

# MINES MAGAZINE



For Colorado School of Mines Alumni and Friends • Winter 2022

## TECHNOLOGY'S **QUANTUM LEAP**

Mines engineers are leading the second quantum revolution and preparing the next generation to take innovation in the field further than ever before.

### Plus:

The Orediggers make history with a record-breaking football season.

New innovations and unique ideas could help solve problems in a variety of fields.

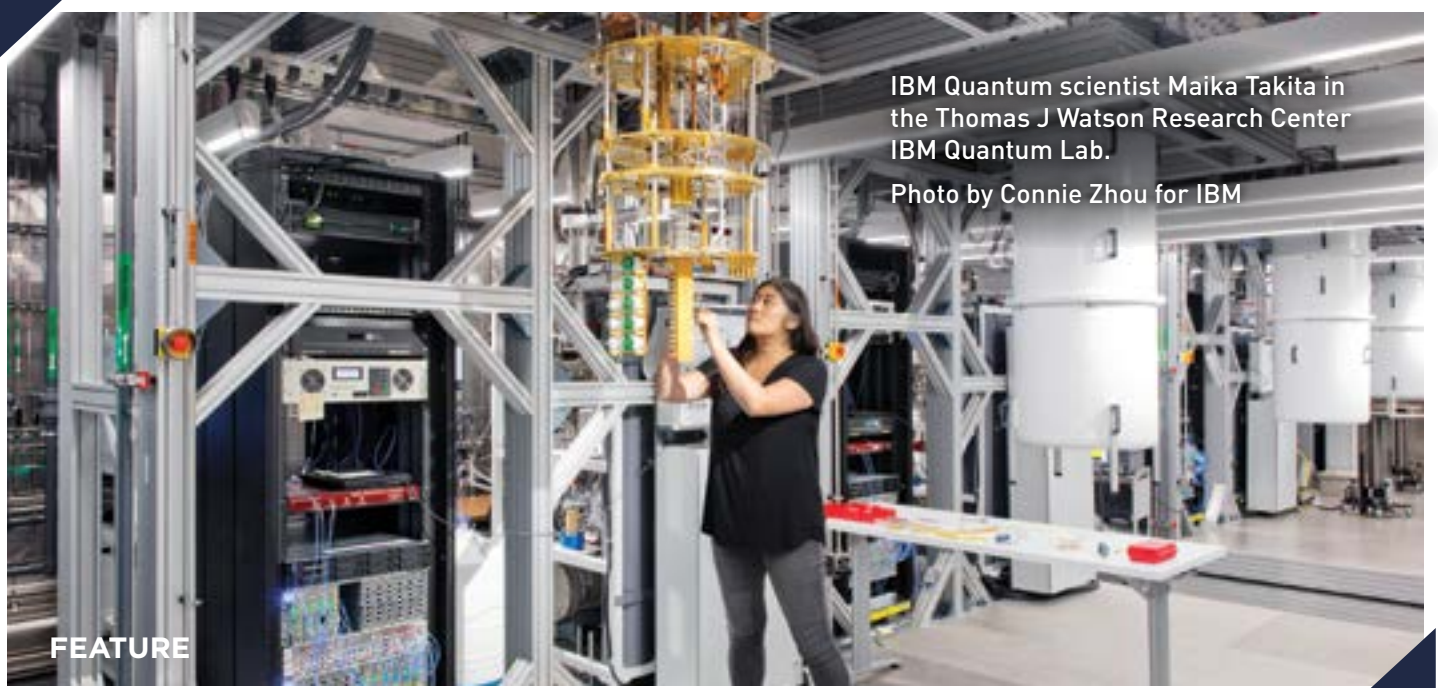


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In December 2021, Mines conferred a total of 284 bachelor's, 246 master's and 79 doctoral degrees, welcoming a new set of Orediggers into the alumni family.

- ▶ Follow Mines on social media for more great shots of the Mines community and Golden and to keep up with everything happening with your fellow Orediggers.



IBM Quantum scientist Maika Takita in the Thomas J Watson Research Center IBM Quantum Lab.

Photo by Connie Zhou for IBM

FEATURE

## TECHNOLOGY'S QUANTUM LEAP 18

Mines engineers are leading the second quantum revolution and preparing the next generation to take innovation in the field further.

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**ON THE COVER:** Quantum engineering is a fast-growing field poised to solve some of the world's most difficult problems and requires skilled engineers to work with and advance emerging quantum technology, such as the IBM Q dilution refrigerator. Photo by Graham Carlow for IBM.



# Start up Something Big

**Students, faculty and alumni now have a growing suite of resources at Mines to accelerate the pace and flow of launching a new business.**

The Beck Venture Center will be the place where aspiring entrepreneurs can turn their ideas into viable startup businesses through skill building and business planning, backed by curated connections with mentors who guide them from conception to capital-raising.

The programs will live in a 33,000-square-foot building designed to bring people together to create more value than they could on their own. Construction should start in early 2022.



“The Venture Center is evolutionary, and it makes sense that Mines is going here,” said entrepreneur Vivek “VC” Chandra PhD '88.

VC said when he was a student, Mines’ rigorous curriculum helped him develop a tough mindset and perseverance—critical qualities for entrepreneurs—but there weren’t options for learning core skills to start a company.

Instead, he learned entrepreneurial skills on the job and in graduate school, becoming a world expert in the natural gas business. His desire to find creative solutions to pressing problems led him to leap into the startup world. In 2013, he founded Texas LNG, a liquid natural gas export project.

“The startup is a humbling process,” he said. “It’s hard work to convince people to invest in your idea with just a letter and a PowerPoint slide deck. I hope the Venture Center will not only teach entrepreneurial skills, but also expose students to folks who can demonstrate them in real-life situations.”



Learn more about the Beck Venture Center at [campaign.mines.edu/venturecenter](https://campaign.mines.edu/venturecenter)



Read about how VC went from geophysicist to founder

# EDITOR'S LETTER

## Staying ahead of the curve and making a difference

There are many exceptional qualities that define Orediggers, but what has stood out to me most recently is the ingenuity of the Mines community and their drive to stay ahead of the curve. Orediggers don't just solve the problems we face today—they also anticipate the challenges that might arise in the near future and work hard to make a difference with the skills they gained from Mines.

As you'll read in this issue, Orediggers remain at the forefront of some of the latest industry innovations and technological advancements. Many Mines alumni are working on new ways to solve problems they encounter in their day-to-day lives, such as protecting wine grapes from wildfire smoke or storm drain contamination. Others are leading the second quantum revolution and ensuring the next generation of engineers has the necessary skills to lead the future of that technology. And there are

some Orediggers who are putting their Mines backgrounds to good use by helping us see the beauty of the natural world in new ways.

All of these instances demonstrate the value of challenging the status quo and investigating new possibilities, new solutions and the benefits of expanding one's skills and knowledge. No matter where Orediggers end up in their careers and everyday lives, I've learned you can count on them to face any challenge head on and exceed expectations.

Oredigger ingenuity and the drive to make a lasting, positive difference in the world truly cannot be found in the same way anywhere else, and I can't wait to see what the Mines community gets up to next.



**Ashley Spurgeon**



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## PREPARING FOR WHAT'S NEXT

### Providing pipelines for the future

The Feb. 17, 2014 cover of *Time* magazine featured a photo of a revolutionary but little-known piece of equipment that promised to, as the headline put it, “solve some of humanity’s biggest problems.” Unfortunately, it continued, “nobody knows how it actually works.”

That article, which focused on an early quantum computer called the D-Wave, was among the first mainstream attempts at explaining the potential promise of quantum computers. Eight years after it appeared, that story’s thesis—that quantum computing holds enormous, but as-yet-untapped and unproven, potential—is still regularly repeated everywhere from news magazines to Reddit threads.

And no wonder. While IBM, the federal government and many companies have been pouring resources into the field in recent years, no one has yet achieved “quantum supremacy”—despite Google’s claim in 2019. The reason? As the *Time* writer put it back in 2014, the challenge is towering—the “computational equivalent of splitting the atom.”

And the stakes are equally challenging. This technology holds the promise of delivering warp-speed advances in healthcare, manufacturing and virtually every other sector. It also has critical national security implications. With so much on the line, federal funding is increasingly pointed toward the field, and businesses big and small are pushing R&D dollars in the same direction. But what is needed now more than anything is the engineers and scientists who can move this from concept to reality.

That’s where Mines comes in. As you’ll see on page 18, our graduates, faculty and students are already enlisted in this effort. We have even been asked to enlarge the quantum workforce not just with our own programs but by helping other universities build pipeline programs like ours—for doctoral, master’s and undergraduate students alike. And our alumni are some of the few already working in and helping shape this evolving industry.

It isn’t the first time that Mines has answered the call to help lead—and produce leaders for—an important industry. This year, we’ll be celebrating the 100th anniversary of Mines’ petroleum engineering program (more on that in *Mines Magazine’s* next issue). Just as we did when we built



that department, Mines continues to answer the needs of industry and society. We continue to be the place businesses and governments alike can turn to for the knowledge and well-trained personnel they need to answer emerging challenges and make the most of still-materializing opportunities.

I hope you enjoy this issue of *Mines Magazine* and all the stories it offers about how Orediggers (including you) are shaping the future.

Go Orediggers!

**Paul C. Johnson**  
President and Professor

# NEW PATHWAYS TO A MINES DEGREE

## Helping transfer students pursue a rigorous STEM degree

BY JASMINE LEONAS

The Colorado Community College System (CCCS) signed an agreement with Mines in 2021 to partner on a new Associate in Engineering Science (AES) degree that will smooth the transfer path from community college to a four-year degree program at Mines.

Though students from CCCS institutions are already able to transfer to Mines, the new AES degree will streamline the process.

“Mines is excited to partner with CCCS on this new degree program and pathway to Mines,” said Mines President Paul C. Johnson. “It is important to us to provide admission opportunities for students from all backgrounds, particularly those who dream of being engineers, scientists and entrepreneurs but may not be ready or able to enter Mines directly from high school. Many of our successful alumni fell into this category with their Mines journey. In partnership with CCCS, we can ensure that those students are ready for Mines and the successful completion of one of our highly ranked degree programs in the applied sciences, business and engineering. Giving transfer students a clear and efficient path for starting their education at a community college and finishing at Mines is a benefit to everyone—the community college, Mines, our state and, most importantly, the student.”

Mines faculty collaborated with colleagues at CCCS to develop the two-year curriculum, which tracks as closely as possible to the rigorous core curriculum at Mines. Graduates of the AES program will complete the core engineering requirements while in community college, maximizing earned transfer credit at Mines and creating a pathway to complete any bachelor’s degree at Mines within two to three years of completing the associate degree.

