members spend the first half of the year designing a Formula-style car and the second half testing and machining the vehicle to prepare for the Formula Society of Automotive Engineers competition.

For Carlton Louie, a rising junior in aerospace engineering and the club's marketing lead, the chance to join Formula was one reason he chose the University of Arizona.

The coolest thing about Formula, said Louie, is learning about every facet of the engineering process, from fundraising to teamwork to welding – even if a lot of the group's activities were in the virtual realm during the pandemic.

A student tests out the Formula vehicle on a weekend drive day.

"We had to bring in our money. We had to coordinate with large groups of people. And you learn a lot of interpersonal skills that you don't get in the classroom. I think it emulates working in a real engineering environment the best out of all the experiences I've had."

Hiring managers agree that Louie's experience has left him well prepared. This summer, Louie is interning at Lawrence Livermore National Lab, using the computational fluid dynamics skills he developed in the club.

UA Medical Device Club

In the UA Medical Device Club, students have worked on projects ranging from a prosthetic leg for a faculty member's dog to a minimally invasive hemodialysis catheter prototype. To introduce new members to prototyping and programming, the club also works on smaller projects, such as air quality sensors and contactless temperature sensors.

"The greatest thing that the Medical Device Club has to offer is freedom to work on a wide range of projects at any skill level while networking with likeminded students and making new friends," said club president Jacob Baker. "It has helped me fill in the gaps that my degree simply doesn't have time to cover in a comprehensive way."

When COVID-19 made it difficult to do hands-on work, the group shifted to brainstorming ideas for future projects. Meetings also became a space where members checked in on one other and provided support.

"My communication skills have grown, and that's made me more effective at connecting with students, professors and others," said Alexandra Janowski, a biomedical engineering PhD student and the club's technology coordinator.

UA Medical Device Club adviser **Urs Utzinger** gives a tour of the Peter and Nancy Salter Medical Device Design Lab, where the club does much of its work.

"You learn a lot of interpersonal skills that you don't get in the classroom. I think it emulates working in a real engineering environment the best out of all the experiences I've had."

CARLTON LOUIE, *aerospace engineering student and marketing lead for Wildcat Formula Racing*

Saguaro AUV

Thanks to his high school robotics club, Charles Penny was already familiar with goal setting and problem solving. He's gained even more experience in Saguaro AUV, in which students build an autonomous underwater vehicle for the annual Association for Unmanned Vehicle Systems International RoboSub competition.

The rising senior in electrical and computer engineering, who led the electrical/software subteam in the 2020-2021 academic year, is surprised by how much he's learned about project management. With most club members balancing full-time academic schedules and part-time jobs, just setting starting and end points isn't enough, he said.

CAD rendering of "Tiburon," the club's latest robosub design

"When you can only get people together for a couple of hours every week, you need to break down the project into a bunch of smaller, achievable goals so a large project becomes less overwhelming," he said.

Over the last year and a half, the team focused mostly on tasks that could be done virtually, such as laying out wiring diagrams and learning about software architecture. They also recorded meetings so participants in different time zones could participate asynchronously.

"I find that what gets brought up the most on my resume outside of work experience is the club," Penny said. "Most questions surrounding it involve being able to effectively communicate on an interdisciplinary team."

After many lessons in project management, it's testing day for the AUV team's robotic submarine model.

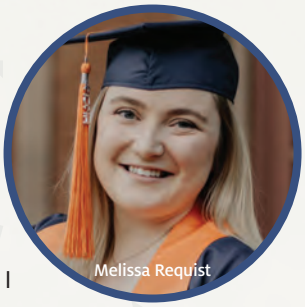
Internship Q&A

Research Is Key for Double Major in BME and Music Performance

MELISSA REQUIST GRADUATED in May 2021 with a bachelor's degree in biomedical engineering and flute performance. She even played the national anthem on her flute at commencement! Below, she shares a little bit about her 2019 internship at the National Institutes of Health Biomedical Engineering Summer Internship Program and her virtual 2020 internship at the Orthopaedic Research Lab at the University of Utah.

What did your day-to-day work look like in each internship?

At the NIH, I worked in the Extremity Trauma and Amputation Center of Excellence at Walter Reed National Military Medical Center doing biomechanics research on individuals with lower limb loss. My days were about 30% working with subjects and collecting data or working with clinical gait lab patients and about 70% data analysis. Working at NIH also exposed me to a variety of scientific and engineering careers that I had not previously known existed.


