

# MINES MAGAZINE

For Colorado School of Mines Alumni and Friends • Spring 2020



## THE FUTURE IS (STILL) UNDERGROUND

Mined materials remain essential to modern life—and require skilled engineers to bring them to the surface.

**Plus:**

Fighting the “forever” chemicals in our water supply

The challenges and opportunities of our energy future

**MINES.EDU**





**@COLORADOSCHOOLOFMINES** 

This photo of downtown Golden was one of the most-liked photos on Mines' Instagram account in February 2020.

► Follow Mines on social media for more beautiful shots of Golden and the Mines campus, and keep up with everything happening with your fellow Orediggers.

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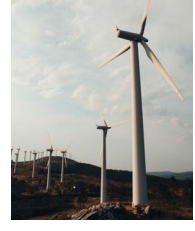


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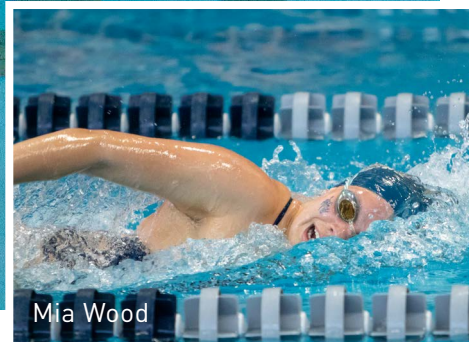
Our knowledge of previous energy transitions is helping us solve today's energy challenges. **30**

**ON THE COVER:** Three mining engineering students practice their skills in Mines' Edgar Experimental Mine, gaining expertise that will make them valuable additions to an industry that is experiencing dramatic change as the world looks to a more mineral-intensive energy future.





Mia, Cobi and April Wood are familiar faces in Mines swimming, building on a family legacy both in and out of the pool.



Mia Wood



Cobi Wood



April Wood

## A FAMILY RELAY BY TIM FLYNN

### Sibling swimmers make their mark at Mines

If there's been one name synonymous with Mines swimming over the past decade, it's Wood. The 2019-20 team features three members of the family: twins Mia and April are in their senior year, and Cobi just joined the Orediggers as a freshman this year. Their older sister, Cayla Wood '14, swam for Mines from 2010 to 2014.

Mia and April had a terrific 2020 RMAC Championships meet. Mia won four events—the 200-, 500-, 1000- and 1650-meter freestyle—and April captured gold in the 400-meter individual medley. The sisters stood together on the podium, finishing first and second in the 500 and 1650, and were

part of the gold-medal 800-meter freestyle relay team. Mia was named the RMAC Swimmer of the Year for her performance.

Cobi was the 200-meter freestyle bronze medalist and 800-meter freestyle relay silver medalist and finished fifth in the 500-meter freestyle as a rookie.

Cayla, who has both her undergraduate and master's degrees in engineering physics from Mines, was an all-American and multiple RMAC medalist in her career. Both Mia and April are following in her academic footsteps as they pursue master's degrees after graduating in May 2020.

## EDITOR'S LETTER

### A fresh take

Spring is known for new beginnings and fresh starts, new ideas and unfettered creativity. This spring, we're launching a new vision for *Mines Magazine* in conjunction with some major initiatives for Mines as we approach the university's 150th anniversary.

We've been thinking about a redesign and new content direction for a while now—not because there was anything wrong with previous issues, but because we can always do better.

But I knew we had to approach changes with care. Mines alumni are fiercely protective of this magazine and their alma mater, and I wanted every change to be intentional. Based on your responses to the readership survey I sent out last year, I took bold steps to give you something better—a better reading experience, better imagery, better stories.

We have a couple of new sections in this issue—one that describes research that Mines faculty and alumni are actively working on and another that explores how the skills and knowledge gained at Mines apply to the wider world and today's societal issues. You'll also notice a "ticker" along the bottom of several pages throughout the issue for all the connections you share with us that

prove the Mines community thrives no matter where you might be in the world.

And just for you, we've brought back class notes to celebrate your accomplishments, good news and life updates—and we're even willing to grow the size of the magazine to accommodate your news, if needed.