Improving the experience for transfer students is also an important part of Mines’ strategic plans as the university approaches its 150th anniversary in 2024, said Gus Greivel, assistant dean of transfer student enrollment and articulation. “This degree maximizes the positive impacts for students wishing to transfer to Mines after studying at a community college,” he said. “We want to be a destination for all students wanting to pursue a rigorous STEM degree.”



## THE MINES ACADEMY: A NOVEL TRANSFER PATHWAY

■ Mines and Red Rocks Community College (RRCC) launched an innovative partnership in 2021 to support diverse nontraditional and traditional community college students’ pursuit of a bachelor’s degree at Mines. The Mines Academy at Red Rocks will provide qualified RRCC students with guaranteed admission into any four-year degree program at Mines upon completion of the two-year Associate of Engineering Science degree.

“The new Mines Academy at Red Rocks has been designed to improve the success of students transferring from Red Rocks to Mines. We want the Mines Academy student to be confident in their academic preparation, to know that their courses will transfer to Mines and to feel that they are members of the Mines community,” said Mines President Paul C. Johnson. “This is truly a novel transfer pathway model that will help to broaden the STEM professional pipeline and continue to grow our long-standing partnership with Red Rocks Community College.”

Students enrolled in the Mines Academy at Red Rocks will take high-quality math, science and engineering courses with small faculty-to-student ratios while also engaging early and often with Mines’ student success services. Academy students will also take a student success course taught by Mines to better introduce them to the campus and culture of Mines.

“Red Rocks already transfers more students to Mines than any other community college in the state, and through this new academy, that process will be even more integrated, student-centered and equitable,” said Mines Provost Richard C. Holz. “We are excited to enhance the long-standing relationship between our two institutions and hope this becomes the model for 2-year to 4-year pathways moving forward.”

The Mines Academy will enroll students beginning in spring 2022, with a start date of fall 2022. The two institutions also plan to leverage scholarships from the Colorado Opportunity Scholarship Initiative to ensure that the Mines Academy is inclusive and affordable.



## PREPARING STUDENTS TO LEAD INDUSTRY AND SOCIETY WHILE BUILDING COMMUNITY

Jerry '68 and Tina Grandey made a \$3 million gift to Mines to create the Grandey Leadership by Design First-Year Honors Experience, a yearlong program that will teach first-year students leadership principles alongside ethics, communication, innovation and entrepreneurship and research and design skills to lead industry and society while building community.

“When we were developing the MINES@150 strategic plan, we were strongly encouraged to focus on producing leaders, not just graduates who are distinguished by their technical problem-solving abilities,” said Mines President Paul C. Johnson. “Jerry and Tina’s gift and their vision for a leadership-focused honors program helps us to accomplish that. We expect this new honors program to attract those top students from around the country who have interest in STEM fields and who aspire to be future leaders in industry and society.”

Students will design a personalized leadership portfolio through reimagining and integrating learning outcomes for two core classes in the Grandey honors experience: an intro to design course and a core communications and ethics course, alongside other classes. They will also participate in cocurricular and extracurricular activities that teach and apply leadership firsthand from year one to graduation.

“Leadership is extremely important, and it doesn’t really make any difference whether you’re the CEO or a researcher,” Jerry Grandey said. “Developing the quality of leadership, the language of leadership, is extremely important. Students should be exposed to it at the very first opportunity when they come to Mines.”

Toni Lefton, executive director of Mines’ University Honors and Scholars Programs and assistant provost for the Signature Student Experience, said the program is unlike any other in the United States because it ties an honors leadership experience to the Grand Challenges for Engineering, making it an entry point for the National Academy of Engineering Grand Challenges Scholars Program.

“Our graduates need to be nimble to solve these engineering grand challenges,” Lefton said. “We want to facilitate systems-minded thinking for a world that’s connected through technology, tools, culture, politics and public policy. We want to foster the leadership thinking and communication that will let students tackle what we don’t know is coming. Ultimately, I hope that the Grandey First-Year Honors Experience leads to a strong pathway to becoming an effective leader and impactful global citizen.”

### CONNECTIONS

- ▶ Have you run into a fellow Oredigger in an unusual place? Gone on a trip with classmates? Visited campus to share your expertise? We want to know all about it! Send us your connections at [minesmagazine.com/connection](https://minesmagazine.com/connection). •





## CONSTRUCTION BEGINS ON MINES' LABRIOLA INNOVATION HUB

Construction began on the latest addition to the Mines campus in December 2021, the long-awaited Labriola Innovation Hub, to bolster entrepreneurship and innovation learning at the university.

The 37,000-square-foot building, located near 13th and Maple streets, is the state-of-the-art centerpiece of the Mines Entrepreneurship and Innovation ecosystem and the Labriola Innovation Complex. It was made possible by a generous lead gift from Frank '52 and Mary Labriola.

The \$18.6 million building, projected to open by January 2023, will feature spaces that magnify interdisciplinary teamwork and creativity, including makerspaces, project-team spaces, creativity and collaboration spaces and design-project classrooms. It will also be home to project-based competition teams, such as the American Society of Civil Engineers concrete canoe and maker- and hacker-oriented clubs.

The new building, designed by OZ Architecture and to be completed by Saunders Construction, will be LEED Gold-certified.

The creation-focused Labriola Innovation Hub is the second building in the university's three-legged E&I ecosystem to break ground. McNeil Hall, with a focus on learning, opened in fall 2020. Construction on the Beck Venture Center, with a focus on launching startups, should begin in spring 2022.

## A STELLAR RETURN ON INVESTMENT

Mines is the **No. 4** public university in the U.S. for salary potential, according to the latest rankings from Payscale.

Mines bachelor's degree recipients earn a median salary of **\$79,300** during the first five years after graduation and **\$148,700** after 10 or more years of work experience.

Mines' 20-year net return on investment—the difference between 20-year median pay for a bachelor's degree graduate and 24-year median pay for a high school graduate, minus the four-year tuition cost—was calculated at \$1,017,000.

Mines also scored high on return on investment on Payscale's Best Value Colleges list, ranking **No. 7** among all public and private universities.



## SOLVING PROBLEMS IN A FLASH

Mines students were given a new opportunity to bolster their entrepreneurial skills and test out new ideas on campus last fall. Mines' Innov8X program, which provides a robust set of courses, a summer residency program and events that support hands-on growth of entrepreneurial skills, hosted a set of flash challenges where student teams could develop and pitch solutions to real-world problems through high-intensity, short-duration efforts.

Student teams set out to define a problem related to two themes: virtual experiences

and health/wellness/outdoors. They were then tasked with determining the target market and audience, exploring alternative solutions to the problem, iterating on those solutions and developing prototypes—all within two hours. The teams presented their solutions to judges, including Mines alumni.

The flash challenges aim to develop students' entrepreneurial mindset and turn problems into solutions with real-world impacts while providing mentorship from industry leaders.



► Terry Fox '89 gave a lecture on campus in October 2021 as part of the Women in Science, Engineering and Mathematics Program's Chevron Lecture Series. •

# HISTORY ON THE GRIDIRON

## Mines football makes history—in more ways than one

BY SAM BOENDER

When the Mines football team returned to the gridiron this fall, the Orediggers appeared no worse for wear after a season away from competition during the COVID-19 pandemic. In fact, quite the opposite was true. Mines snapped its 642-day hiatus on the evening of Sept. 2, 2021, with a dominant 42-3 victory against Western Oregon at Marv Kay Stadium, and that was only the beginning of what proved to be a historic season for the Orediggers.

The following three months saw Mines football accomplish many things that had never been done in the 133-year history of the program. Seven straight wins brought the Orediggers up to No. 3 in the American Football Coaches Association National Poll for their highest ranking ever. That seven-week run included a runaway 76-0 victory at Fort Lewis and a 20-14 overtime nail-biter against Western Colorado during Mines' Homecoming weekend. Running back Michael Zeman led the early charge with more than 100 yards rushing in six of the seven wins while racking up 12 total touchdowns—10 on the ground and two more receiving. The Orediggers were arguably more

impressive defensively through those first seven games, with 59 tackles for loss, 26 sacks, seven interceptions and six forced fumbles which were all recovered.

Mines' late-October stumble at Colorado Mesa, in which the Orediggers nearly pulled off a last-second comeback but ultimately lost, was merely a blip on the season's radar. The team immediately bounced back and closed the regular season with three consecutive wins for yet another slice of history as Mines clinched its third straight Rocky Mountain Athletic Conference title. The 63-0 win in the regular-season finale against Adams State at Marv Kay Stadium also afforded Mines its 14th conference championship overall and locked the Orediggers in as Super Region IV's No. 1 seed for the NCAA playoffs, marking another first in program history. But the milestones still didn't stop there.

The Orediggers found themselves pitted against Bemidji State after taking full advantage of the first-round bye as the bracket's top seed. The result was a 55-6 blowout—Mines scored 35 of those points in

## CEMENTING THEIR NAMES IN HISTORY

In addition to the football team's overall success, Mines' extraordinary season included numerous individual accolades.

**23** Orediggers were voted to the All-RMAC teams

**5** student-athletes were awarded all-region distinction

Mines claimed multiple NCAA player of the week awards

Running back Michael Zeman was named finalist for the Harlon Hill Award, the top honor in all of NCAA Division II football

Head coach Gregg Brandon surpassed **100** wins in his career

the third quarter, while the defense engineered a game plan that held the nation's No. 7 offense to zero touchdowns. The Orediggers advanced to their first national quarterfinals, where they dispatched second-seeded Angelo State by a score of 34-26 and marked another Mines football high point as the Orediggers punched their first-ever ticket to the national semifinals to face Valdosta State.

The rest, as they say, is history. "It feels good to do right by the guys who have gone before us," said linebacker Gabriel Kortz. "It also feels good looking up in the crowd and seeing all the freshmen and redshirt freshmen on the team and knowing we're doing right by them by setting up a program with a tradition of winning and success."

While the Orediggers ultimately ended their season in the semifinals, it's safe to say that Mines football left it all on the field as they made history on the gridiron.

► For more on Mines Athletics, visit [minesathletics.com](https://minesathletics.com).



## CONNECTIONS

- David Estabrook '00 gave a lesson on finances and budgeting this fall in partnership with Mines' economics and business department. •



## Work with us

### Did you know Mines alumni can engage with the Career Center in many ways?



#### Hiring for internships or full-time positions?

We can connect you with current students to meet your business needs.



#### Interested in volunteering?

The Career Center would love to hear your career journeys and how they might inspire students.



#### Looking for your next career move?

The Career Center serves recent graduates for the first two years beyond graduation and partners with the Alumni Job Center to serve alumni for a lifetime, including full access to our renowned Career Days.

