UNM Engineering

Engineering Solutions

Message from the Dean

WELCOME TO THE 2020 issue of *UNM Engineering.* This time last year, I don't think any of us could have imagined the year that has been 2020. A global pandemic. A rapid shift to online learning. Faculty and staff who had to make the swift transition to work remotely. Research labs closed for weeks. Student projects forced to end prematurely. Canceling important in-person events, including graduation. A halt to travel. An uncertain global health and economic future for all of us. And last but not least, a monumental shift for higher education.

In the earliest days of the pandemic, our engineers found a way to help.

It's safe to say that an inordinate amount of my time the last six months has been taken up managing all of these issues and more—making sure that the School of Engineering's mission of serving its students, as well as supporting our thriving research enterprise, is upheld. And although the past couple of semesters have been the most challenging of my 35-year career in academia, I am by nature an optimist. And I am pleased to report that despite the chaos in the world around us, the School of Engineering continues to have so much good news to report. Here are a few highlights:

- In the earliest days of the pandemic, our engineers found a way to help. Thousands of 3D-printed masks and face shields went into production within weeks, helping frontline workers in our state. Read about the efforts of Christina Salas and many others who helped in this effort on Page 2.

- Despite our research operations halting for several weeks in the spring to due COVID-19 restrictions, our research expenditures for FY20 were nearly steady with FY19 ($36.3 million this year vs. $36.4 million in FY19). Of course, had there not been the shutdown, we would have been on track to break another record, but the fact that we were able to hold steady speaks to the dedication and productivity of our faculty.

- Private giving in FY20 was immensely successful. The School's fundraising goal last year was $6 million, and we brought in a whopping $8 million, far surpassing our goal. Thanks to our fundraising team and to all the donors who made this happen and continue to believe in us. (Read about one such alumnus and donor, who helped get the astronauts home on Apollo 13, on Page 16.) We have big plans in the future for raising even more money!

- Although we are still waiting for the numbers to be finalized, the signs are pointing to enrollment numbers that are actually slightly higher than in years past! After years of declines, and at a time when many students are opting out of a semester or even a year of college while the pandemic runs its course, it is heartening to see so many students returning—or even coming in for the first time—to the School of Engineering.

We are still in the midst of this pandemic, and there will continue to be challenges this academic year and for many years to come. But the School is in a good position within UNM compared with other colleges. I am confident in the strength and creativity of our UNM leadership, our faculty, our students, and our donors and supporters that working together, we will weather this storm.

The times are tough, but we are tougher.

Christos Christodoulou
Jim and Ellen King Dean of Engineering and Computing

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Christina Salas, associate professor in the Department of Orthopaedics & Rehabilitation at UNM and special assistant to the dean of engineering for Health Sciences Center relations, led the production for 3D-printed masks for COVID-19.

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SAFE

UNM ENGINEERING FACULTY, STUDENTS HELD COVID-19 EFFORTS WITH PRODUCTION OF MASKS, SHIELDS AND OTHER SUPPLIES

"WE SAW A GREAT NEED IN THE COMMUNITY, AND WITH BOTH A TOP ENGINEERING SCHOOL AND A TOP MEDICAL SCHOOL AT UNM, THESE FORCES QUICKLY BECAME ALIGNED AND ORGANIZED BEHIND THIS EFFORT."

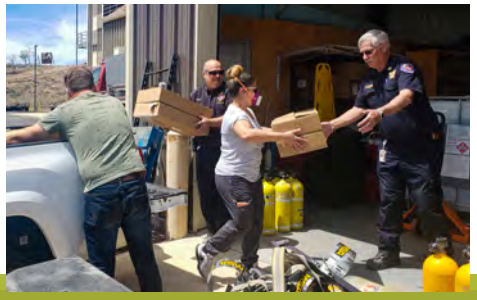
CHRISTINA SALAS

UNM Engineering launches massive COVID-19 efforts

It didn't take long after news of the global pandemic of the coronavirus hit for the School of Engineering to begin looking for ways to help. In particular, news that those on the front lines — medical professionals and emergency workers — lacked basic personal protective equipment (PPE) like masks as well as hand sanitizer were concerning, yet, being engineers, they immediately saw solutions.

Christina Salas, an associate professor of the Department of Orthopaedics & Rehabilitation at UNM and special assistant to the dean of the School of Engineering for Health Sciences Center relations, was appointed to coordinate and lead the School's varied efforts, in particular, 3D printing face masks. Salas has a unique qualification, being familiar with both the medical side, working frequently with

Christina Salas (left) and flight nurse Laura Kief Shaffer spearheaded the 24/7 mask-making efforts for UNM.



Above: Christina Salas with a 3D printer. Top right: Masks and supplies are distributed to hard-hit McKinley County. Bottom right: Salas and Dean Christodoulou with Salas' "Angels Among Us" award.

hospitals and physicians on biomedical devices, as well as the engineering side of designing, building and producing equipment used by medical professionals.

"We saw a great need in the community, and with both a top engineering school and a top medical school at UNM, these forces quickly became aligned and organized behind this effort," Salas said. "Our hope is to use UNM's resources of expertise, equipment and creativity to really make a difference to those in the trenches working with patients."

A lot of work behind the scenes took place to make sure the masks—based on a design they liked from researchers outside UNM—could be used by those in the field, according to current safety regulations. Salas was tasked with coordinating the needs of UNM Hospital physicians and working with the engineers to make sure the masks met the correct specifications. Salas worked closely with Dr. Justin Baca, Dr. Jonathan Marinaro (director of the UNM Center for Surgical Critical Care), both from UNM Emergency Medicine, and Dr. Benoit Blondeau, acute care and trauma surgeon from UNM's General Surgery, on the 3D printing efforts.

In the first weeks of the 24/7 operation, the COSMIAC research facility south of campus was the headquarters for manufacturing. Thanks to an award from the U.S. Space Force, the group was able to acquire a dozen 3D printers, HEPA filter material that has a similar filtering capability as N95, and other needed supplies. At peak production, the group was producing about 500 masks a week, used by both hospital workers at UNM as well as other medical providers across the state.

As of late August, 10,000 3D-printed masks had been manufactured, and 6,000 masks and 2,000 shields had been distributed to communities around the state, including some of the hardest-hit areas like Gallup and the Navajo Nation. The Salas group also produced 3D-printed acrylic swabs for TriCore Reference Labs for COVID-19 testing, as well as parts for a pneumatic ventilator design that uses electrical components that was developed by a local company. In addition, more than $5,000 worth of food, water and supplies were also distributed.