Yet while we added a lot of new content, the things you love are still here—they just might look a little different. We still have news stories to keep you informed on the latest campus happenings, profiles on alumni who are doing interesting work around the world, ways to get involved and more.

As always, *Mines Magazine* is produced with you in mind, with content to inform, inspire and, we hope, make you feel proud of your alma mater and fellow Orediggers.

I look forward to hearing your thoughts on our new approach—or anything else you'd like to share.

Happy reading!

Ashley Spurgeon

► To learn more about the inspiration behind *Mines Magazine's* visual redesign, turn to **page 42** for some of the iconography and illustrations we found in the *Mines Magazine* and *The Prospector* archives to create our new look.



# MINES MAGAZINE

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**RISE UP FOR MINES AND HELP THE OREDIGGER COMMUNITY THROUGH THE COVID-19 PANDEMIC**

If you know of a job opening or internship within your company or community that could be of interest to a Mines student, now is a great time to share it. Mines' graduating seniors—many of whom face challenges conducting job searches—and other students are actively searching for jobs and internships. Connect with the Mines Career Center at [careercenter@mines.edu](mailto:careercenter@mines.edu).

A gift to The Mines Fund or Student Emergency Fund will help provide aid to those who have been severely impacted by COVID-19, while helping to ensure all students finish out the spring semester strong. Make a gift or learn more at [weare.mines.edu](http://weare.mines.edu).

The Oredigger community is resilient. Now, more than ever, is the time to rally together to care for Mines. Visit [weare.mines.edu/covid19resources](http://weare.mines.edu/covid19resources) for more information about how you can help.

**OREDIGGERS BEING OREDIGGERS**

Staying uniquely Mines in the face of a global pandemic

I'm writing to you from my home office in the president's residence on campus. It's early April—a time when in any normal year you can feel the growing anticipation for E-Days, graduation and field sessions.

But this year is not a normal one. Behind me sit nearly empty residence halls. On any other day, the Starzer Welcome Center would be packed with visitors touring our beautiful campus. Our classrooms and research labs are mostly dark.

By all visual indicators, the university appears closed, but it's not. In fact, it's as busy as ever—just in less obvious ways. In late March, the world changed for all of us. At Mines, that meant asking students to move back home, canceling athletic seasons and asking faculty to convert their courses from in-person classroom instruction to remote learning in a two-week period of time. That's a big ask for a campus that emphasizes hands-on learning and collaboration.

Fortunately, with Mines being Mines and Orediggers being Orediggers, we got it done. Professors moved their team-oriented courses online. Students have buckled down and continued their work in virtual classrooms. And the professionals who provide support behind the scenes have facilitated it all while working from dining room tables and guest-room desks.

There is no less effort—if anything, there's an increased commitment to delivering the rigorous and challenging

education Mines is known for. We're forced to be creative, rethink learning and find other ways to connect with each other.

I'm experiencing that firsthand with the class I'm teaching. It's a lot of work to create a quality remote learning experience. I miss our 8 a.m. class meetings in CoorsTek, but my students seem just as engaged in our virtual classroom as they were in person, and I can offer them more flexible office hours than before.

We don't know how long we'll be in this remote university mode—certainly longer than we'd like. But we'll discover things and develop skills that will be immensely valuable once this pandemic threat passes. I believe we'll be better teachers, and our students will be better prepared to succeed in their digitally connected and global future. And we'll more clearly see the immense value of being part of the Oredigger community and how much we rely on that network to make it through difficult times.

Stay well. Stay safe. I look forward to the time when we can celebrate being part of Mines together, in all the unique ways that Orediggers do.

**Paul C. Johnson**  
President and Professor



**CAREER DAY**

SEPTEMBER 15, 2020

Registration opens mid-May



Attract the best and brightest engineers for your company. Don't miss out on this huge event to interact with 2,000+ Mines students and alumni.

For more information, contact Associate Director of Employer Relations James Saulsbury at 303-273-3205.