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## OREDIGGER ICONS ENSHRINED AT HOMECOMING

### Four former Mines athletes inducted into the Hall of Fame

Homecoming 2021 saw the return of many traditions and in-person activities, including the Mines Athletics Auction and Hall of Fame Banquet to honor Oredigger athletes who made historic and lasting contributions to Mines' athletic program. Four Oredigger icons were inducted into the hall of fame this year. Here is the newest class of Mines Athletics Hall of Fame members.

#### **Anna Evans '14, MS '21**

Women's Soccer, 2010-13

Evans was the catalyst behind the transformation of Mines women's soccer into a national power, earning three all-America and two Academic All-America honors in her career. She scored 55 goals and 23 assists as an Oredigger and led Mines to four RMAC titles—three tournament and one regular-season—from 2011 to 2013.

#### **Mark Husted '09, PhD '19**

Men's Cross Country and Track & Field, 2006-10

Husted is the only Oredigger to win national titles as a student-athlete and as a coach, capturing two NCAA Division II crowns on the track in the

men's distance medley relay and 800-meter and helping Mines cross country to the 2019 NCAA Division II team championship. He was a six-time all-American on the track and three-time Academic All-American.

#### **Mack McLain '12, MS '15**

Men's Cross Country and Track & Field, 2008-12

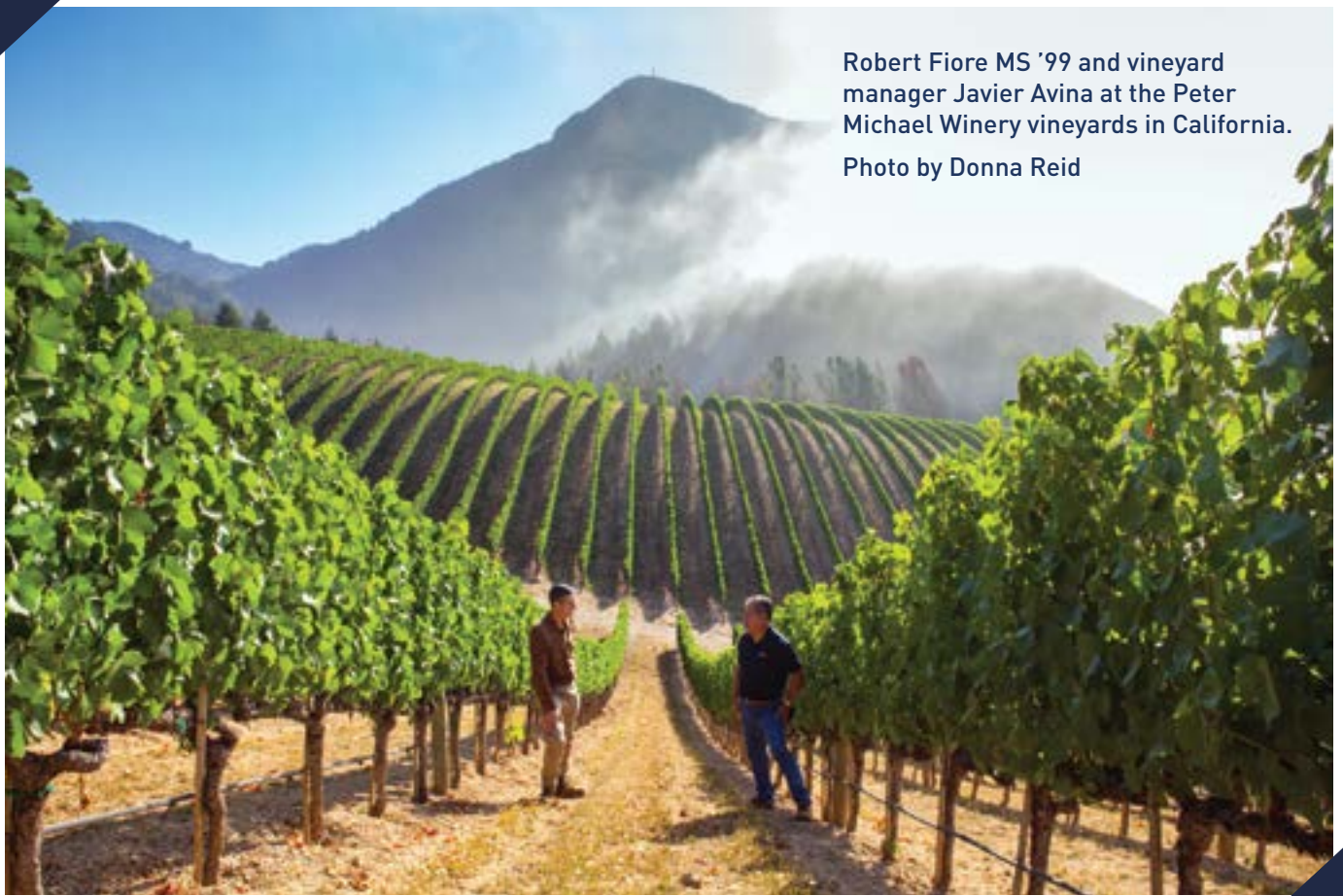
McLain is the most decorated student-athlete in Mines history as a three-time national champion and 12-time all-American for the cross country and track & field programs. The middle-distance specialist won NCAA Division II crowns in the men's distance medley relay, 1,500-meter and mile and is Mines' only three-time national champ.

#### **Bob Stitt**

Football Head Coach

Stitt, who coached Mines football from 2000 to 2014, won a program-record 108 games and helped put the program on the national map. He won RMAC titles in 2004, 2010 and 2014, along with the program's first NCAA Tournament appearance.

Robert Fiore MS '99 and vineyard manager Javier Avina at the Peter Michael Winery vineyards in California.  
Photo by Donna Reid



## PREVENTING A CASE OF SOUR GRAPES

Activated carbon hoods protect wine grapes from wildfire smoke

BY JEN A. MILLER

As California wildfires continue to grow in frequency and intensity, wineries in Sonoma and Napa Valley are looking for ways to protect their grapes from wildfire smoke, which can ruin the taste of the grapes and, therefore, any wines made from them.

Robert Fiore MS '99, a winemaker at Peter Michael Winery in California, is working on one potential solution: covering grapes with activated carbon, or AC hoods, which “purify the air so that smoke compounds don’t reach the skin on the surface of the grapes,” he said.

AC is a form of carbon—usually charcoal—made extremely porous through physical or chemical treatments. Just one gram of AC can have a surface

area of up to 32,000 square feet. “It’s an extraordinary amount of surface area,” Fiore said.

Molecules and chemicals adsorb onto that carbon, preventing contamination. Already, AC is used in everything from water purifiers to methane and hydrogen storage to treating poisonings and overdoses.

The idea of using AC fabric on grapes came from Sir Peter Michael CBE, who, in addition to founding Peter Michael Winery in 1983, trained as an engineer and founded a number of technology companies.

After the intense 2020 California wildfires, he asked Fiore if putting grapes in an AC bag would filter out smoke compounds.

### CONNECTIONS

- ▶ Mines alumni were invited to the November Lunch Bunch event to hear updates from the Mines Veteran’s Alliance and ROTC program. •

After consulting with professors from the University of California, Davis, and California Polytechnic State University on the viticulture side, Fiore thought it might work. He sourced three different kinds of AC fabric, which he then sent to Kerry Wilkinson, professor of oenology at the University of Adelaide in Australia, for her to test on grape clusters there.

Not only has Wilkinson been studying the problem of smoke taint for more than 10 years to combat the effects of bush fires on the Australian wine industry, but being on the other side of the planet, she was in ideal grape growing season at the time Fiore proposed this idea.

In field and laboratory tests, Wilkinson found that the hooded grapes had 97 percent less smoke taint compared to non-hooded ones—far more effective than any other method tried before. Fiore conducted his own test on some of Peter Michael's grapes in 2021 to see if the hoods would affect the development and maturity of grapes and the wines made from them. He expects to summarize his findings in winter 2022.

Becoming a winemaker after studying geophysics might seem like a leap, but Fiore's interest in wine started when he was in college studying geological sciences at the Ohio State University.

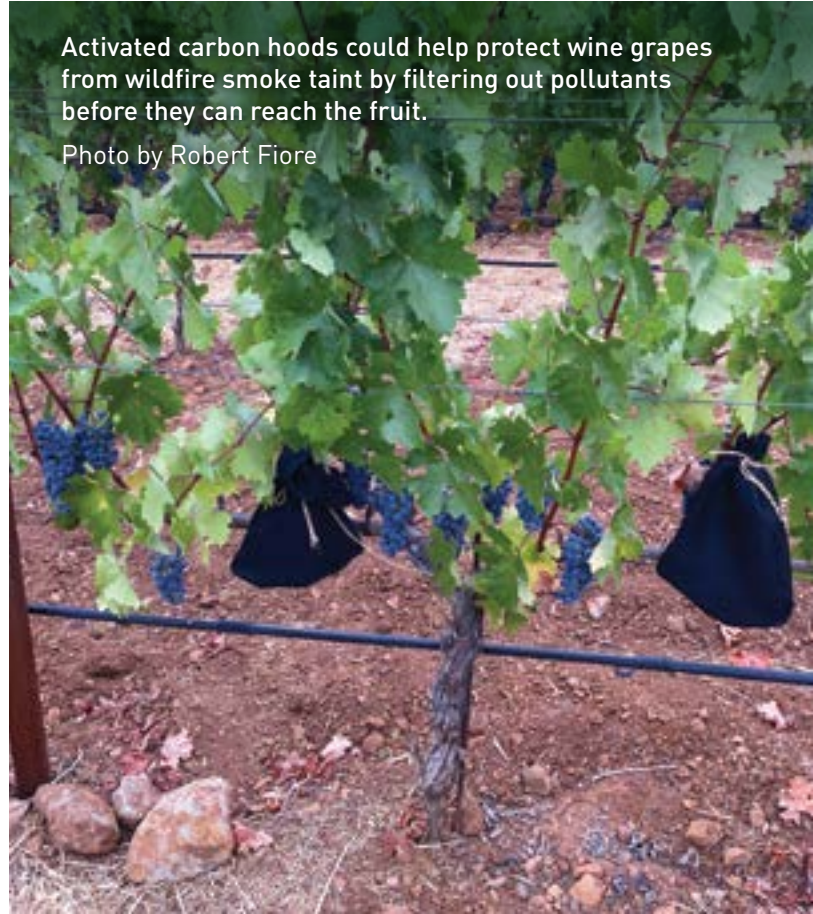
"When other people were having keg parties, my friends and I were having wine and cheese parties," he said. After graduating from Mines with a master's degree in geophysics, he moved to California, conducting seismic imaging for Chevron, and his interest in wines grew. While working full time as a geophysicist, he interned at different wineries, worked harvests and started a boutique wine label, the Wan Fiore Project, with his brother-in-law.