Another part of the operation involved 200 to 300 nurse volunteers, led by local flight nurse Laura Kief Shaffer. First housed in a warehouse adjacent to the COSMIAC space, then later in Stamm Commons when the mask operation moved to the Centennial Engineering Center, canopies with UV hoods were turned into a cleanroom-like space where manufactured masks and shields were sterilized, had filters inserted, then vacuum sealed to prepare them for distribution. In order to streamline the process of distribution to those most in need, UNM was able to coordinate with the New Mexico Department of Homeland Security.

"RIGHT NOW, WE'RE SEEING SO MANY PEOPLE WHO WANT TO CONTRIBUTE, THEY WANT TO HELP, THEY WANT TO SHOW SUPPORT FOR OUR ESSENTIAL WORKERS."

HEATHER CANAVAN

Additional efforts

Peter Vorobieff, a professor of mechanical engineering, also led an effort to produce face shields. He is studying the physics of face masks, collaborating with biologists and mathematicians to determine the effectiveness of masks against virus particles and the best ways of disinfecting masks for reuse. These masks will be manufactured with the collaboration of the New Collar Network, which includes 3D print shops in New Mexico and several other states, and the international Fab Lab Network connected to the Massachusetts Institute of Technology, which includes more than 1,000 fab labs worldwide.

And Heather Canavan, a professor in the Department of Chemical and Biological Engineering created a group called ScrubHub ABQ. The group, set up in Canavan's garage, 3D printed face shields and masks for healthcare workers; partnered with local brewery Broken Trail Brewery & Distillery to produce and distribute hand sanitizer; and also gathered and distributed materials and equipment needed to sew fabric masks for non-healthcare workers in the community. ScrubHub provided stipends for volunteers who operate the printers, courier the materials necessary to make PPE, and distribute the PPE to those who need it. Longer term, the group would like to create a nonprofit branch to respond to future health emergencies.

National recognition

Salas, along with Laura Kief Shaffer, were featured in the August 2020 InStyle magazine called "Badass 50: Healthcare Workers Who are Saving the Day." The issue focused on healthcare workers from each state who have gone above and beyond in the extraordinary circumstances of the COVID-19 crisis.

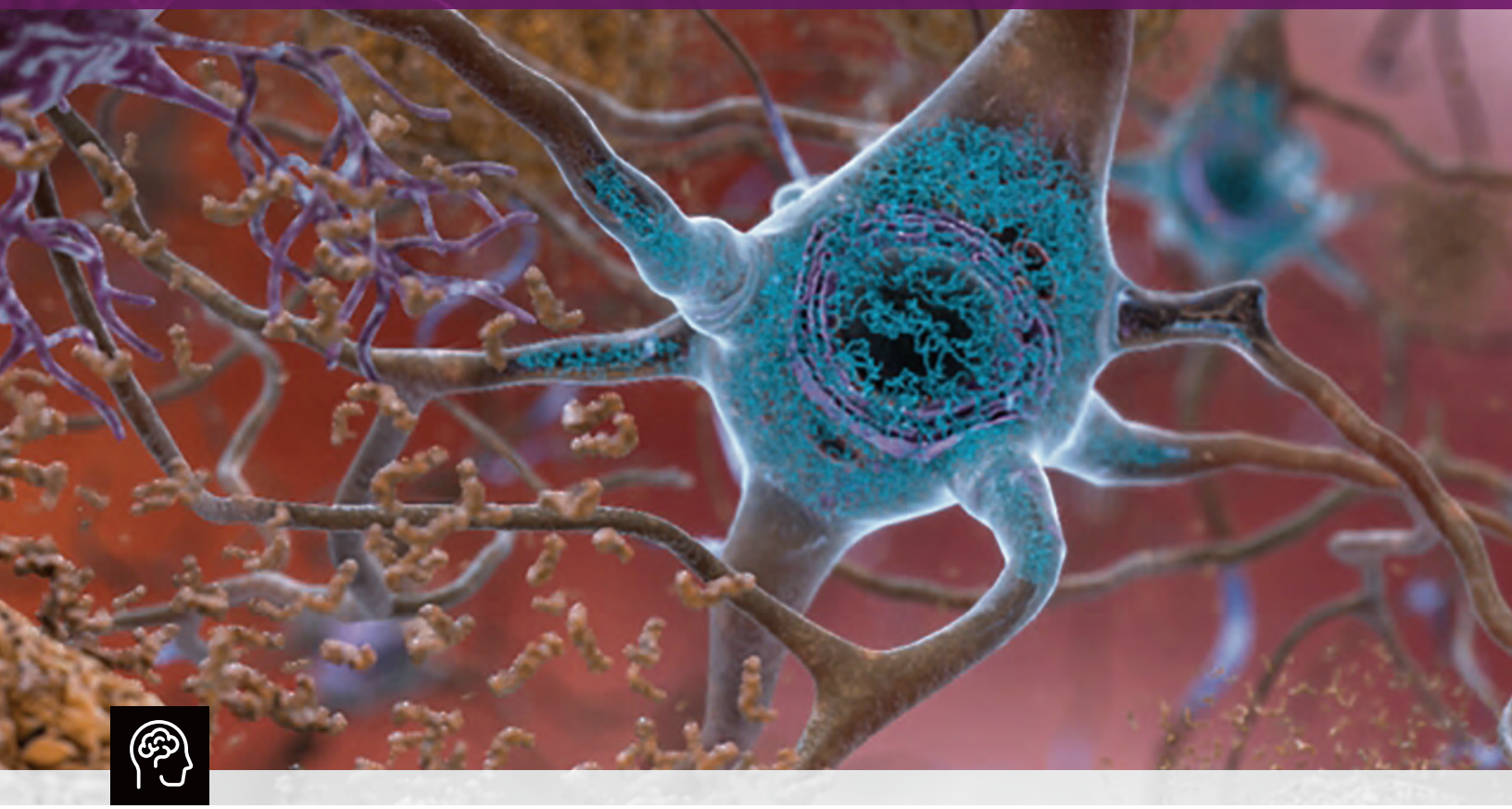
Future direction

Salas said as the need for PPE winds down as the first wave of the pandemic ends, the production may scale back further or even halt. Late this summer, the group did make some improvements on mask design, including thinner and more effective filters. If and when there is a need to restart production, Salas said the new design would be utilized.

To donate

Donations to support the 3D printing operation can still be made through the UNM Foundation at https://www.unmfund.org/fund/3d-printing-fund/. Salas said funds would be needed if production needs to ramp up later for another wave of the virus. Funds left that are not used for this purpose will be utilized for Salas' regular research in 3D printing of biomedical devices.