[CAREERS.MINES.EDU](http://CAREERS.MINES.EDU)

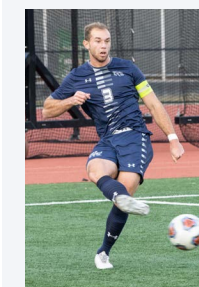


**BRINGING HOME THE CHAMPIONSHIPS**

A quick look at the 2019-20 athletics season

- 1** national championship
- 1<sup>ST</sup>** in the Learfield/IMG Directors' Cup fall standings
- 3** Academic All-Americans
- 3** RMAC regular-season championships (Men's Soccer, Football, Men's Cross Country)
- 3** RMAC tournament championships (Men's Soccer, Women's Soccer, Volleyball)
- 6** NCAA team appearances
- 12** All-Americans

Mines had **84** Academic All-Americans in the last decade, the most in NCAA Division II, and ranked sixth for total Academic All-Americans across all NCAA divisions.



"At Mines, it's the best engineering school in the nation, and we have to put in a lot of hard work when we come here. Everyone on this team does, and everyone here is so bright and so smart—it makes all the hard work worth it."

**-JASON ZOBOTT, MEN'S SOCCER CAPTAIN**

Zobott earned the 2019 CoSIDA Division II Academic All-American of the Year, only the third Mines student-athlete to receive the award.

Follow the latest news from Mines Athletics at [minesathletics.com](http://minesathletics.com).





**CALLING ALL ENTREPRENEURS: A NEW SPACE FOR IDEAS**

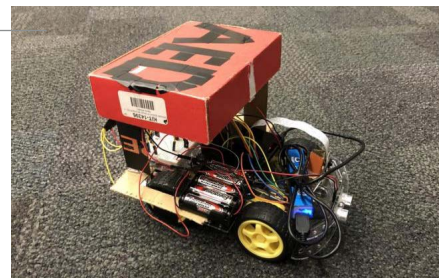
As a way to support student, faculty and alumni entrepreneurs, Mines is adding a new building to campus: the Beck Venture Center, made possible by a \$4.5 million challenge gift from Mike and Kelly Beck, the parents of two recent Mines graduates. The center will provide space, knowledge, mentoring support and connections to other entrepreneurs and investors necessary for building sustainable and successful commercial entities. It will also enable further collaboration with industry, community and alumni partners.

Envisioned as a three-story, 40,000-square-foot facility, the new center will be located at the corner of 18th Street and Washington Avenue.

**A ROBOTIC LIFELINE**

A team of Mines students spent 36 hours designing and building the Fully Autonomous AED Emergency Response System, using security camera footage to automatically detect if someone in a building is suffering from sudden cardiac arrest and dispatch a robot carrying an AED to that location. Their efforts paid off, winning SB Hacks VI at the University of California Santa Barbara.

“It’s really satisfying to see what you can accomplish if you sit down and set your mind to something for 24 or 36 hours—a group of four people working toward a common goal,” said mechanical engineering student Peter Wilson. “It’s pretty impressive what you can complete just given that short amount of time.”



**AN UPCYCLED SOLUTION FOR MINE TAILINGS**

Students with an idea for upcycling Henderson mine tailings into high-value flat glass products won the 2019 Henderson Sustainable Development and Entrepreneurship Challenge. The \$25,000 grand prize-winning idea, Tailings to Glass, proposed harnessing the roughly 280 million tons of tailings, currently stored at the Henderson mill as a feed stream, for the production of flat glass for windows, doors, mirrors, solar panels and more.

“Tailings are an available resource, especially with the diminishing amount of easily available silica worldwide,” said mechanical engineering student Meghan Cameron. “We can make use of what we have. This was a large lesson in innovation and creative problem-solving. We were able to create a specific idea to address all the needs of the challenge, whether it was the community aspects, the land use aspects or all the engineering aspects.”

**CAREER DAY**

**221** companies and organizations visited campus for the Spring 2020 Career Fair on Feb. 4, 2020.

**1,895** current Mines students attended the event.

**#IDIGMINES GIVING DAY**

**\$301,859** was raised during the annual #idigmines Giving Day on Feb. 6, 2020.

**29** campus causes participated

**RANKINGS**

**19<sup>TH</sup>** Mines’ rank among the top universities in the U.S. for return on investment when looking at earnings over the course of their graduates’ careers.

Mines was also the only non-maritime public university in the top 20.