Melissa Requist

As a research analyst at the University of Utah, I focused on image-based biomechanics analysis of small bones in the midfoot. My day-to-day work consisted of image segmentation and morphologic and bone density analysis on segmented images. This internship was fully remote, so I did all of the work from my mom's office at home and, of course, had a lot of Zoom calls.

How was the experience of a virtual internship different than the experience of an in-person internship?

My in-person internship consisted of a lot of direct patient interaction, which obviously isn't possible in a virtual format. However, working remotely allowed me to learn computation methods and image analysis programs that I wouldn't have necessarily focused on if I had been doing in-person work.

Did your University of Arizona education help prepare you for success in your internships?

My education, and especially research, at the University of Arizona was instrumental to me getting and succeeding in these internships. I started researching bone viscoelastic properties and design of surgical devices with Dr. Daniel Latt in fall 2017. This research, along with classes, especially biomedical statistics, prepared me to be able to understand scientific research and develop meaningful analyses in my internships.

What's next for you?

This summer, I am starting the MD-PhD program at the University of Utah to pursue my medical degree and PhD in biomedical engineering. After the next eight years of school, I plan to continue with clinical training in a residency program, and am currently interested in orthopaedic surgery, but that might change!

Michael Marcellin Makes 'Thinking Like an Engineer' Top Educational Priority

MICHAEL MARCELLIN, Regents Professor of electrical and computer engineering, has several claims to fame, including major contributions to the development of JPEG 2000, a wavelet-based image compression method. However, he's known since his first year of college that he wanted to become a professor. So, these days, he's back to focusing on what moves him most: students.

Marcellin advises groups including the Baja Racing Team, Wildcat Formula Racing, and the engineering honor society Tau Beta Pi. He's also the founding adviser of the Arizona Autonomous Vehicles Club and the Coaster Cats Club.

"I think the hands-on experiences provided by clubs are super valuable to students' careers," he said. "Even if they don't help classroom performance, they absolutely improve students' ability to see the big picture, understand why what they're learning is important and integrate their work into a bigger system – basically, to think more like an engineer."


Among **Michael Marcellin's** claims to fame is JPEG 2000.


From left to right: **Justin Hyatt**, **Christian Davila-Peralta**, and **Roslyn Norman**, leaders of Paramium Technologies.

2020s

The UA startup Paramium Technologies received a $256,000 National Science Foundation Small Business Innovation Research Grant in 2020. **Christian Davila-Peralta**, MS/ME 2018 and PhD/ME 2020, is the company's co-inventor. **Roslyn Norman**, BS/ME 2020, is the engineering manager.

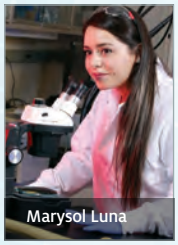
2010s

Ryan Bronson, BS/OptE 2017, was assigned to the Perseverance rover build and test schedule after less than a week on the job at Collins Aerospace. The rover touched down on Mars in February 2021. "Watching Perseverance land successfully on Mars and knowing I played a small role in helping to make that safe landing possible was surreal."

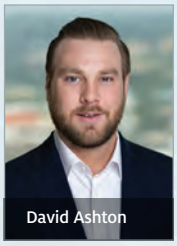
Fermin Prieto, BS/BME 2017, graduated from the University of New Mexico School of Medicine in spring 2021. Prieto came to the United States from Mexico when he was 14, and he hopes to use his skills to serve a Hispanic community. Next, he's off to the University of Washington for his orthopedics residency.


Fermin Prieto

Jack Lundin, ME/MGE 2016, CEO of Bluestone Resources Inc., was recently named to the board of directors for Lundin Mining Corp. Lundin also serves on the board of the UA Lowell Institute for Mineral Resources. The Lundin family donated $2 million, plus a $2.5 million challenge grant, to the university in 2020.


Marysol Luna

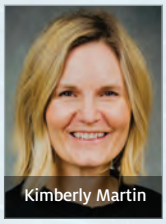
Marysol Luna, BS/BME 2015, was the first self-reported Latina to earn a PhD in mechanical engineering at Cornell University. She earned her PhD in 2020 and is now working as an associate in biomechanics at Exponent, a multidisciplinary engineering and scientific consulting firm.


David Ashton

David Ashton, BS/IE 2013, has known he wanted to be an intellectual property attorney since he was in high school. He went on to law school at Texas Tech University and is now applying his engineering mindset to his position as an associate at Patterson and Sheridan LLP.