When Chevron said he'd have to move to Houston for the next step in his career path, he decided to stay in California, get another master's degree in viticulture and enology from UC Davis and work in wine full time.

Geophysics also plays a role in the wine industry, Fiore said, and is used to better understand the environment in which grapes are grown. Wineries often use remote sensing multispectral data to make maps of vineyard canopy growth and electromagnetic and resistivity data for mapping soil heterogeneity

Activated carbon hoods could help protect wine grapes from wildfire smoke taint by filtering out pollutants before they can reach the fruit.

Photo by Robert Fiore



in the vineyard. "Combining these data with maps of soil pH, aspect, slope and water-holding capacity helps delineate tremendous wine-growing terroir from another site that's not as exceptional," he said.

Fiore said that AC hoods do show promise—for grapes and other fruits—but right now aren't practical for large-scale deployment. "To bag grapes on a vine and then do it in a row and then do it in a whole vineyard is an extraordinary amount of labor," he said. He hopes that by sharing these findings with other winemakers, scientists and engineers, they can come up with ways to put them into use more widely for maximum benefit.

"The more people working on it and the more smart people that are involved, the more likely we can come up with a practical solution," he said. "But at least we know that we're moving in the right direction."

- ▶ Tota Mukherjee '96, Jennifer Jacobs '16 and Jonathan Paz '17 participated in a virtual event in November to share what it's like to live and work on the West Coast. •



# ADDRESSING THE CHALLENGES OF THE GLOBAL ENERGY FUTURE

Energy innovation requires new technology, balance and Mines experts to lead the way

BY ASHLEY SPURGEON

The global energy sector today is focused on finding sustainable energy sources and reducing the world's carbon footprint. But for many, it's unclear what the winning solutions will be, whether they will have long-term viability and when the world's energy needs can be satisfied by net-zero carbon emissions sources.

We reached out to Susan Perrell '81, an environmental advisor at Aera Energy, and George Wayne '85, MS '92, vice president of market services at Kinder Morgan, to get their take on the innovation currently underway in the field and what will be required as we move forward into our global energy future. Here's what they shared.

**The world's energy future doesn't mean eliminating fossil fuels completely—it's focused on new innovations, such as those related to carbon capture, utilization and storage, to help eliminate carbon emissions and maintain a reliable, affordable and balanced energy portfolio.**

Many oil and gas companies are working to lower their carbon footprint and supplement tried and true energy sources with new, more sustainable options to get closer to the goal of a net-zero carbon future. For example, Kinder Morgan, one of the largest energy infrastructure

companies in North America, is finding this balance by positioning itself to provide energy solutions for the future in areas such as CCUS and low-carbon fuels. The company is focusing on business development activities through its newly established Energy Transition Ventures team or finding synergies with its traditional-based business of energy transportation and storage.

But these activities also mean that any new technology or energy source must check the right boxes to adequately meet the world's needs. "It has to stay within the bounds of reliability, affordability and being clean," Wayne explained.

That's a challenge that's easier said than done, but many companies are making significant efforts to find those solutions while making reductions in their own environmental impacts. Aera Energy, for example, has not only entered the race to create more sustainable energy sources but is also looking into new technologies and practices to sequester carbon emissions. "We're looking at every possible way to become carbon neutral," Perrell said.

One of the ways Aera is doing that is by using what it already has. As one of the largest oil and gas operators in California, Aera owns several oil fields that have been

## CONNECTIONS

- ▶ President Paul C. Johnson joined M Club Portland in early November to share campus updates and what lies ahead for the university and catch up with Portland-area Orediggers. •

producing for nearly a century, meaning the oil in those reservoirs is now largely depleted. Perrell and her team are working to repurpose those depleted reservoirs into storage for CO<sub>2</sub>.

“There’s a lot of pore space—the interstitial airspace between each grain of sand in that reservoir—that used to be occupied by oil and water. We produced the oil out of the reservoir, we decreased the fluid saturation and fluid pressure in the pore spaces that were once filled,” Perrell said. “These reservoirs are no longer as productive as they once were, and now their pore space is ready to serve a new role as a permanent storage space for CO<sub>2</sub>.”

Perrell is investigating how Aera can remove CO<sub>2</sub> from their emissions, compress it and turn it into a liquid that can be injected underground into the reservoirs. “An oil reservoir that stored oil and gas for millions of years has already proven itself to be a highly secure place to store CO<sub>2</sub>,” she said.

And this is just one example of the carbon sequestration work happening at Aera—and throughout the oil and gas industry. There are many other similar projects that are providing the necessary innovation to change how the world sources and manages its energy output.

### **But that doesn’t mean oil and gas is on its way out.**

“From a very practical standpoint, oil and gas will be around for quite a while,” Wayne said.

Wayne explained that there needs to be a balance between the energy sources we currently use and alternative sources, otherwise we will cause more problems.

“For instance, if everybody put up solar panels on their homes and industries, it would place a huge burden on the electric grid,” he said. “You’d have to totally reengineer the grid to be able to support something like that to not only make it reliable but affordable for all consumers. There are a lot of simple, practical things that have to happen to make this transition happen.”

The solutions that must be considered when developing the global energy future can’t take an all-or-nothing approach. The world must find the middle ground where oil and gas still has its place while being supplemented by additional energy sources and sustainable practices.

### **While there are many technical challenges in developing new practices and technologies,**

### **there is also a need for more expertise in regulation and policy to speed up and improve innovation in these areas.**

Developing CCUS technology or clean energy sources is a technical challenge in itself, but it’s equally challenging to get these new types of projects reviewed and approved by regulatory agencies so they can be implemented and put into everyday use.

“I know, confidently, that we will tackle all the technical challenges, and we will make the technology more cost-effective and more efficient over time,” Perrell said. “But under a relatively new regulatory framework, it’s still a challenge to permit these carbon sequestration projects. There have been just so few projects that both permit applicants and permitting agencies are inexperienced with CCUS permitting programs.”

The regulatory permitting cycle can take years to complete in addition to the technical studies and engineering needed to get a sequestration project or potential energy source off the ground. More engineers with expertise in environmental, geological, geophysical, reservoir and other engineering fields, as well as stakeholder engagement, are needed to help move these projects forward.

“Economics and policy are very important,” Wayne said. “Understanding and quantifying the economic differences is critical to being able to apply a technological solution.”

### **Although these challenges seem daunting, Perrell and Wayne agree that Mines graduates are primed to lead these challenges—from the technical to the economic.**

“Mines is uniquely positioned—we’ve been hanging out in oil and gas reservoirs for decades. We have a profound understanding of geological systems, processes and engineering technologies, and we know how to communicate all this to others. We got this,” Perrell said. “And we’re really good at it.”

Mines researchers and alumni actively working on energy solutions, whether in a lab, classroom or out in the field, see firsthand just how these new innovations can be applied for maximum benefit.

“Faculty at Mines have energy experience and can connect the dots for students,” Wayne said. “Then our alumni are out in industry and can easily connect the dots for regulators and politicians and people who have these aspirations to make these things more realistic and tangible.”

► Learn more about the Global Energy Future Initiative at Mines at [mines.edu/global-energy-future](https://mines.edu/global-energy-future).

► Several M Clubs hosted holiday parties in December 2021 to celebrate the season. President Paul C. Johnson even popped in to the Houston celebration to welcome the new December graduates into the alumni family. •



# OUT OF THE GUTTER

## A new invention provides a solution for storm drain pollution

BY LYNN CLARK

As an inventor with four U.S. patents and four registered trademarks, Brian Deurloo '97 loves developing new ideas. His first patent was for magnetic cigarette butts, and the other three are for his commercialized invention, The Gutter Bin® stormwater filtration system, which helps keep cigarette butts and other trash out of rivers and oceans.

"I've hated cigarette butts since I was a kid," Deurloo said. "I thought, wouldn't it be cool if you could pick them up with a magnet? I filed the idea away."

Fast forward to 2015. Deurloo and his wife emerged from the Bell in Hand Tavern in Boston and saw a 220-year-old cobblestone storm drain clogged with cigarette butts. Disgusted, Deurloo wondered where the trash went—to the water treatment plant or the bay? He discovered the stormwater goes into the ocean or the river. Worldwide, about 4 trillion cigarette butts hit the ground every year, he said, potentially poisoning the water supply with nicotine, which is one of the strongest insecticides in the world and known to kill fish quickly.

"I remembered my idea about using a magnet to pick up the butts, and I decided to design and patent it," he said.

Deurloo looked for help at Mines, and was introduced to Terry Lowe, a research professor in the George S. Ansell Department of Metallurgical and Materials Engineering. "I remember sitting in the metallurgical lab—I hadn't been in that building since 1990," Deurloo said. "Dr. Lowe told me the idea is great, but it's a (terrible) business. Even though he was skeptical, he agreed to work with me. But he suggested I find another idea for solving the problem that could actually make money."

Four nights later, he sat up in bed at 2:37 a.m. with a vision of a gutter filter that would capture debris, including cigarette butts. By 3 a.m., he started creating a cardboard prototype in his garage, and at 4 a.m., he was at Walmart buying supplies. A few months later, he entered a University of Wyoming startup challenge and won it.

The Gutter Bin is an adjustable funnel system that is installed into storm drains to direct polluted water into

### CONNECTIONS

- ▶ Mauricio Gutierrez MS '99, president and CEO of NRG Energy, joined the Payne Institute for Public Policy for a conversation about clean energy in November 2021. •



a patented water filter that can be quickly and easily removed, weighed, emptied and recycled.

Today, his environmental technology company, Frog Creek Partners, works with The Greenway Foundation, MYCELX and Rotary International clubs and has installed Gutter Bins at the Denver Zoo, in Vail, Fort Collins and Sheridan, Wyo., and many other places. There are even several Gutter Bins at the new Meow Wolf arts collective in downtown Denver.

What's more, the Microsoft Community Environmental Sustainability Initiative made a \$100,000 grant to Frog Creek Partners and the Rotary Club of Cheyenne, Wyo., to install 64 Gutter Bins in Cheyenne to help restore and protect Crow Creek from the threat of stormwater pollution, according to a media release. The filters should capture three tons of pollution a year. His latest project is with the city of Colorado Springs, which is required to spend \$460 million on stormwater infrastructure in the next 20 years after being sued by the Environmental Protection Agency and the state of Colorado for polluting Fountain Creek and the Arkansas River.