—From a Georgetown University Center on Education and the Workforce study

**NEW GRADUATE PROGRAMS**

**7** new graduate programs launched at the start of the 2019-20 academic year, including options related to:

- Advanced energy systems
- Resource commodity analytics
- Humanitarian engineering
- Electrical engineering
- Data science
- Earth resources development engineering
- GIS and geoinformatics

**4** additional graduate programs were recently approved, with new offerings in quantum engineering, robotics, smart manufacturing and economic geology and exploration methods.



**A ROMAN HOLIDAY AND DANCING HORSES KICK OFF 2020**

Mines’ music program had a busy start to 2020. The marching band kicked off the new year by performing in the Rome New Year’s Parade. The parade is a key part of the festive season celebrations and pageantry in the Italian city, with tens of thousands of people lining the route to St. Peter’s Square in Vatican City. This was the second time in the band’s 108-year history that students have performed outside the U.S., the other being a trip to Dublin for the St. Patrick’s Day Parade in 2016.



Just a few weeks after they returned from Rome, the band provided live music at Colorado’s National Western Stock Show for the “An Evening of Dancing Horses” event, which brings together the best equestrian talent from around the world for an evening of formal dressage, reining, liberty and other talents.

**AT MINES, WE CLIMB TOGETHER**

At the start of the 2019-20 academic year, Mines launched Every Oredigger, a comprehensive, campus-wide initiative aimed at promoting mental health, championing resiliency and preventing suicide at Mines.

Through culture changes, direct services, campus support and training, policy and procedure, communications and more, Mines has pledged to be a community that encourages and supports the well-being of all.

▶ Learn more about Every Oredigger at [mines.edu/everyoredigger](https://mines.edu/everyoredigger).

**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).

▶ Mines staff member Christina Vessa ran into Leif Colson ’72, MS ’05 on the rooftop of the Hotel Colón in Barcelona, Spain, in September 2019, where they talked about Mines and living in Colorado.



# MAKING A DIFFERENCE

Scholarship support inspires confidence and boosts student success

BY ASHLEY SPURGEON

For someone with strengths in math and science, applying to Mines was a no-brainer for Juno Padilla when deciding on his next step after graduating high school in 2016. But the journey to Mines wasn't quite that simple for the mechanical engineer who will graduate with a bachelor's degree in May 2020.

As the first person in his family to go to college, Padilla's transition to college was daunting at times, but the scholarship support he received helped him find the confidence to work hard and live up to the high expectations that come with a Mines education.

We met up with Padilla to talk about how scholarships have been essential to his success and what his future holds. Here's what we learned.

**Scholarships gave Padilla the confidence to succeed at Mines and inspired him to be a role model for others.**

Padilla was awarded scholarships from the Daniels Fund, Gates Millennium Scholars and Greenhouse Scholars programs, which fully funded his undergraduate education and allowed him to pursue a path he wasn't sure was possible.

"Scholarship support helps students who are, many times, behind the curve and have to catch up to some of their peers," Padilla said. "A scholarship helps students regain that confidence and know somebody supports them, somebody is putting financial support in them. That



means that they believe in them and reassures them that they are where they are meant to be."

**Because of his experiences at Mines and the opportunities his scholarships afforded him, Padilla is encouraging others, including his family, to pursue higher education.**

"I truly believe that [scholarships] have not only just changed my life—they have changed the course of life for all my family members," Padilla said. "I always harp on my little brother to apply to college. I've actually also encouraged my mom to start taking some college classes. She let me reach for my dream, so I tell her to go reach for hers."

**Because of his opportunities at Mines, Padilla is ready to make a difference.**

Padilla's mechanical engineering degree will provide him with many professional opportunities, but no matter what he ends up doing, he's focused on making the world a better place, specifically in communities like the one he comes from.

"I hope to lead a career of difference-making, of making sure people have

the opportunity to reduce inequality all around," he said. "I want to be known as somebody who leads with compassion and generosity and just cares for others."

► To hear more about Padilla's experiences, watch a video at [minesmagazine.com](http://minesmagazine.com).

## SUPPORTING STUDENT OPPORTUNITIES AT MINES

"I graduated eighth in my class in high school, and even with that, scholarships were hard to come by.