2000s

Geotechnical contractor Keller appointed **Kimberly Martin**, BS/CE 2005, as senior engineer to oversee environmental and societal sustainability for North America. Martin is the former chair of the Arizona Geo-Institute and was previously a lead geotechnical engineer at Exxon Mobil.


Kimberly Martin

Preeti Pande, PhD/MSE 2001, is the new chief marketing officer of Plug Power Inc., a provider of turnkey hydrogen solutions. She has developed and launched technology platforms on multiple continents, served as VP of business development at Shocking Technologies, and held senior positions in the semiconductor industry.

1990s


Troy Hayes

Troy Hayes, BS/ChE 1995, is the new director for the Phoenix Water Services Department. A second-generation Phoenix Water Services employee, Hayes has been with the city for over 20 years.

Cemal Basaran, PhD/CE 1994, published a book titled "Introduction to Unified Mechanics Theory with Applications" in February 2021. It was a bestseller among new releases in three categories on Amazon. He also created the Unified Mechanics Theory group on LinkedIn, which has over 4,500 members.

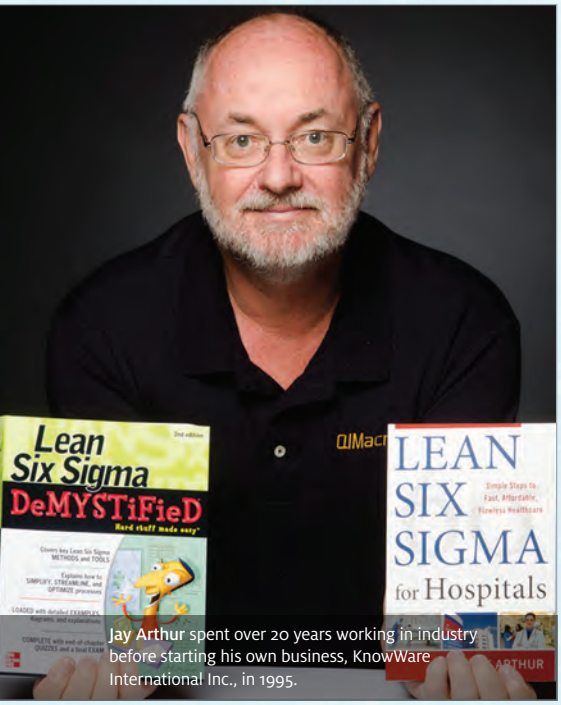
1980s

Anthony Mulligan, BS/ME 1988, CEO of Hydronalix, created the Emergency Integrated Lifesaving Lanyard, or EMILY, an uncrewed water surface vehicle for rescuing people in distress. EMILY was in the news recently when the Michigan Department of Transportation used the technology to inspect the status of bridges.

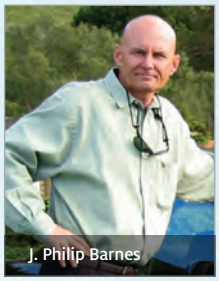

Preeti Pande is the chief marketing officer for Plug Power Inc., which provides turnkey hydrogen solutions.

1970s

Mark Baker, BS/EE 1978, received the Daniel C. Jackling Award from the American Institute of Mining, Metallurgical and Petroleum Engineers "for his contributions to computerized dispatch system development and automation in open pit mines." Baker is a founding principal of Modular Mining Systems, and he serves as governor for the Mining Foundation of the Southwest, as a director of the Lowell Institute for Mineral Resources, and a member of several UA advisory boards.



Jay Arthur spent over 20 years working in industry before starting his own business, KnowWare International Inc., in 1995.


J. Philip Barnes

J. Philip Barnes, BS/ME 1978, recently retired after 40 years of air-vehicle and subsystems concept design and performance analysis at Northrop Grumman, and he now does part-time consulting. He has written numerous technical papers on aerodynamics and green flight and delivered lectures at various institutions, including USC and Cal Poly. Learn more at HowFliesTheAlbatross.com.

Stanley M. Miller, BS/GeoE 1976 and MS/GeoE 1979, recently retired. After his graduation, he worked as a mining geotechnical consultant in Tucson, then completed a PhD at the University of Wyoming and spent 30 years in academia before returning to consulting. He is a licensed professional engineer in six states and holds a patent for PYRAWALL, a vegetated, geosysnthetic wrap-face retaining wall system.

Hycroft Mining Holding Corp. nominated **David Naccarati**, BS/MinEng 1975, to its board of directors. Naccarati, who has more than 45 years of experience in the mining industry, was formerly an adjunct professor in the UA MGE Department.