"Our goal is to get highly networked people to focus money on cleaning up stormwater," Deurloo said. "We want to get the community to get involved in cleaning up their own rivers."

Deurloo's work is getting noticed nationally, too. He was just listed on the Forbes Next 1000 of 2021, which showcases inspirational entrepreneurs with under \$10 million in revenue.

"I was blown away that they chose me," he said. "If you would have asked me if this would happen five years ago, half of me would say no way, and the other half would say why did it take so long. I was happy to receive that vote of support. It tells me I'm on the right track."

"I'm dreaming big," said Deurloo, whose win in the University of Wyoming's Casper Start-Up Challenge gained him a grant and an office. "I want it to be the most impactful environmental company in the world. Nicotine pollution is a worldwide problem. My new goal is creating an economical means to clean up storm drains and rivers around the world."

## THE INFLUENCE OF EXPERTISE •

### Mines faculty bring valuable perspectives and leadership to major organizations

**Iris Bahar**, computer science department head, was named a fellow of the Institute of Electrical and Electronics Engineers in January 2022. Bahar was honored for her "contributions to modeling and design of power-aware and noise-tolerant nanoscale computing systems."



Elevation to fellow is a distinction reserved for a select group of IEEE members with extraordinary accomplishments in the organization's fields of interest. Less than 0.1 percent of IEEE voting members receive the honor every year.

**Tracy Camp**, professor of computer science at Mines, was named executive director of the Computing Research Association in December 2021, becoming the fourth executive director in the organization's 50-year history.



As executive director, Camp will seek to build upon CRA's existing leadership role in the computing research community and work to help the community pursue bold research visions, practice and advocate for socially responsible computing research, encourage the participation of diverse populations in research and continue to make the case for strong federal support of science and technology. She will assume the role on July 1, 2022.

**George Sowers**, a professor in Mines' space resources program, was appointed to serve on



the Human Exploration and Operations Committee of the NASA Advisory Council in January 2022. Sowers will serve a two-year term on the standing committee as a subject-matter expert. The scope of the HEO Committee includes all human exploration and operations-related programs, projects, activities and facilities at NASA—including the Artemis program to return humans to the Moon.

- ▶ Alumni participated in the spring Career Days with a virtual event on Jan. 26 and in-person fair on Feb. 1 to engage with industry professionals, find new career opportunities or recruit Mines students for their companies. •



IBM Quantum Computing Scientists Hanhee Paik (left) and Sarah Sheldon (right) examine the hardware inside an open dilution fridge at the IBM Quantum Lab at IBM's T. J. Watson Research Center in Yorktown, NY.

Photo by Connie Zhou for IBM

# TECHNOLOGY'S **QUANTUM LEAP**

By Sarah Kuta

The second quantum revolution is here—and Mines engineers are prepared to lead it

**A**s part of her job interview at ColdQuanta's high-tech Boulder, Colorado office nearly three years ago, Hannah North '18 performed a slightly unusual task: she played Operation, the battery-powered children's game that requires players to carefully remove items with tweezers from a red-nosed "patient" on the operating table.

The company's leaders wanted to test North's patience, steadiness and attention to detail, skills she would need to use while carefully assembling containers for ultracold atoms as part of ColdQuanta's quest to develop and build novel quantum technologies.

Thanks in part to her Operation skills, North landed the job as a precision assembly technician. She's since been promoted to quantum engineer, a new research and development role that supports atomic and molecular physicists as they experiment with atoms that have been cooled to just above absolute zero.

North is one of the many Mines graduates now working in quantum technology, a fast-growing field that's poised to solve some of the world's most difficult problems by harnessing the unique properties of atoms and subatomic particles.

In the past, the few quantum jobs that existed were held almost exclusively by people with PhDs in physics. But as more and more companies enter the

race to develop technologies such as quantum computers and quantum sensors, they need well-rounded engineers who can help them put theory into practice.

To help meet this growing demand, Mines is training the next generation of the quantum workforce with a new graduate degree, undergraduate minor and traineeship program. Graduates of these programs—as well as Mines alumni who are already working in quantum—will undoubtedly help shape the future of quantum technologies, which have the potential to drive innovation in fields such as pharmaceuticals, information security and finance.

"The engineering mindset is really the exact right way to approach a lot of experimental physics projects," said North. "I don't have an advanced degree, and I'm still encouraged to operate in the same space as PhD physicists. That's the future of quantum engineering. It's making a field that was previously only accessible to people who had a PhD or many years of postdoc experience accessible to a larger number of people, people who have a background that looks more like mine, to solve problems in the way that an engineer does."

## **The Second Quantum Revolution**

Today's quantum technologies have roots in the early 1900s, when physicists first began exploring the very small particles that make up all matter and energy. These early discoveries helped give rise to the modern electronics we use every day, such as desktop computers.

“Our ability to understand what’s happening and use quantum systems in devices stems from our knowledge of quantum mechanics—that was quantum 1.0, and it brought big changes to everyday life for everyone,” said Meenakshi Singh, Mines assistant professor of physics.

In recent years, science has advanced to the point that researchers can now control and manipulate quantum systems, which opens up potential new opportunities in computing, sensing, imaging and communications. Researchers are calling this current phase the second quantum revolution, or quantum 2.0.

“There’s been an explosion of interest in quantum technologies in recent years,” said Eliot Kapit, Mines associate professor of physics and director of Mines’ new quantum engineering program. “Quantum computers, really in the last five years or so, got a surge of commercial interest. Big tech companies took notice and started investing in quantum computing research teams.”

Governments across the globe are also keen to advance the science of quantum technologies, including the U.S. government, which created the National Quantum Initiative in December 2018 to “accelerate quantum research and development for the economic and national security of the United States,” according to the initiative’s website.

“This is seen as the next space race,” Kapit said. “We’re in a huge competition with other countries.”

The development of quantum computers, in particular, has generated intense interest around the world. Whereas classical computers create and store information as bits, which represent either a 1 or 0, quantum computers use quantum bits, or qubits, which can exist in a superposition of both 1 or 0. Qubits can also exhibit entanglement, a quantum phenomenon in which their states remain linked no matter how far apart they are.

Scientists believe that these and other special quantum properties will lead to improved processing speeds and increased computing power, which will someday make it possible to solve certain problems that classical computers can’t—such as optimizing supply chains or simulating molecules for the development of new drugs or materials.

Because quantum states such as superposition and entanglement are fragile and can easily be disturbed by interactions from their environment, today’s quantum computer prototypes—which look like big, shiny, industrial chandeliers—are finicky and prone to errors.

“You wouldn’t be too happy if, when you run your normal computer, it tried to do some computations and it had errors all the time and you could only run that computation for a limited time before all the information is scrambled and you lose any sense of what you were trying to do—that’s the state that quantum computing is at right now,” said Joseph Glick ’09, MS ’11 who

## What do quantum engineers do?

Quantum engineering is a relatively new field that draws on the principles of physics, electrical engineering, materials science, computer science, chemistry and mathematics to help develop and improve hardware and software that’s relevant to quantum technology, such as quantum computers and quantum sensors.

Researchers and professionals in this field may have some knowledge of quantum fundamentals—they’re quantum-aware or quantum-literate—but they’re not necessarily deep subject-matter experts like physicists. Instead, like other types of engineers, they have well-rounded training and knowledge that helps them ask questions and solve problems in quantum contexts.

Quantum engineers take the scientific discoveries of researchers and theorists and put them into practice, developing and testing novel applications in quantum technology. Their work is helping companies and government agencies push the boundaries of quantum computers, quantum sensors and other quantum devices.

*“That’s the future of quantum engineering. It’s making a field that was previously only accessible to people who had a PhD or many years of postdoc experience accessible to a larger number of people, people who have a background that looks more like mine, to solve problems in the way that an engineer does.”*

**Hannah North ’18**  
Quantum Engineer, ColdQuanta



Mines graduate student Daniel Alvarez manipulates a sample in the quantum lab on campus.



works on experimental quantum hardware at IBM.

Even as the technology improves, however, quantum computers will likely never replace the classical computers that people and businesses use every day. The technology will only be useful for certain, very specific tasks—and scientists are still trying to determine exactly which ones.

While experimental physicists like Joseph Glick are taking a hands-on approach to developing the parts and pieces that make IBM's quantum computers function, theoreticians like Jennifer Glick '11—who happens to be married to Joseph Glick—are investigating how and when various industries could actually benefit from quantum computers.

Her group at IBM partners with companies, national laboratories and universities to investigate ways that quantum computers can help solve problems or advance their businesses. In 2019, for example, Glick worked with international bank Barclays to develop quantum optimization methods for settling securities transactions. She also partnered with Boeing to come up with quantum algorithms that could be used in the future to design materials for aircraft.

“One of the hardest things is just trying to figure out, ‘Is quantum computing even a useful technique to throw at this problem?’” she said. “Because it might turn out there are really good, state-of-the-art classical methods that already do pretty darn well and it wouldn't be worth running the thing on a quantum computer.”

Because quantum is so new, Glick said her role feels a lot like working at a startup. In addition to working on projects with very diverse subject matter, she's also gotten involved in software development.

“Nothing is predefined in quantum computing,” she said. “We're all just figuring it out as we go. You can basically define what you want your role to be, and that's really cool. For people who find it motivating to have a lot of control over defining their career, quantum is a great place to be.”

*“We recognized that this is something that's been identified as a national need and, as quantum technology moves out of academia and national labs to industry, you're going to need a bigger workforce—and you are never going to have enough people with PhDs to do that.”*

**Eliot Kapit**

Director, Mines Quantum Engineering Program

## **Diversifying—and demystifying—quantum**

Teams of researchers at companies such as IBM, Google, Amazon, Intel and Lockheed Martin are working hard to improve and scale up quantum computers. But to eventually develop devices that are consistent, accurate and useful, companies first need to hire scores of well-prepared, curious workers who are familiar with quantum concepts and research methods. That's where Mines comes in.

“We recognized that this is something that's been identified as a national need and, as quantum technology moves out of academia and national labs to industry, you're going to need a bigger workforce—and you are never going to have enough people with PhDs to do that,” said Kapit. “We realized you could teach people, in a year or so, enough skills to really be able to make a contribution now to technological processes, to jump right in on day one.”

In addition to covering the fundamentals of quantum mechanics, classes in Mines' new quantum engineering program teach students how to program quantum computers, how to design and build quantum components and how to take measurements and conduct experiments at extremely low temperatures, which help stabilize quantum states.

The program is a collaborative effort between Mines' departments of applied mathematics and statistics, chemistry, computer science, electrical engineering, materials science and physics, a structure that reflects the interdisciplinary nature of advancing quantum technology itself.