SMART



EARLY DETECTION OF BRAIN DEGENERATION ON THE HORIZON WITH INNOVATIVE SENSOR

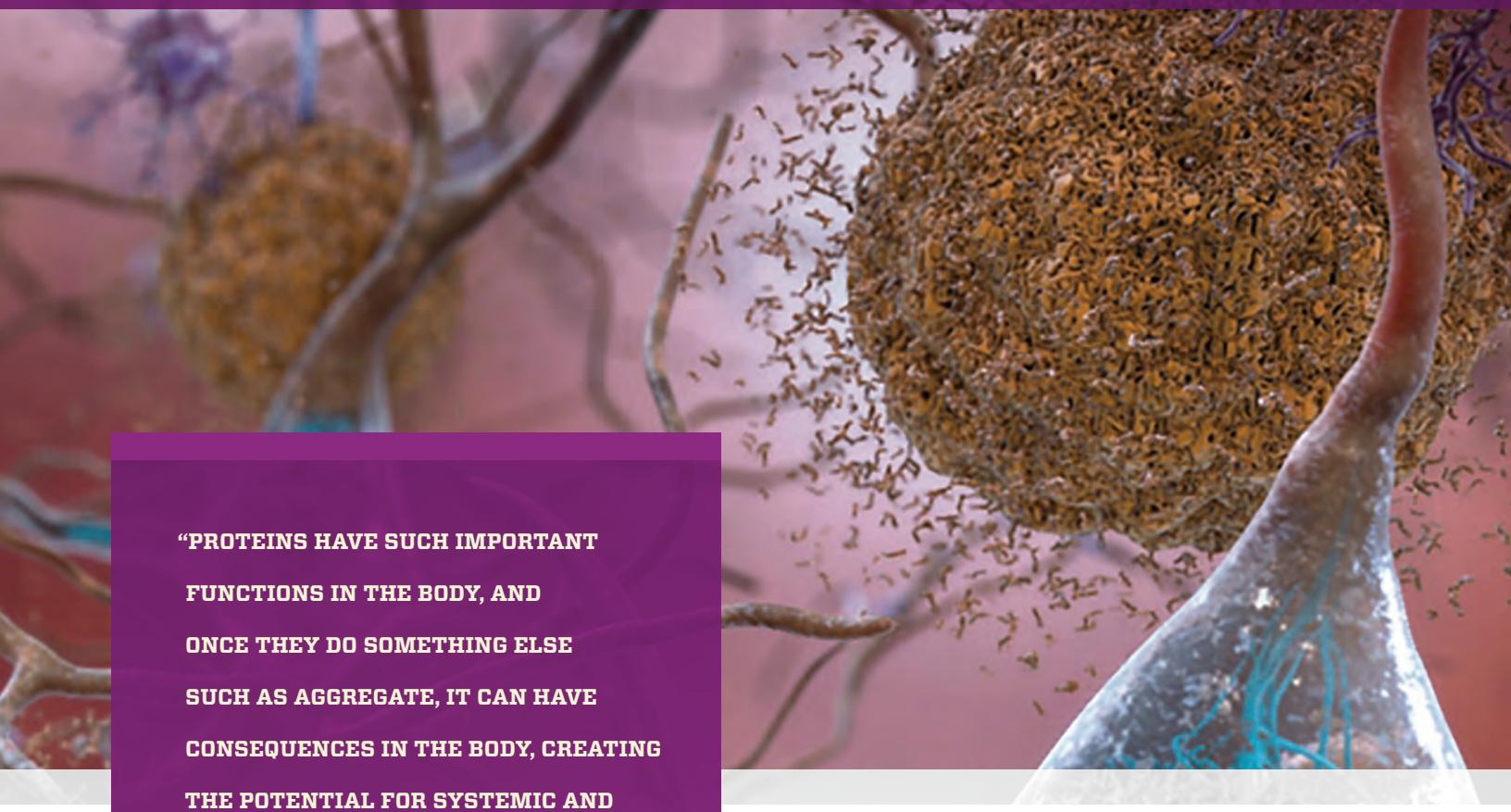
Neurodegenerative diseases such as Alzheimer's and Parkinson's can be devastating to patients and their families. These diseases are difficult to diagnose before symptoms show, meaning it's often already too late to reverse the damage to the central nervous system.

Early detection is key for management of symptoms and attempts to stall progression of the disease, but current knowledge is limited when it comes to tools that aid in early detection. That knowledge gap is being addressed through cutting-edge research by a team at UNM led by Professor **Eva Chi** of the Department of Chemical and Biological Engineering.

In order to understand complex diseases of the brain, one has to understand the complexity of human biology and the brain itself. Of particular importance are proteins — molecular structures inside a cell that can number into the tens-of-thousands — and their ability to dictate how cells function. Proteins start off with the same basic building blocks, called amino acids. The amino acids organize into a chain, and the unique function of the protein depends on how the amino acids are ordered in the chain. Once the amino acid ordering is complete, the protein chains fold themselves in various ways in order to bind to other molecules to perform certain tasks.

All proteins are made of the same building blocks; the folding of the protein into distinct shapes dictates its unique purpose inside the body. For example, digestive enzyme proteins break down our food into nutrients, and transport proteins such as hemoglobin carry substances throughout our body. Of particular interest to those who study brain degeneration are tau proteins inside neurons (brain cells) that help with cellular and nerve communication in the brain.

Protein folding is an intricate process, and as such, a lot can go wrong inside the cell. Protein folds can fail altogether, or an error in the protein chain could cause a misfold. Some of these misfolds have been linked by research scientists to numerous diseases in humans, especially when the misfolded proteins stick together. The resulting sticky clumps of proteins are called protein aggregates. "Proteins have such



"PROTEINS HAVE SUCH IMPORTANT FUNCTIONS IN THE BODY, AND ONCE THEY DO SOMETHING ELSE SUCH AS AGGREGATE, IT CAN HAVE CONSEQUENCES IN THE BODY, CREATING THE POTENTIAL FOR SYSTEMIC AND NEURODEGENERATIVE DISEASES."

important functions in the body, and once they do something else such as aggregate, it can have consequences in the body, creating the potential for systemic and neurodegenerative diseases," Chi said. Previous research over the past decade has shown a link between degenerative brain diseases and aggregation of tau proteins inside neurons (tauopathy), as well as plaque-forming clumps of protein fragments called amyloid beta that disrupt the pathways between the cells. Scientists hypothesize that these protein aggregates form in the brain long before symptoms appear, and Chi's research is focused on detection of these aggregates using a type of biosensor. Through past research, Chi and her team have developed a highly-responsive biosensor called Oligo (p-phenylene ethynylene) electrolytes, or OPEs. OPEs are as a molecular structure created in a lab that can regulate electrical signals between neurons, as well as light up under a microscope when interacting with certain types of proteins.