Jay Arthur, BS/SE 1973, is the author of two books on Lean Six Sigma and the creator of QI Macros, an Excel-based add-on that provides charts and tools for Lean Six Sigma. QI Macros is used in thousands of hospitals to improve health care quality and patient safety. Arthur lives in Denver with his wife. He has two daughters and four grandchildren.


A.J. (Tony) Coco

1960s

A.J. (Tony) Coco, BS/EE 1960 and former mayor of Tustin, California, writes that 2019 and 2020 were "interesting times." His adventures included open heart surgery, an artery stent and a tricuspid valve repair, in just a 12-month stretch. He is "still managing to enjoy his retirement and is now walking up the hill every day, nagged by his daughter's exhortation to 'go for a wonderful walk' she set as a repeating alarm on his iPhone."

FROM THE ARCHIVES

Thank you to the people, including Steve Goisman, BS/EE 1997, and Naomi Mahoney, BS/EngMath 1993, who identified the person in the mystery photo of our last issue. Carolyn Collins, née Lamb, BS/EE 1993, was in the Alpha Kappa Alpha sorority, the African American Studies program and the Society of Women Engineers. After finishing her degree, she found a passion for education and has been an algebra teacher for over 20 years. Her advice to current students: "No matter how hard things might get, just don't give up."

Donors Help Make Experiential Learning Possible

OVER THE LAST 15 months, our Engineering Wildcats have been dealt a hand they could not have foreseen, and they've played it boldly with tenacity.

Students adapted well to the challenges of the pandemic and online learning, mastering new concepts and completing coursework virtually. Nevertheless, many missed in-person classes and extracurricular activities. No matter how talented the instructor, how determined the student, how compelling the coursework, or how modified the activities, research tells us that engineering students do best when they are immersed in hands-on learning. They have to do engineering to learn engineering well.

Student Design Center Essential to the Vision

The college is emerging from the past year stronger. With students returning in person in the fall, the Student Design Center, or SDC, remains our top fundraising priority. The center will be a home for everything students tell us they missed most during the pandemic – a place to gather with friends, study, explore and develop skills. Perhaps most importantly, the SDC will enable all College of Engineering students to reach their full potential.

The Student Design Center establishes an essential environment conducive to interdisciplinary experimentation, collaboration and learning. It provides much-needed design, maker and build spaces, in addition to collaborative classrooms and a student advising center. And it houses clubs and organizations that foster student success and nurture the world's next leaders.

Solid Foundation Upon Which to Build

In recent years, the college has received generous gifts from alumni and donors who share the vision for experiential learning and understand the importance of a dedicated Student Design Center.

Ryan and Sarah Kanto funded a multiyear project – led by University Distinguished Professor of Chemical and Environmental Engineering Paul Blowers – to understand teaching strategies that improve retention. Financial support from Peter and Nancy Salter built the Peter and Nancy Salter Medical Device Design Lab, where students hone their skills in fabrication, testing and software development. And a generous gift from the Berge Family named the Craig M. Berge Engineering Design Program, which brings experiential learning opportunities under one umbrella across the college for all four years of the undergraduate experience.

The SDC is the next big piece in growing the college and securing students' futures for years to come. It is essential to increasing student recruitment and retention and improving success.

We cannot wait to meet in person and share more about the college's plans.

"Research tells us that students learn engineering best by experiencing it. The Student Design Center is the next big piece in growing the college and securing students' futures for years to come."

Margie Puerta Edson, CFRE
Assistant Dean, Development and Corporate Relations
520.626.0572 • puertaedson@arizona.edu

THE UNIVERSITY OF ARIZONA
College of Engineering

The University of Arizona
College of Engineering
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CALLING ALL ALUMNI!

Where has life taken you since graduation? We'd like to know and so would your college classmates. Please email us with details (no more than 300 words) and be sure to include the following information:

- Name and year you graduated
- Major
- Degree (BS, MS, PhD, etc.)
- Details of your activities

We'd also be interested to see – and share – pictures of your family, your latest work project, that boat or hot rod you just finished building in your garage, or your blossoming gardens. Vacation photos are great, too. We'll publish your news and photos online and in the next print edition.

Please send your email to *classnotes@engr.arizona.edu*

BEEN IN THE NEWS LATELY?

Let us know if you've been getting some media attention. Just email the link, and we'll keep spreading the news on the college website and in social media.

FROM THE ARCHIVES

This photo has us stumped. There were no notes on the back of the print to give us a clue, so we need your help identifying the people and project.