"Because my grandfather was willing to help me out financially, I named a scholarship after him. It wasn't until 2008 that I started the process of creating the endowment. I had an opportunity to give back to students so they wouldn't have to graduate with so much debt. You want to make sure that the students have the same opportunities that you had with a little less stress."

**Jeremy Zimmerman '86, MS '89**

Founder of the Victor H. Drake Memorial Scholarship Fund



Photo by Chris DuRoss, USGS

## A COLLABORATION LIKE NO OTHER BY TERESA MEEK

Mines and the USGS go way back, and the partnership is only getting stronger

No one is quite sure when Mines and the United States Geological Survey began working together. Faculty and government scientists were likely comparing notes long before the agency built the Geological Hazards Science Center on the Mines campus in 1977.

But on one point, everyone agrees: Both institutions have achieved results they never would have obtained without the help of the other.

For Mines, collaborating with the USGS has allowed researchers to work on a broad spectrum of projects.

"They have a very active group in mineral resources, so there's been a lot of interaction in that area," said Richard Wendlandt, emeritus professor of geology and geological engineering. "I've worked with them on projects ranging from gas hydrate research to the petrology of the Earth's mantle and lower crust. It's been quite a diverse range."

But Mines students see the biggest benefits. USGS researchers help

students with logistics, an important part of geological research. "They bring good field support and help us get into difficult areas," said Wendy Harrison, professor of geology and geological engineering, who recalled USGS scientists helping doctoral students find appropriate locations for research on mining contamination and how fluoride gets into groundwater.

More than 100 dissertations and over 50 master's theses have been completed with USGS help. "We get funding for our students from their research fellowships and grants, and we get the scientific input of people who are top in their fields," said Steve Enders, professor of geology and geological engineering and director of subsurface frontiers.

And that's not to mention the access to advanced equipment. "Students take advantage of world-class analytical facilities at the USGS Federal Center that don't exist at Mines," said Wendlandt, referring to the electron microprobe he's

used to analyze minerals at a very fine scale and the high-precision laser spectrometers students use to examine micrometer or nanometer-size rock slices.

But the benefits of collaboration go both ways. "Mines' faculty, postdocs and graduate students often have a combination of skills and expertise we can't readily find in the federal government," said Peter Griffiths, USGS regional deputy director of operations.

And after many years of successful collaboration, Mines hopes this partnership will continue to grow as more USGS scientists and Mines students and faculty collaborate on problems related to the energy transition, mineral resources, underground infrastructure and more.

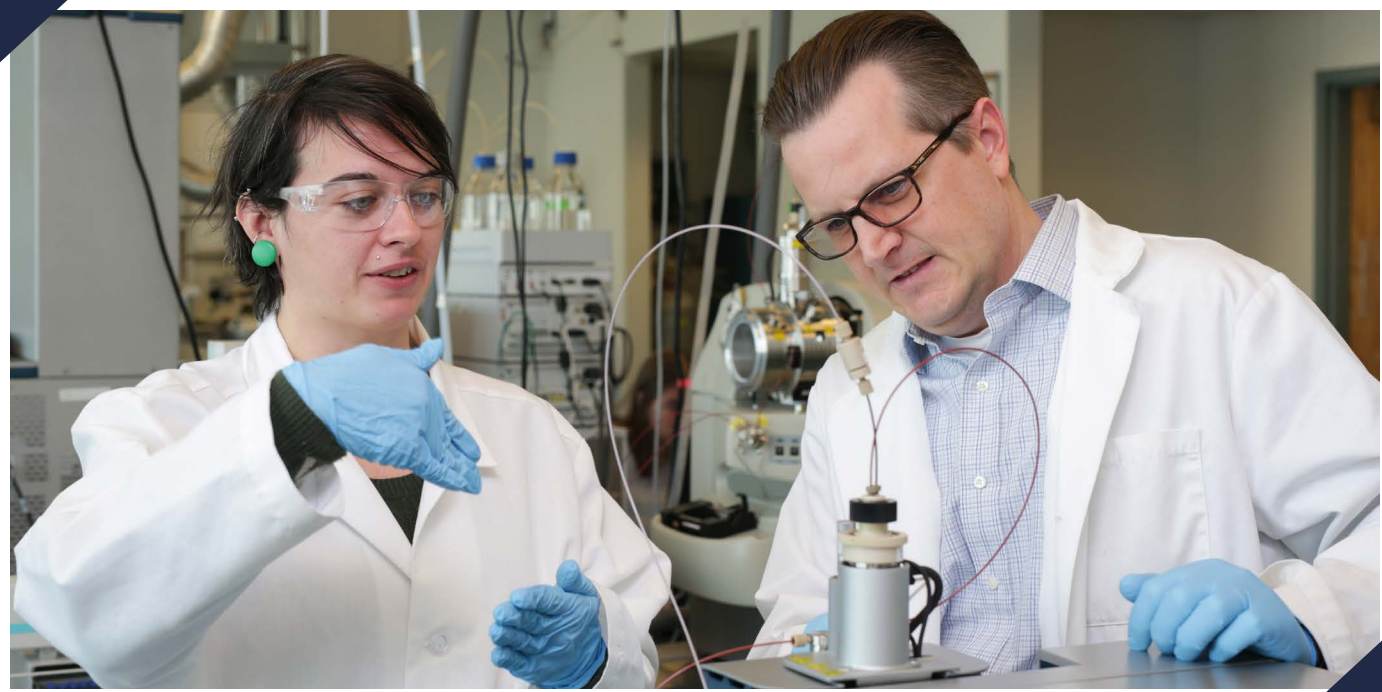
According to Wendlandt, "The opportunities for expanding the collaboration are going to be huge."