Aggregates form inside one cell at the start, and as a disease such as Alzheimer's progresses into the next stages, the aggregates recruit more healthy proteins inside the cell before spreading to multiple cells in the brain. Since Alzheimer's, Parkinson's, and similar diseases are not infectious, is unclear how the aggregation spreads from cell to cell. Mice models can track functionality through cognitive tests, but researchers cannot yet track biochemical changes inside a living human brain. Chi hopes the OPE sensors will also shine some light on this process.

"These diseases have a stage based on what the brain looks like, and the disease spreads throughout the brain, but we don't know how it spreads. With other types of problems in the body, there are tests—X-rays, MRIs—but there is nothing for aggregates in the brain, and it's something the field has been working towards," Chi said. "The goal is to discover the next generation of sensors that can detect the protein aggregates that are more relevant to causing these diseases. In the long run, these sensors, if effective, will work along the lines of brain imaging that can detect the size, location, and cell-to-cell spread of the aggregates."

Chi began this research at UNM in 2013 through a private grant from the Huning family, and her current grant from the National Institutes of Health builds on the knowledge she has gained since starting on this journey.

RESEARCH ROUNDUP

■ COSMIAC, a School of Engineering center that focuses on space-related research received a $19 million award to conduct communications, positioning, navigation and timing projects, which have been deemed a priority to the U.S. Space Force and other military and governmental researchers.

COSMIAC Director **Craig Kief** said it is believed to be the largest cooperative agreement ever processed between the Air Force Research Laboratory (AFRL) and the School of Engineering.

The project, known as COMPNT, focuses on communications, which is critical for space assets. On its facility roof, located south of campus near the Albuquerque Sunport, COSMIAC supports a massive number of radio frequency and optical communications systems. The testbeds run 24 hours a day, providing communications to other COSMIAC testbeds around New Mexico and to spaceborne satellites travelling 5-miles-a-second in low-earth orbit. The other area of focus is the global positioning system, or as it more commonly known in the space industry, positioning, navigation and timing

■ **Edl Schamiloglu,** Distinguished Professor of Electrical and Computer Engineering and associate dean for research and innovation at the School of Engineering, is leading a team of five universities on a 2020 Multidisciplinary University Research Initiative (MURI) Award. Schamiloglu said that "Exploration of Fundamental Limits to High Power Electromagnetic Amplification" will strive to develop high-power amplifiers, as well as to understand what the fundamental limitations are along the way. Amplifiers are key to achieving not only waveform diversity,

Edl Schamiloglu is leading a team of five universities on a 2020 Multidisciplinary University Research Initiative (MURI) Award.

but waveform agility. Also on the UNM team are **Mark Gilmore** and **Jane Lehr,** both professors in the Department of Electrical and Computer Engineering. The five-year, $7.5 million grant is shared with the University of Maryland, the University of Michigan, Michigan State University, and the University of California, Irvine.

■ **José Cerrato,** associate professor in the Department of Civil, Construction and Environmental Engineering, has been selected for a Fulbright Scholarship, which will allow him to travel to Spain to research ways to better detect contaminants in water near mining sites. Cerrato will establish a collaboration between the Electrochemistry Institute at the University of Alicante in Spain and UNM for the development of electrochemical sensors to detect metal contamination in water near mining legacy sites. His travel is expected to begin in spring 2021. In Spain, Cerrato will be conducting work on developing improved sensing technology to help alleviate some of the effects of these contaminants.

cybersecurity

José Cerrato will travel to Spain on a Fulbright Scholarship to research water contaminents near mine sites.

"Our research opportunities continue to grow, and they remain a driving force of opportunity for UNM Engineering and economic impact on the state of New Mexico."

EDL SCHAMILOGLU

To meet the growing demand to fight cybercrime, the U.S. Navy has established a program at UNM to train ROTC cadets in cybersecurity. "Engaging University of New Mexico ROTC Cadets in Cybersecurity Research" began Jan. 1. The program, part of the Office of Naval Research Navy ROTC Cybersecurity Training Program, provides hands-on training to cadets as they earn a bachelor's degree in engineering or computer science. **Fernando Moreu,** assistant professor of civil, construction and environmental engineering, is the principal investigator.

A group from The University of New Mexico is working with Sandia National Laboratories robotics experts on efficient ways to intercept enemy unpiloted aircraft systems midflight. **Rafael Fierro,** a professor in the Department of Electrical and Computer Engineering at UNM, is leading the UNM part of the project. He directs the Multi-Agent, Robotics, and Heterogeneous Systems (MARHES) Laboratory at UNM, which has extensive experience in real-time control of unmanned aerial systems, including working with Sandia on the precursor to this project.

UNMANNED AERIAL SYSTEMS

UNM and Sandia National Laboratories signed a new 10-year memorandum of understanding for a strategic alliance on June 24. The agreement focuses largely on how UNM and Sandia can collaborate to solve challenges relating to national security, said **Diane Peebles,** Sandia's New Mexico partnerships manager. In particular, the agreement focuses solving big problems in a multi-disciplinary and multi-institutional manner; exposing a pipeline of talent to problems of practical importance; and accelerating technology adoption through introducing new ideas into the marketplace.

collaboration

Sandia National Laboratories

Transitions and Achievements


Hyoung K. Lee


Melanie Moses


Ali Bidram


Susan Bogus Halter


Sang M. Han

New Faculty

The following faculty have joined the School of Engineering in 2020–21:

Amanda Bienz, assistant professor of computer science. Bienz joins UNM from the University of Illinois at Urbana-Champaign, where she was a postdoctoral researcher. Her research is focused on supercomputing topics.

Claus Danielson, assistant professor of mechanical engineering. Danielson previously worked as a research scientist at Mitsubishi Electric Research Laboratories. He specializes in model predictive control.

Joseph Haugh, lecturer in the Department of Computer Science. Haugh has been a programmer and analyst with the UNM Clinical and Translational Science Center.

Ali Heydari, assistant professor of mechanical engineering. He was previously an assistant professor at Southern Methodist University. His research interests are theory and application of controls in robotics, assistive walking devices, and cyberphysical systems.

Bruna Jacobson, assistant professor of computer science. She has been a postdoctoral fellow, research assistant professor and adjunct faculty member in UNM's Department of Computer Science. Her research interests include computational biology and machine learning for biomaterials.

Pankaj Kumar, assistant professor of mechanical engineering. Kumar comes from the University of Nevada, Reno, where he was a research assistant professor in the Department of Materials Science and Engineering. His research interests are additive manufacturing techniques for structural alloys.