“Making a large-scale quantum computer work is an effort at the complexity level of something like the Manhattan Project or supercolliders,” said Kapit. “Like any mega science project, this is an enormous effort being carried out across a huge array of disciplines.”

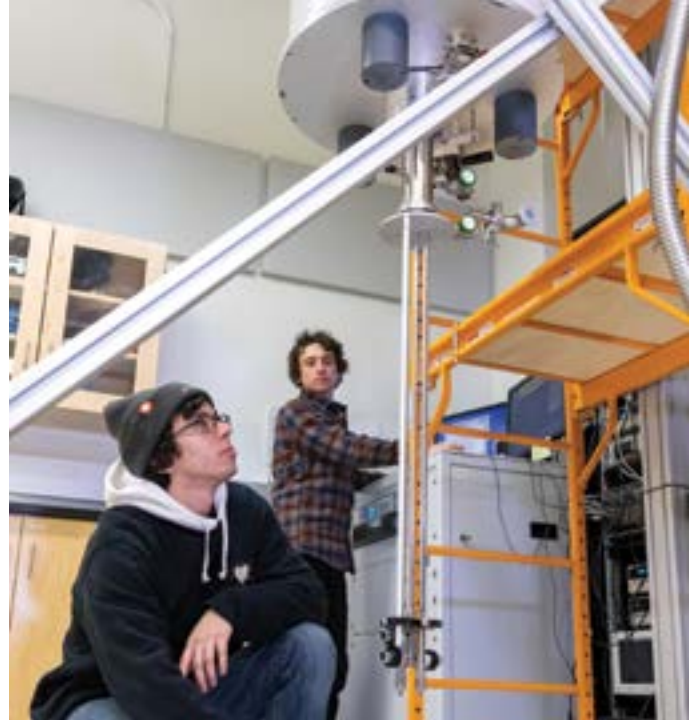
Mines is also partnering with San José State University on a new student training program funded with a \$3 million grant from the National Science Foundation. With the NSF Research Traineeship funding, the two universities will develop interdisciplinary training programs to help prepare master's and doctoral students for careers in quantum information science and engineering.

Some of the funding will support an MS/PhD bridge program so master's students from SJSU, a Hispanic-serving institution in the California State University system, can study at Mines for a semester or two.

“We're hoping to broaden the scope of who participates,” said Hilary Hurst '12, an SJSU assistant professor in the Department of Physics and Astronomy who is leading her university's involvement in the traineeship program. “We are excited about the prospect of using educational materials that Mines has developed and



Graduate student Matt Tennerly prepares a silicon sample for photolithography in the clean room on campus.



Graduate students Matt Tennerly and Caleb Rotello work with the dilution fridge in the quantum lab on the Mines campus.

working together to develop new ones to develop a blueprint for teaching quantum to a new array of students, not just Princeton, not just Harvard, not just PhDs. We're going to need folks of all skill levels to work toward these technologies."

While building quantum education from the ground up, faculty at the two schools also have another big goal: to make the field diverse and inclusive right from the start with initiatives such as implicit bias training for faculty and staff and a mentor-mentee network. By the traineeship program's fifth year, they're aiming for at least 40 percent of participants to come from underrepresented groups.

"We want to make sure this is an inclusive research environment for everybody because research has shown that most people who drop out of science drop out because they have this impostor syndrome—they feel like they don't belong," said Singh. "We're including all of these things from the beginning to make sure that we get diverse students and that when they're here, they feel equipped, they feel included and they can succeed."

Above all else, Mines faculty hope to demystify the field and show students from diverse backgrounds that they, too, can play a role in determining the future of quantum.

"It has this aura of mystery and difficulty, but that stems from our preconceived notions," Singh said. "We need to work toward doing away with these preconceived notions."

### **A new quantum engineering program at Mines**

Recognizing the growing demand for quantum-proficient professionals in the workforce, Mines created a new graduate program and undergraduate minor in quantum engineering.

The graduate program, which officially launched in fall 2020, includes thesis and non-thesis master's degrees as well as graduate certificates and students can specialize in hardware or software. In their classes, graduate students learn about quantum information fundamentals, quantum many-body physics, quantum programming and low-temperature microwave measurements for quantum information. They also gain hands-on experience using quantum instruments and tools, such as helium-cooled units and microwave network analyzers.

The new minor also exposes undergraduate students to quantum theory and gives them access to relevant equipment so they can work in quantum-related roles with just a bachelor's degree.

Both new interdisciplinary offerings bring together faculty from electrical engineering, physics, computer science, materials science, chemistry and applied mathematics and statistics.

## NATURE THROUGH A GEOLOGIST'S LENS

Capturing nature's most beautiful scenes using a combination of geology and photography knowledge

BY AND SCHUSTER

Any good photographer can tell you that light, composition and the subject are what make an image. Professional nature photographer Stephen Weaver PhD '88 knows his subject more than most—he's also an igneous petrologist geochemist and thus uniquely positioned to capture nature's beauty with a lens.

Weaver, who is in his 27th year as technical director of the geology department at Colorado College, photographs both grand and intimate landscapes, combining his lifelong affinity for nature with his creative passions and geologic understanding to produce vibrant images of the natural world.

Weaver's "Lithic Landscapes" series—a collection of photos of various forms and formations of rock—depicts stunning colors and artful formations on both large and small scales. When deciding what rocks to shoot, Weaver prioritizes beauty and light. "I look for images based on variations of textures, layers, lines, shapes and colors," he said, "and for compositions that show



Photo by Colorado College

the viewer a beautiful, artful image extracted from the rock unit and outcrop."

In addition to his technical knowledge of geology and other natural sciences, Weaver uses his understanding of light and

geometry to help him compose his works. "My compositions are all about 'seeing' and extracting an image from the often chaotic and messy views of nature," Weaver said. "I strive to make images that are not only beautiful and pleasing to the eye

### CONNECTIONS

- ▶ Nearly 100 alumni, parents and Quarterback Club members gathered for a pre-game tailgate on Saturday, October 23 in Grand Junction for the annual Mines-Colorado Mesa football match up. •



but that also illustrate something of the complexities of the rocks that make up earth materials and contribute to the structure of the surface landscape.”

When asked what inspired him to make art from nature, Weaver said it’s his natural inclination. He grew up in rural Pennsylvania and spent his childhood hiking and exploring the outdoors. “I was getting biology, geology—the whole of natural sciences,” he said. “I’ve always been a field person.”

As a new geologist, Weaver originally started photographing rock formations as part of his field work. “I always had a camera with me, so it was the perfect thing,” he said. He began earning money from his work by selling photographs for use in geologic textbooks, and his artistic talent combined with his knowledge of rocks made him the perfect candidate to find the right images.

**“I STRIVE TO MAKE IMAGES THAT ARE NOT ONLY BEAUTIFUL AND PLEASING TO THE EYE BUT THAT ALSO ILLUSTRATE SOMETHING OF THE COMPLEXITIES OF THE ROCKS THAT MAKE UP EARTH MATERIALS AND CONTRIBUTE TO THE STRUCTURE OF THE SURFACE LANDSCAPE.”**

Today, Weaver focuses solely on fine art photography, showing his pieces in galleries and selling them on his website. He also teaches photography around the

state and plans to retire next year and spend even more time outdoors.

Weaver hopes his work touches viewers both by showing them something beautiful and by reminding them of the importance of preserving the natural

world. His artistic eye combined with his geologic knowledge render in stunning detail aspects of nature the rest of us may be unlikely to notice on our own. As he put it, “I’m really trying to communicate the presence of the natural world to the viewer and really trying to spark their interest.”

▶ Learn more about Weaver and see his photography at [stephen-weaver.com](http://stephen-weaver.com).

## SHERIDAN ROSS PC

ATTORNEYS AT DIFFERENT PERSPECTIVES



Patent



Trademark



Commercial  
Litigation



IP Litigation



## A RETURN TO GOLDEN

Homecoming was back after a year's hiatus and bigger than ever

In many ways, Fall 2021 was a return to a sense of normalcy after a year of pandemic restrictions and virtual events. And to celebrate the return to in-person activities, Mines welcomed alumni back to campus for Homecoming and to commemorate the resilience and grit Orediggers are known for.

This year, Mines saw nearly 500 alumni attend the Homecoming festivities, making it one of the biggest weekends in recent history. The weekend was packed full of events fit for a celebration of camaraderie and Oredigger spirit. Alumni cheered on the Orediggers at the Homecoming football game and turned out for the annual 5K run/walk. They caught up with their classmates at the 50th class reunions for both the 1970 and 1971 classes. They celebrated each other's accomplishments at the Boots & Barrels alumni party and awards ceremony. They even got to attend the McNeil Hall grand opening, made possible by Charlie '71 and Judy McNeil. The building is the first of the new entrepreneurship and innovation ecosystem at Mines and will be followed by the Labriola Innovation Hub and Beck Venture Center.

We've gathered some of our favorite shots from Homecoming weekend to relive the festivities and share some of that indelible Oredigger pride.



### CONNECTIONS

- ▶ President Paul C. Johnson welcomed nearly 30 local alumni to campus for an informal lunch, campus update and Q&A at December's Lunch Bunch event. •



Photo by Tom Cooper



Photo by Tom Cooper

## GET CONNECTED, STAY CONNECTED

### A new volunteer platform makes giving back to Mines easy

For the first time ever, all the ways alumni and friends can connect with Mines are together in one easy-to-use tool that lets you explore your interests and create new ways to give back to the university. The new volunteer platform, Get Connected, offers alumni and friends opportunities to give their time and talent to Mines and through Mines. Whether you want to be more involved with students or give back to your local community, the website showcases meaningful volunteer experiences around the world that maximize the value of your service. From participating on admissions panels to serving as Capstone judges, helping with golf tournaments or mentoring others, there are so many ways you can get involved.

Get Connected highlights all these opportunities in one location and connects you back to the university. All volunteers—whether you're just getting involved now or have been giving back for years—need to create a profile to explore and participate. Join more than 850 alumni volunteers who made an impact on the Mines community last year.

► Sign up now at [volunteer.mines.edu](http://volunteer.mines.edu).



► Dave '84 and Jean '86 Wilson hosted a watch party on Dec. 11 at The Wild Game in Bergen Park, Colorado, for 60+ alumni to enjoy the NCAA National Semifinal football game vs. Valdosta State. •



# FROM GEOLOGY TO VASCULAR AND ENDOVASCULAR SURGERY

An engineer's path  
into medicine

BY JENN FIELDS

Though her extensive academic career has centered on medicine, Erica (Walker) Mitchell '85 started her postsecondary education with a family tradition—attending Mines.