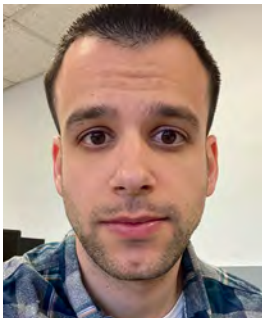
Hyoung K. Lee, professor and chair of nuclear engineering (see items on pages 11, 15).

Haobing Liu, assistant professor of civil, construction and environmental engineering. Liu's research has focused on transportation, including electrification, statistical analysis, energy modeling, and public health impacts. He comes from Georgia Tech, where he was a research engineer.

Milad Marvian, assistant professor of electrical and computer engineering. His research focuses on various aspects of quantum computing and information science. He holds the additional title of NSF Quantum Computing & Information Science Faculty Fellow. He was previously a postdoctoral associate at Massachusetts Institute of Technology.

Anjali Mulchandani, assistant professor of civil, construction and environmental engineering. Mulchandani joins UNM from Arizona State University, where she earned her Ph.D. in environmental engineering. Her research is focused on water treatment and capture/harvesting, and nanotechnology.

Lei Yang, assistant professor of electrical and computer engineering. Yang was previously a postdoctoral associate the Department of Computer Science and Engineering at Notre Dame. Her research interests are in automated machine learning, embedded systems and high-performance computing architectures.


Georgios Fragkos


Roya Nasimi


Raju Ghimire


Andre Chavez


Stefi Weisburd

Leadership

Hyoung K. Lee began Aug. 1 as chair of the Department of Nuclear Engineering. He comes from Missouri University of Science and Technology (see items on pages 11, 15).

Faculty Achievements

Melanie Moses, a professor of computer science, has been selected as a council member of the Computing Community Consortium of the Computing Research Association.

Ali Bidram, an assistant professor in the Department of Electrical and Computer Engineering, has been selected as the 2020 Albuquerque Section IEEE winner of the Outstanding Engineering Educator award.

Susan Bogus Halter, professor in the Department of Civil, Construction and Environmental Engineering and AGC Endowed Chair, was named Outstanding Educator of the Year for 2019 by the National Association of Homebuilders.

Sang M. Han, a professor in the Department of Chemical and Biological Engineering, has been named a 2020 AVS Fellow by the American Vacuum Society.

Student Achievements

Georgios Fragkos, a Ph.D. student in the Department of Electrical and Computer Engineering, was awarded the Albuquerque Section IEEE 2020 Outstanding Graduate Engineering Student award for outstanding academic performance in the field of computing and communications.

Roya Nasimi, a Ph.D. student in the Department of Civil, Construction and Environmental Engineering, won second place in the Structural Health Monitoring and Control Annual Paper Competition of the American Society of Civil Engineers Engineering Mechanics Institute. Nasimi's paper was titled "Unmanned Aerial Vehicles (UAVs) Equipped with Lasers, Cameras, and Algorithms Measuring Bridges Condition under Trains."

Raju Ghimire, a doctoral student in the Nanoscience and Microsystems Engineering Program, has been selected as one of 16 to receive the 5 Sigma Physicist Award, given by the American Physical Society.

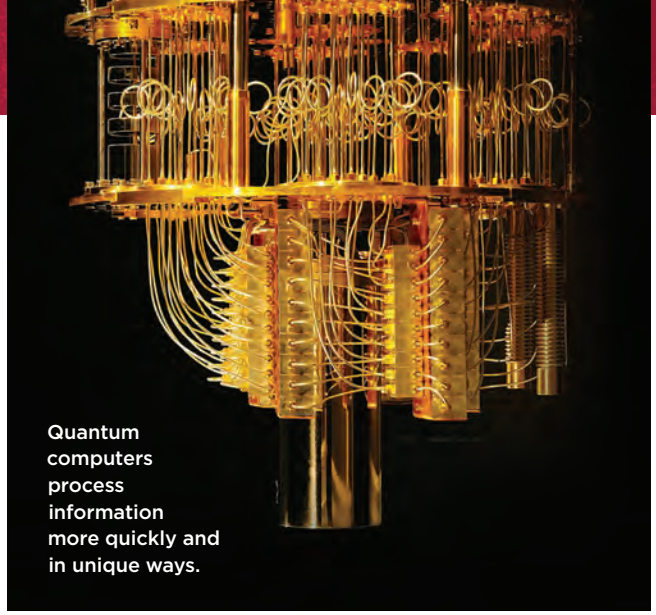
Andre Chavez, a Ph.D. student in the Department of Electrical and Computer Engineering, won a poster award at the National Renewable Energy Laboratory Reliability Workshop. The poster was titled "Electromechanical Characterization of Crack-Tolerant, Carbon-Nanotube-Reinforced Composite Gridlines Using In Situ Strain Test Setup under Scanning Electron Microscope."

Staff Achievement

Stefi Weisburd, education and outreach manager in the School of Engineering, had been selected as a 2020 New Mexico Excellence in STEM Award winner for her mentoring activities for K-12.

UNM BECOMES IBM Q HUB'S FIRST UNIVERSITY MEMBER

The University of New Mexico has joined the IBM Q Hub at North Carolina State University as its first university member.



Quantum computers process information more quickly and in unique ways.

The NC State IBM Q Hub is a cloud-based quantum computing hub, one of six worldwide and the first in North America to be part of the global IBM Q Network. This global network links national laboratories, tech startups, Fortune 500 companies and research universities, providing access to IBM's largest quantum computing systems.

Mainstream computer processors inside our laptops, desktops, and smartphones manipulate bits, information that can only exist as either a 1 or a 0. In other words, the computers we are used to function through programming, which dictates a series of commands with choices restricted to "yes/no" or "if this, then that." Quantum computers, on the other hand, process quantum bits or qubits, that are not restricted to a binary choice. Quantum computers can choose "if this, then that or both" through complex physics concepts such as quantum entanglement. This allows quantum computers to process information more quickly, and in unique ways compared to conventional computers.

"This is a very vibrant time in our field, moving from physics to broader activities."

Access to systems such as IBM's newly-announced 53-qubit processor (as well as several 20- qubit machines) is just one of the many benefits to UNM's participation in the IBM Q Hub. The IBM Q Hub will provide unique training and research opportunities for UNM faculty and student researchers for years to come.

Michael Devetsikiotis, chair of the Department of Electrical and Computer Engineering at UNM, had a vision to create a quantum ecosystem at UNM, one that could unite the foundational quantum research in physics at UNM's Center for Quantum Information and Control (CQuIC) with new quantum computing and engineering initiatives for solving big real-world mathematical problems.

CQuIC is the foundation of UNM's long-standing involvement in quantum research, resulting in participation in the National Quantum Initiative passed by Congress in 2018 to support multidisciplinary research and training in quantum information science.

UNM has been a pioneer in quantum information science since the field emerged 25 years ago, as CQuIC Director Ivan Deutsch knows first-hand. "This is a very vibrant time in our field, moving from physics to broader activities," Deutsch said.

With strategic support from the Office of the Vice President for Research, Devetsikiotis secured National Science Foundation funding to support a Quantum Computing and Information Science faculty fellow. In fall 2020, Milad Marvian joined the Department of Electrical and Computer Engineering as an NSF Quantum Computing & Information Science Faculty Fellow. He is the second faculty member hired at UNM in quantum information, the first being Tameem Albash, also in the Department of Electrical and Computer Engineering.

As part of the Q Hub at NC State, UNM gains access to IBM's largest quantum computing systems for commercial use cases and fundamental research. It also allows for the restructuring of existing quantum courses to be more hands-on and interdisciplinary than they have in the past, as well as the creation of new courses, a new master's degree program in QCIS, and a new university-wide Ph.D. concentration in QCIS that can be added to several departments including ECE, Computer Science, Physics and Astronomy, and Chemistry.

ENGINEERING PROFESSOR HONORED WITH NIH TRAILBLAZER AWARD FOR DRUG-DELIVERY PROJECT

Francesco Sorrentino, associate professor of mechanical engineering, has been awarded the National Institutes of Health Trailblazer Award from the National Institute of Biomedical Imaging and Bioengineering for a project that could improve the way drugs for diseases are timed and delivered to patients.

The project, "A Closed Loop Control System with Live Cells in the Loop," also includes Andrew Shreve, Regents' Professor in the Department of Chemical and Biological Engineering, and Todd Thompson, associate professor in the Department of Pharmaceutical Sciences at the UNM Health Sciences Center, as co-principal investigators.

Sorrentino and his team will apply mathematical modeling and optimal control methods to develop innovative approaches to multiple drug therapies in which the sequence and timing of their administration is optimized. Designing new delivery schedules has significant benefits, including minimizing the overall dose of each drug, which can reduce overall toxicity.

While the range of applications for this research is vast, the focus of Sorrentino's research for this project is on optimization of drug schedules to regulate autophagy, a key physiological process known to be involved in cellular aging, neurodegeneration and immune defense. The enhancement of autophagy during cellular stress, as when patients are undergoing cancer treatment, can lead to therapeutic resistance, making it an effective model for the design of optimal strategies.

Key aspects of this research will be conducted in the UNM Autophagy Inflammation and Metabolism Center, the only autophagy-focused NIH Centers of Biomedical Research Excellence center in the country, of which Sorrentino is an associate member.

Although much has been achieved in tailoring cancer therapies based on molecular events that drive cancer development and progression, there is significant potential for control theory-based treatments to enhance the well-being of cancer patients through careful tuning of dosage delivery of multiple pharmacological reagents.

In the overall context of control implementation in translational settings, the most successful example to date is the design of insulin-delivery functions in patients with diabetes. Progress in that area offers strong motivation for development of control strategies for drug delivery in treatment of other diseases, in particular, cancer.

"The long-term impact of this work is significant, as it will advance scientific knowledge leading to the development of optimized therapies for other diseases," Sorrentino said. "These therapies have the potential to impact millions of people around the world."

This area of research marks a new pathway in Sorrentino's career. He has conducted extensive research in the area of control theory and synchronization, with complex mathematical equations filling the board in his office and prominently displayed in a lot of his academic publications. Creating mathematical models—a theory-based practice—has been the focus of his work. His work has looked at how various systems are linked and how each action affects another action, exploring such areas as how to reduce energy consumption when trying to control a large distributed system, like the power grid, the food web or the Internet.

Sorrentino said the ability to take his theoretical work and collaborate with those in the medical field is one of the best things about working in academia.

"You work for a long time in one area of focus, so it's invigorating to be able to find new applications for your work and collaborate with researchers in other areas whom you might not ordinarily collaborate with," he said. "My hope is that this Trailblazer award will bring visibility to the wok being done in this area and one day lead to improved treatment and cures for patients."

PROJECT FOCUSES ON IMPROVING HOW HUMANS AND AUTONOMOUS TECHNOLOGY INTERACT

From drones delivering packages to your doorstep to adaptive cruise control or even self-driving features on cars, autonomous systems are now found in everything from manufacturing processes to airplanes to automobiles. The technology is rapidly expanding, affordable and accessible, but as we know, these systems are not perfect. They are undoubtedly amazing feats of engineering, but they rely upon algorithms that must interact with the most imperfect of subjects—the human.

Meeko Oishi, a professor in the Department of Electrical and Computer Engineering at UNM, is leading a project to examine this interaction and develop better ways for autonomous technology to interact with humans.

She is leading a multi-institutional 5-year, $5.5 million project funded by the National Science Foundation through the Cyber-Physical Systems (CPS) program that will seek to develop a framework for improving these systems and making them more adaptable to real-life human behavior.

Pitfalls of current autonomous systems range from overreliance, which can lead to complacency and a lack of situational awareness, to disuse, or an unwillingness to engage with the autonomous system due to perceived unreliability of the autonomous system, as well as a lack of trust in its behavior. Oishi's team will investigate ways to anticipate and mitigate these phenomena, as well as other human-automation interaction problems, such as "gamification," which occurs when humans "trick" autonomous systems into performing in some way other than that which they were intended.

Oishi says that a major focus of the project is on theoretical and algorithmic development, motivated by practical problems in current systems, as well as problems that could occur in futuristic systems. Her team will integrate human factors into mathematical and computational models, with a focus on accommodating the inherent heterogeneity of users with diverse backgrounds and experiences.

There are four main goals of the project:

- *Create cognitive models that are personalizable and computable that take into account a human's intent, skill level, trust level, attention and other factors.*
- *Create algorithms for predictive modeling and verification that can anticipate potential problems and work to mitigate such problems in run-time.*
- *Create cognitive control that responds to both the human cognitive state and the physical state of the system so that the system can adjust to objective system performance, as well as to human attention, workload, and trust, in a dynamic fashion.*
- *Develop algorithms for transparent communication so that the intent of the autonomous system is clearly conveyed to the human in a manner compatible with the task and circumstance.*

UNM is the lead institution of the project. At UNM, Oishi is joined by Tryphenia Peele-Eady from the College of Education. She is also collaborating with investigators from the University of Colorado at Boulder, University of Texas at Austin, and Purdue University, as well as United Technologies Research Center, Sandia National Laboratories, and the Air Force Research Laboratory at Kirtland Air Force Base.