“Going to medical school after Colorado School of Mines was such a breeze in the sense that we’d developed such good study habits,” Mitchell said. “Mines teaches you to think critically, like an engineer.”

A surgeon, educator and researcher, Mitchell serves as the interim chief of vascular and endovascular surgery at the University of Tennessee Health Science Center in Memphis and a professor of surgery in the College of Medicine. “As a vascular surgeon, there are more engineers in the field than any other specialty,” she said. “I think it’s because you apply many engineering principles, such as hemodynamics and laws of physics.”

Her path to becoming a physician started early. Her father’s work as a petroleum engineer took the family all over the globe. “He was working in Angola and South Africa, but we were raised in Zimbabwe, which at the time was Rhodesia,” she said. He’d left the oil industry to go into farming, which

## CONNECTIONS

- ▶ Charlie S. McNeil '71 was the distinguished speaker at the December 2021 undergraduate commencement ceremony. •

ultimately cemented Mitchell's interest in medicine.

"I had always wanted to be a doctor," she said. "Growing up, our kitchen was always the triage center for anyone ill or injured on our farm."

When civil war broke out in Rhodesia, the family fled, first to South America, then to Wyoming and Colorado. Mitchell was 16 at the time and soon followed in the college footsteps of her father, who graduated from Mines in 1948, and her sister, who was already a Mines student when Mitchell enrolled. Mitchell majored in geology. At the time, Mitchell said, "The pathway to medicine wasn't as clear as it is now."

"When I graduated, oil prices collapsed, but I got a job working

an old gold mine in Lefthand Canyon," she said. But she soon began taking prerequisites for medical school and entered the University of Colorado's School of Medicine in Denver, then completed

**"AS A VASCULAR SURGEON, THERE ARE MORE ENGINEERS IN THE FIELD THAN ANY OTHER SPECIALTY. I THINK IT'S BECAUSE YOU APPLY MANY ENGINEERING PRINCIPLES, SUCH AS HEMODYNAMICS AND LAWS OF PHYSICS."**

residencies and fellowships in Colorado and Oregon and a master's degree in surgical education from Imperial College London.

Now, Mitchell is focused on research and educating the next generation of surgeons. "We do a lot of simulation and competency assessments in medicine, and engineering prepares you well for that—you have to have

a plan, it's very methodical," she said. "I've written one of the first textbooks in vascular surgery that applies decision-making algorithms to the care of surgical patients: what to do when a patient presents with a certain elective or emergent condition, for example; the decision tree drives you down a specific pathway. Mines prepared me well in terms of decision-making."

Though many students today focus on biology to get into medical school, Mitchell believes her unconventional route gave her the tools of scientific inquiry that she uses—and teaches—today.

"You can be a doctor coming out of Colorado School of Mines—it really prepares you well," she said.



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## A GOOD INVESTMENT

Launching a new business takes more than a good idea

BY ASHLEY SPURGEON

Starting a new venture is no easy task, and turning that venture into a successful enterprise is even more difficult. But for Brett Conrad '82, investing in a new venture is his bread and butter. He even has a proven track record to show that the hard work of investing in and building a new business is often worth it.

Although he earned a bachelor's degree in petroleum engineering from Mines, Conrad decided a more varied career path was a better fit. After getting his MBA and seeing a rising interest in snowboarding in the 1980s, Conrad launched an outdoor apparel company with Sandy White '83 to fill that niche. The business took off, but he eventually wanted to pursue other ventures within the outdoor apparel industry. He invested in new ideas, such as a step-in boot binding system that he helped launch and sell, and worked his way up into top management at Ride Snowboards.

Conrad eventually moved on to stock trading and investing in software companies before his brother asked him to help launch the U.S. branch of the athletic apparel brand Lululemon Athletica, one of the largest and most public-facing companies he's helped get off the ground.

### CONNECTIONS

- ▶ Mines alumni in San Antonio, Texas volunteered at the San Antonio Food Bank in January 2022, helping create 901 boxes of food supplies for their local community. •

After leaving Lululemon, Conrad started a clean energy fund and later a capital management company, which he still manages today.

We sat down with Conrad to learn more about investing in new businesses, what it takes to lead a startup and practices leaders should keep in mind when nurturing a company.

**Mines Magazine:** You've been involved in starting some influential businesses in your career, from running Lululemon's U.S. operations to other ventures in the apparel industry and beyond. How do you manage the risk of a new venture with the uncertainty of whether it will become successful or not?

**Brett Conrad:** You know, we hear of the successful ones, like Lululemon, but for every Lululemon, there's a thousand other apparel companies that are nowhere near as successful and you don't hear about. You think everyone can do it and that it's easy to start a company that ends up having a \$50 billion market cap, but that's just not true.

Sometimes I end up spending more time on my problem investments than I do on ones really taking off, but I've had to figure out what is a good return on my time and be disciplined as to when it's time to essentially give the reins over to someone else. And that's the nature of startups.

But Lululemon is fun to talk about, because it was one of those things where 100 things went right, and it's fun to see now a global company with nearly 30,000 employees grow from a handful of people and an idea. It was neat to be part of that in the early days.

**MM:** What were the biggest factors in Lululemon's early success that other entrepreneurs might be able to learn from?

**Conrad:** Lululemon was really exceptional in that it was the right idea at the right time with incredible business execution. The social trends we researched were in our favor. More women than men were becoming college graduates in the year 2000, and that has just expanded since. Women have more buying power and investing power. They want exceptional

product with a relevant buying experience.

Additionally, professional women want to work out on a daily basis with clothing that performs, fits and looks great. Also, talented women entrepreneurs who typically run the stores—high-quality college graduates themselves—have a great career path doing something they love. All of this was in the context of being the first company to focus on the performance aspect of yoga apparel right when participation in yoga was accelerating for much of the same reasons I've mentioned.

**MM:** What you're saying is that to lead a successful enterprise, you have to look at the big picture, current trends and take care of the people behind a company?

**Conrad:** Yeah. Great leaders these days are really interested in developing their people, because their people are the ones that drive the engine of their company or organization. How do you help people get better 24 hours a day—inside and outside of work—create the right mindset and help people learn more? We like to train people to be masters of their own vision and goals so what they do every day is more exciting, more fun, more engaging and more productive. We can't get much done on our own—we need a team to do that.

**MM:** Many Mines alumni have gone on to launch their own companies or invest in new startups. What do you think makes Mines graduates particularly well suited to these kinds of business ventures?

**Conrad:** I remember going to my first geology lab, and I thought, "Oh my goodness, we're going three times as fast as we did in high school." The Mines experience is all about learning a lot of new things, interacting with others and learning from them. There's also a high degree of integrity with Mines graduates, and I love being around that type of person. These days, the world is changing so fast, and you have to be able to learn quickly to keep up and dive into new projects—it's really just keeping that mindset of I'm in school every day and I've got to be able to take in and learn from whatever is thrown at me.

- ▶ January's Lunch Bunch event invited Mines alumni to a virtual discussion, led by Executive Vice President Kirsten Volpi, about the latest campus construction and what's next for Mines' infrastructure. •



## TECH TIP

### What to do with an old mobile device

How many mobile devices do you have? If you're like most people, you likely have a smartphone, tablet and laptop to keep you connected in your day-to-day. But unless they're eventually traded in for an upgrade, each of those devices reaches the end of its useful life or replaced by a newer version, and the old device tends to get shoved to the back of the junk drawer to become electronic waste.

Luckily, most of the materials used in making these products can be reused and recycled, including plastics, glass, metal and aluminum. Here are a few ways you can dispose of your old devices safely.

#### Recycle it.

Many nonprofit organizations and local communities offer electronics recycling options where you can drop off rechargeable batteries and cell phones. There are also facilities certified for electronic recycling. To learn more or find a R2 certified facility, visit [sustainableelectronics.org](http://sustainableelectronics.org).

Many electronics manufacturers and retailers offer robust recycling programs as well, with companies such as Amazon and Apple offering gift cards or in-store credit for qualifying products.

#### Donate it.

If your device still works or can likely be refurbished, consider donating it to a charity or nonprofit. These devices are often a valuable tool for individuals and families without the resources to buy a new one.

With all of these options, make sure to erase all personal information from your devices by wiping or even removing the hard drive before sending it off to its new home.

- ▶ Have a useful tech tip you'd like to share, or want to know more about an everyday technology? Let us know at [minesmagazine.com/contact-us](http://minesmagazine.com/contact-us).

## CONNECTIONS

- ▶ Jennifer Miskimins MS '00, PhD '02 hosted the Midland Connect event in January 2022 to discuss plans for Mines' petroleum engineering department and where the petroleum industry is heading. •



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**Proceeds support student scholarships at Mines.**



## WORDS OF WISDOM

### Mines alumni share their tried and true leadership tips

Several times a year, Mines offers opportunities for the Oredigger community to learn from Mines alumni who have become industry leaders and CEOs through roundtable discussions. These alumni typically offer tips and tricks for building a successful career, growing leadership skills, pitfalls to avoid and how to be resilient through any internal and external challenges. Here are some of the best tips and tricks they shared.

**If you're looking to take the next step in your career or change industries, an advanced degree might give you the skills and knowledge to get there.**

1

"For a Mines graduate, one thing that [business school] will teach you is thinking from a greater distance—from 30,000 feet—rather than diving into the details. But in all honesty, the main thing it does for your career is a bit of a restart. If you feel like you should be at the next level in your organization but you're not being seen that way, if you exit and come back with an MBA or another advanced degree, that gives management the excuse to put you in a different department, a different position—elevate you."

**Nancy Keegan '82**

*Director*

Mines Foundation Board of Governors

#### CONNECTIONS

- ▶ To kick off the 100th anniversary of petroleum engineering at Mines, alumni were invited to an event in January 2022 to hear department updates, network with other alumni and celebrate the milestone. •



**1 Nancy Keegan '82**  
 Director  
 Mines Foundation  
 Board of Governors



**2 Joseph Eazor '85**  
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**3 Kelly Taga '00**  
 Senior Division President,  
 Northern Colorado  
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**4 Andrea Wescott  
 Passman '98**  
 Chief Operating Officer  
 Caerus



**5 Christine Staples '96**  
 CEO  
 G20 Technologies

**2** "I've had good fortune from taking measured risks. Transitioning from the petroleum industry to go back to graduate school and then leaving the consulting industry to go to the corporate world were calculated risks. All those experiences sort of build a portfolio of capabilities and a mentality of leadership that I've leveraged through my career."

**Joseph Eazor '85**  
 CEO and President  
 ERT

**Your degree doesn't have to constrain you to a particular type of work or career path—it's more about what gets you excited.**

**3** One of the things I ask people that I hire is "What makes you want to get out of bed in the morning—what do you get excited about and what are you anxious to get in and go make happen for the day?" Those are the things that will propel you in whatever career path or industry you decide to take."