Outreach and broadening participation in computing is also a significant part of this project. The team is creating an undergraduate summer research program focused on providing underrepresented students with experience in cyber-physical systems.

Additional information can be found at autonomy.unm.edu.

Sharon, Mee, Hyoung K., and Hee (Joseph) Lee

MEET HYOUNG K. LEE, NEW LEADER OF THE DEPARTMENT OF NUCLEAR ENGINEERING

The University of New Mexico's Department of Nuclear Engineering welcomed a new leader this academic year with the arrival of **Hyoung K. Lee.**

Lee, who comes from Missouri University of Science and Technology (Missouri S&T), began as department chair and professor on August 1.

He earned his bachelor of science and master of science degrees in nuclear engineering from Seoul National University in Korea in 1986 and 1988, respectively, and his Ph.D. in nuclear engineering from the University of California, Berkeley, in 1995. Lee's areas of research expertise center around medical physics and nuclear imaging topics, which include applications of nuclear imaging in medicine, nuclear energy, safeguards and nonproliferation; radiation detection; machine learning for spectroscopy and nuclear imaging; and digital image processing, analysis and CT reconstruction.

After earning his doctorate, he was employed in Korea in both industry and academia. He transitioned to Missouri S&T in 2009, where he has been a professor in the Department of Mining and Nuclear Engineering, chair of the nuclear engineering program, and director of the nuclear reactor.

While at Missouri S&T, Lee has led strategic planning for the nuclear engineering program, has grown the number of faculty in the department, has expanded the facilities and equipment and was involved in securing $9.6 million in research grants from the Nuclear Regulatory Commission, Department of Energy, Defense Advanced Research Programs Agency (DARPA) and many other organizations. In 2012, he received the Young Faculty Award from DARPA.

At UNM, Lee will be focused on strategic planning for the department, growing the medical physics program, and working on securing large, multi-institutional research grants that will help to raise the visibility and reputation of the department. He would also like to boost enrollment and grow the faculty ranks.

> "I WANT TO DREAM BIG." — HYOUNG K. LEE

Lee said he was attracted to UNM for several reasons. "UNM has great potential in nuclear engineering with two national labs—Sandia National Laboratories and Los Alamos National Laboratory—in close proximity," he said. "I would really like to expand those collaborations."

He also sees UNM as well-positioned because they have a medical school, which will be key to helping expand research and academic programs in the areas of nuclear and medical physics. A master's program in medical physics, a collaboration between the Department of Nuclear Engineering and the School of Medicine, was recently relaunched and is looking to grow. Lee's experience in medical physics will boost that mission, as well as provide an area of specialization not currently found in the nuclear engineering department.

"I want to make the department boom again," he said. "I want to dream big."

Lee is married to wife Mee, and has two children: Hee (Joseph), a student at University of Missouri, and a daughter, Sharon, a student at Rutgers University. Both children plan to go to medical school.

ALUMNUS' GIFT FOCUSED ON DEVELOPING FUTURE LEADERS IN ENGINEERING

Gordon Myers arrived at UNM in the mid-1960s, fresh from earning his bachelor's degree in electrical engineering and applied science from Caltech. While he enjoyed his time at the prestigious institution, UNM was appealing to him because it was a leader in the computer field, and he craved being at a large university with a broader set of educational opportunities.

He found that—and a lot more—at UNM. It was at UNM that Myers met his wife, Diane. The couple remained married until her death in 2014, just after the couple's 47th wedding anniversary. They had two daughters, Wendy and Laura, and three grandchildren.

Left: Gordon and Diane at Yellowstone. Right: Gordon and Diane at the 1966 UNM Homecoming.

Although the couple had divergent academic paths (Diane earned a bachelor's degree in English and Gordon a master's degree in electrical engineering, both in 1968), they both were passionate about improving public education, especially in under-served communities. Since they held such fond memories of their time at UNM, Gordon was looking for a way to make a big impact on campus that would honor Diane.

Gordon Myers found that opportunity with the establishment of the Diane and Gordon Myers Honors Engineering Fund. The fund will support programs at UNM for Honors College students in the School of Engineering to add to the richness and depth of their educational experience.

He was inspired to create the fund after he met Christos Christodoulou, Jim and Ellen King Dean of Engineering and Computing, and Greg Lanier, who served as dean of the Honors College. The two deans had collaborated on projects to expand honors opportunities to engineering students, and their enthusiasm was infectious. Plus, Diane had benefitted from the honors courses she took at UNM, so it was a natural fit to support an honors program.

Over his long and successful career at IBM that took him all around the country, he managed thousands of people, learning that "you don't manage, you inspire." Myers feels strongly that while a strong technical background is important in engineering, true success in the field requires an expanded set of experiences. "You need a blend of skills to be successful," he said. "We are all a prisoner of our own experiences. There's a broader world, a bigger world out there. You need to experience life outside your normal comfort zone."

Developing these unique experiences will be the goal of the fund. Possible uses include curriculum development, assisting with undergraduate research expenses and funding student travel. Myers was encouraged by the first honors engineering course, taught by Christodoulou in 2019, and how it attracted so many females, so he feels that a strong honors collaboration will diversify the student base in the School of Engineering.

After graduating from UNM, Myers started his career as a programmer for IBM, supporting the Apollo missions at NASA's Mission Control Center in Houston. He joined at a fortuitous time, serving as one of the programmers on the historic Apollo 11 that put the first man on the moon, as well as the "successful failure" Apollo 13 mission, which was dramatized in a popular movie. For the latter, he was one of a team to be honored with the Presidential Medal of Freedom in 1970 for helping to bring the three-man crew home safely after a nail-biting journey.

These days, instead of calculating maneuvers for lunar modules, he has his sights on the stars, serving as president of the American Association of Variable Star Observers, and enjoying life in the San Francisco Bay area. Myers also has his sights set on the stars for the School of Engineering and the growth of the honors program. "I hope a program like this will bring more women and minorities to UNM," he said. "There is no quick solution, but UNM is in a unique position to grow diversity in the sciences and engineering."

FIVE FOR Carl Willis

It's perhaps no surprise that Carl Willis, a lecturer in the Department of Nuclear Engineering, chose nuclear engineering as his field. He was born in Oak Ridge, Tennessee, one of three secret Manhattan Project cities that were built to support the atomic bomb project in World War II. His father was a physicist and his mother was a geologist and educator who worked out of a room in the Graphite Reactor (i.e., the Clinton Pile), the first industrial-scale nuclear reactor at Oak Ridge. Since 2017, Willis has been a lecturer at UNM, and since April 2019, he has been a Nuclear Regulatory Commission-licensed senior reactor operator at UNM.