**Kelly Taga '00**  
 Senior Division President, Northern Colorado  
 Richmond American Homes

**Listening to others and honing the skills you want are key to becoming a better leader.**

**4** "Before my MBA, I was a horrible listener. Actually listening to other people, that is one of the foundations to being a much better leader and being more engaged. Surround yourself with people with skills you don't have so you can learn from them and continue to hone your skills."

**Andrea Wescott Passman '98**  
 Chief Operating Officer  
 Caerus

**The learning doesn't stop after graduating from Mines.**

**5** "The idea of learning and a growth mindset, and through your whole life, continuously learn is my advice. Take every opportunity to learn something new."

**Christine Staples '96**  
 CEO  
 G20 Technologies

▶ Watch the full roundtable discussions on the Mines Foundation YouTube channel, and visit [weare.mines.edu/events](http://weare.mines.edu/events) to keep an eye out for future discussions with industry leaders.

▶ To foster support amongst the Mines community, alumni were invited to register for the next wave of the Mines Mentoring Program, to lend their time and expertise toward mentoring other Orediggers or find a mentor themselves. •



Local Mines alumni gathered at the Denver Museum of Nature and Science in December 2021 for the Denver holiday party to celebrate the season and welcome new graduates into the alumni family.

## 1970s

**Vicki Cowart MS '77** announced her retirement from Planned Parenthood of the Rocky Mountains in October 2021 after serving as president and CEO for 18 years. Before joining PPRM, Vicki built her career as a geoscientist, including working as the Colorado state

geologist, director of the Colorado Geological Survey and president of the Association of American State Geologists.

## 1980s

**James Kleckner '81** was appointed to Vermilion Energy's board of directors in October 2021.

## 1990s

**John Hill MS '90** was appointed to Honey Badger Silver Inc.'s board of directors in October 2021.

**Gregg Nyberg '92** was named chief technology officer of Landmark Bio in October 2021.

We're proud of Mines alumni. We want to cheer you on and celebrate your accomplishments. Tell us about your recent wedding, a new baby or your new job. Share a personal or professional accomplishment, volunteer activity or your favorite Mines memories. Stay connected to the Oredigger family.

▶ Submit a class note at [minesmagazine.com/classnote](https://minesmagazine.com/classnote).

**Éric Lemieux MS '97** was appointed as a strategic advisor for Hawkmoon Resources Corp. in September 2021.

## 2000s

**Kari Barnes '01** joined Fox Rothschild as a partner in the Intellectual Property Department in November 2021.

**Kari Gonzales '02** was appointed as president of Transportation Technology Center Inc. in September 2021.

**Kevin Rowland '03** was appointed as Flatirons Digital Innovation's new chief operating officer in September 2021.

**Peter (Nick) Montano '04** was appointed as vice president of projects for B2Gold Corporation in November 2021.

**Jacqui (Schmalzer) Stackhouse '07** and **Dan Stackhouse '07, MS '08** welcomed twins to their family. Ryder and Skylar were born on Aug. 12, 2021, joining big brothers Shane (6), Logan (4) and Jackson (2).

**Charlotte McNamee '08** was nominated to be part of the TE100 Transition Economist's top 100 women of the energy transition and was selected as one of 10 finalists in the renewables category.

## 2010s

**Jair Diaz Navarro '11** was appointed as a senior mining engineer at Condor Gold's La India Project in Nicaragua in September 2021.

**Stephanie Corey '12** and **Alex Corey '12** welcomed their son, Grayson James, on Oct. 29, 2021.



**NABEEL BABBITT '13  
AND SARAH KELLY '14**



### ORDER OF THE ENGINEER

Thirty Orediggers, including December 2021 graduates, other alumni and graduate students became members of the Order of the Engineer at the fall 2021 induction ceremony on Nov. 16, 2021.

Founded in Canada in 1925, the Order of the Engineer, an honorary engineering society, was established in the U.S. in 1970 and currently includes more than 200 chapters at colleges and universities in all 50 states and in many territories. Mines' chapter was formed in 1983 and currently boasts over 2,000 alumni members.

Inductees must take an oath and are encouraged to wear the signature stainless steel ring on the small finger of their working hand, a symbol of the unity and spirit of the engineering industry.

**Tyler Scott '12, MS '13 and Kristin Scott '13** welcomed a baby boy to their family. Evan arrived on Oct. 12, 2021.

**Denise Mitrano PhD '13** was awarded *Environmental Science & Technology's* 2022 James J. Morgan Early Career Award in December 2021 in recognition of her work focusing on the distribution and impacts of anthropogenic materials in technical and environmental systems.

**Sarah Kelly '14 and Nabeel Babbitt '13** tied the knot on April 25, 2021, in Riviera Maya, Mexico. Seventeen Mines alumni attended the wedding, and Blaster's cousin was even part of the fun. The couple initially met at Mines when Nabeel was a resident

assistant in Thomas Hall during Sarah's first year at Mines.

**Cassidy Steen '18 and Matthew Ryan '18** were married on June 12, 2021, in Castle Rock, Colorado. The couple met through fraternity and sorority life at Mines. The wedding party included Samara Omar '16, MS '18, Aditya Malkan '18, Satvik Saini '18, MS '19, Parker Steen '20, Jordan Daubenspeck '16, Laurie Kendall '18, Michael Maxwell '19 and Victoria Martinez-Vivot '19.

**Hannah Deahl '19, MS '20 and Shane '18 Kelley** were married in Boulder, Colorado, on May 25, 2021. Seventeen Mines alumni attended the wedding. The wedding party included Keith Rippetoe '17, Connor Mattes '18,

Keith Mody '18, Ashlyn Hohenshelt '19, MS '20, Breanna Lescale '18, Max Watson '18, Hunter Nelson '18, Daniel Scarbrough '18 and Paul Winckler '19.

**John Copley '18, MS '20** was one of five national recipients of a Department of Energy National Nuclear Security Administration Stewardship Science Graduate Fellowship to study materials under extreme conditions.

## 2020s

**Dorcas Idowu PhD '21** joined Syracuse University's civil and environmental engineering department in January 2022 under the Future Professors Fellowship Program.



**MATTHEW RYAN '18 AND  
CASSIDY STEEN '18**

**HANNAH DEAHL '19, MS '20  
AND SHANE KELLEY '18**



**GRAYSON COREY**



**EVAN SCOTT**





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## IN MEMORIAM

Remembering Orediggers who have passed away but will always remain part of the Mines community

**Robert P. “Bob” Bills ’70** died June 26, 2021. He was a long-standing CEO of multiple businesses in the federal and government contracts sector of small- and minority-owned businesses.

**Christopher J. Center ’80** died June 30, 2020. Christopher began his career as a petroleum engineer before working in ocean ultrasound exploration and advanced medical software.

**Leo A. Holt ’70** died June 12, 2021.

**James D. Jerrell ’52** died Feb. 24, 2021. Jim was born in 1930 and served in the United States Marine Corps for 25 years, retiring as a captain. In his post-military career, Jim was an engineer who specialized in CAD systems and owned a drafting business.

**Steven J. Maione ’69, MS ’71** died Oct. 15, 2021. Steven was born in 1947 and began his career as a petroleum geologist for Union Oil Company of California before joining the company’s geothermal division. When he retired after 27 years, Steven worked as a geological consultant in 3D seismic interpretations.

**Robert S. “Bob” Pawlowski, Jr. MS ’87** died June 28, 2021. Bob started his career with ARCO before joining Chevron in 2006 and served as advisor to Chevron’s geothermal business in Indonesia. Bob was instrumental in planning and executing the world’s largest airborne gravity and magnetics survey in the partitioned zone between Kuwait and Saudi Arabia.

**William A. “Bill” Schneider** died March 31, 2021. Born in 1933, Bill joined the Mines faculty as a geophysics professor in 1977. In addition to his enthusiasm for teaching and working with Mines students, Bill was instrumental in founding the Center for Wave Phenomena and supporting the Reservoir Characterization Project during his tenure.

**Martin W. Sharps ’81** died Oct. 24, 2021. Born in 1958, Martin spent his career in the oil and gas industry in countries such as Colombia, Thailand, Vietnam, Indonesia and Angola.

**Robert J. “Bob” Weimer** died Aug. 25, 2021. Born in 1926, Bob was an internationally known geologist and made significant contributions to petroleum exploration. He joined the Mines faculty in 1957 as a geology professor, later serving as department head. He retired from teaching in 1983 but remained active on campus as an emeritus professor and geo-consultant in the Denver area. Both the Weimer Distinguished Lecture and the Weimer Geology Trail on campus were named in his honor.

▶ To submit an obituary for publication in Mines Magazine, visit [minesmagazine.com/obituary](https://minesmagazine.com/obituary).

Memorial gifts to the Colorado School of Mines Foundation are a meaningful way to honor the legacy of friends and colleagues while communicating your support to survivors. For more information, call **303-273-3275** or visit [weare.mines.edu/givingguide](https://weare.mines.edu/givingguide).



## THE COLLEGE TOUR

Sharing the best parts of the Mines experience in a new way

Mines commonly shares stories about the unique aspects of campus and what it's like to be an Oredigger, but in 2022, Mines will be sharing in a new way—and to a much larger audience.

Mines' students, faculty, alumni and its scenic campus will be featured in an upcoming episode of *The College Tour*, a TV series that tells the stories of colleges and universities across the U.S. and gives viewers a distinctive campus tour that they wouldn't even get from visiting in person.

The film crew visited campus for a week in October 2021 to capture all the best parts of the Mines experience. Mines' episode will feature nine current

students and a faculty member who introduce viewers to different parts of the Mines experience, from our top-notch academics and close-knit Oredigger community to unparalleled industry connections and the exceptional value of a Mines degree. And, of course, the episode will show off the beauty of the Mines campus and its home in the heart of Golden.

The episode will be available to watch on several major streaming platforms and Mines' YouTube channel. Stay tuned for more details about the episode's release date, a watch party and more in the months ahead.





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Mines has long been at the forefront of science, technology, engineering and math education, preparing engineers and scientists to become leaders in their fields. And while the school remains an elite institution for its foundational subjects such as geology, metallurgy, petroleum engineering and more, Mines has also expanded its focus to include other fields and give industry the experts needed to solve current challenges and lead new innovations to propel the world forward. As Mines approaches its sesquicentennial, we're celebrating our past while looking to the future and all we aim to accomplish next.

▶ Follow along at [mines.edu/mines-at-150](http://mines.edu/mines-at-150).