Why are you passionate about educating the next generation about nuclear engineering?

Nuclear technology is among the least understood and appreciated modern technologies. It's not typically given much exposure in high school science curricula. I think there's also a prevailing public view that nuclear technology is esoteric, out of reach, dangerous, and fundamentally hard to understand. So there's an enormous opportunity to be an ambassador to the subject and help cultivate enthusiasm in the rising generation.

What is it like to operate a nuclear reactor?

UNM is home to one of the smallest nuclear reactors in the country. Operating this reactor tends to be a simple repetitive process of making occasional control rod adjustments, reading the neutron instrumentation, and entering information in logs. Behind the scenes, being a licensed operator involves supervisory duties, maintenance and drills on various schedules, filing reports to the NRC, maintaining proficiency as measured by periodic requalification exams, and getting medical exams for physical fitness to operate.

You are a big collector of nuclear artifacts. What kinds of things do you have?

I have items from Marie Curie's laboratory and a large piece of the first nuclear reactor (the Chicago Pile) that belonged to Herbert L. Anderson. I am particularly attracted to quack medical devices containing radium, such as the "Radiendocrinator" sold in the 1920s. This credit-card-sized, gold-plated radium source was devised to be worn by men against the scrotum with the thought that it would enhance virility.

Where do you see the future of nuclear engineering going?

This is an exciting time for progress on small modular reactors. Most of my career has involved particle accelerators, which are important as therapeutic radiation sources and diagnostic radioisotope sources in medicine. Radiation detection technologies are becoming more sophisticated to advance medical and industrial imaging. Space exploration relies heavily on nuclear technology. Our foreign policy depends on knowledgeable voices on matters relating to nuclear weapons. So there are many ways that this field promises to be interesting and rewarding.

Besides collecting radioactive artifacts, what are your hobbies?

I am an amateur radio operator, I dabble in plasma art, I have traveled to nuclear-impacted places like Fukushima, Chernobyl and Semipalatinsk. And I have a small three-rank pipe organ that I play exceedingly badly!

ENGINEERING

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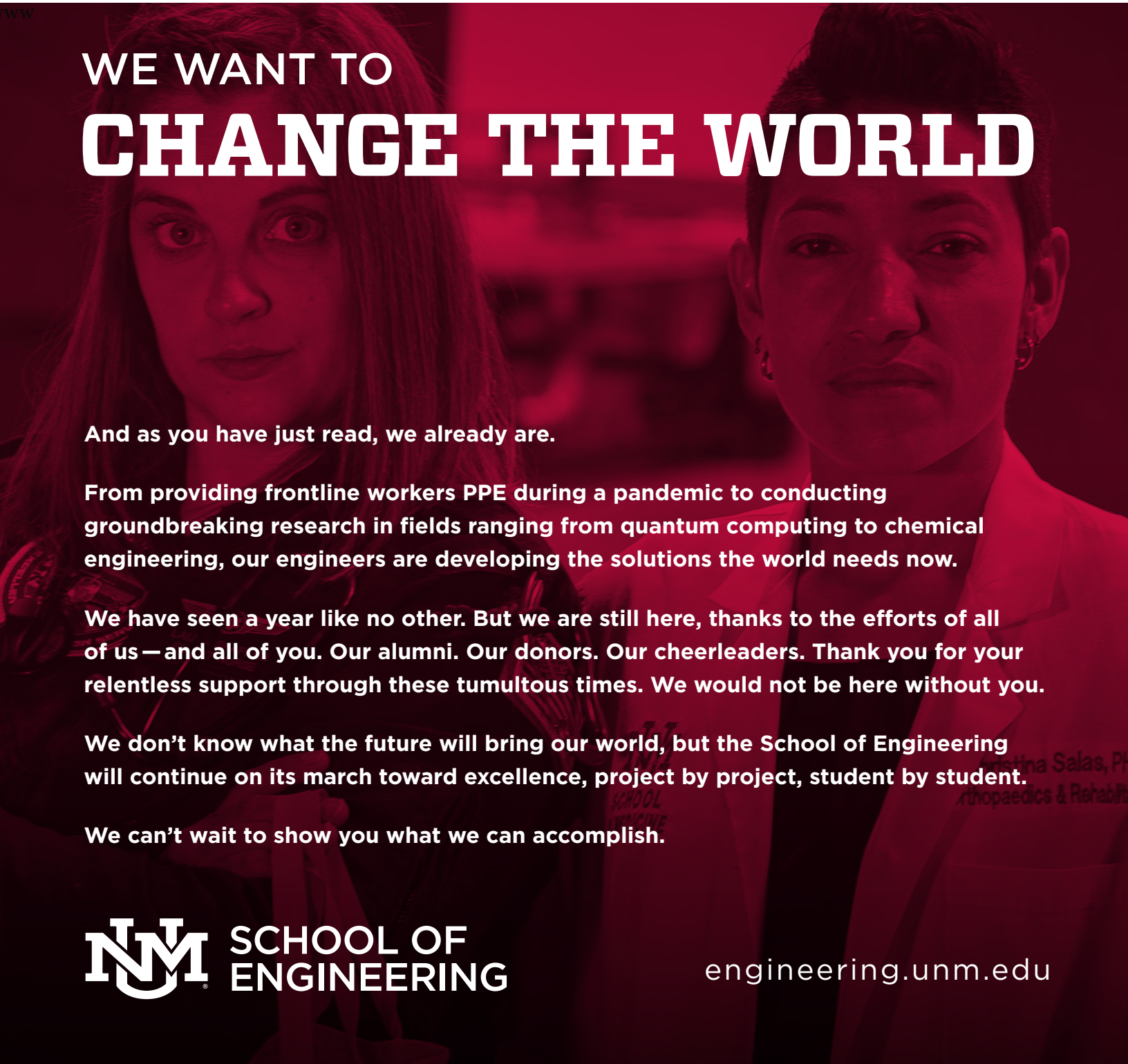

WE WANT TO CHANGE THE WORLD

And as you have just read, we already are.

From providing frontline workers PPE during a pandemic to conducting groundbreaking research in fields ranging from quantum computing to chemical engineering, our engineers are developing the solutions the world needs now.

We have seen a year like no other. But we are still here, thanks to the efforts of all of us—and all of you. Our alumni. Our donors. Our cheerleaders. Thank you for your relentless support through these tumultous times. We would not be here without you.

We don't know what the future will bring our world, but the School of Engineering will continue on its march toward excellence, project by project, student by student.

We can't wait to show you what we can accomplish.

SCHOOL OF ENGINEERING

engineering.unm.edu