### CONNECTIONS

► Simone Aiken '01 visited campus in February 2020 to host a workshop where she shared her strategies for obtaining software contracts and negotiating salaries. •

► In February 2020, the Women of Mines Interest Group hosted more than 60 alumnae and students for a meet-and-greet on campus with Teresa Taylor, author and former CEO of Qwest Communications International Inc. •





## TAKING THE 'FOREVER' OUT OF 'FOREVER' CHEMICALS

BY EMILIE RUSCH

### Fighting PFAS contamination in our water supply

When Earl Tennant first reached out to environmental attorney Rob Bilott about the mysterious ailments befalling the cows on his West Virginia farm, no one was talking about “forever chemicals.”

In 1998, few people had heard of perfluorooctanoic acid (PFOA), a persistent fluorinated chemical nicknamed “C8” that the nearby DuPont plant was using to manufacture Teflon.

Twenty-two years later, communities across the U.S. are getting a crash course in PFOA and other poly- and perfluoroalkyl substances (PFAS) as they grapple with drinking water contaminated with these “forever chemicals,” so called because of their failure to break down in the environment. In Colorado, Fountain, Security and Widefield south of Colorado Springs and parts of south Adams County are among them.

An emerging body of evidence shows the fluorinated chemicals can cause cancer and developmental, endocrine, renal and metabolic problems.

Mines welcomed Bilott to campus earlier this year for the Herbert L. and Doris S. Young Environmental Issues

Symposium. In a keynote talk and panel discussion, Bilott helped shed light on the future of PFAS—and Mines’ important role in the fight.

“I’m afraid we’re probably looking at another 20 years of research into what do we do with this stuff,” Bilott said during his keynote. “How do we handle it now that we’re finally realizing it’s out there and we’ve all been exposed and it’s everywhere?”

#### Tackling the PFAS problem

Today, Chris Higgins, professor of civil and environmental engineering, and his colleagues at Mines are at the forefront of the fight against “forever chemicals.” Researchers are making an impact in the areas of fate and transport—how these chemicals move and accumulate in the environment, Higgins’ expertise—and remediation—what to do once they’re in drinking water, the focus of fellow Civil and Environmental Engineering faculty Timothy Strathmann and Chris Bellona.

In many ways, Mines was perfectly poised to be a leader on PFAS, Higgins said, because of its historic strengths in



environmental chemistry and water issues and its commitment to solving real-world problems.

“What’s particularly unique is I feel like we are better suited to deal with practical problems than a lot of other schools,” Higgins said. “It’s not that we don’t do fundamental research, but our engagement with industry, with practitioners, with real problems, is very well recognized on campus and encouraged.”

**“ONE FIVE-GALLON BUCKET OF THIS FOAM—OF THIS HISTORICAL FOAM CONTAINING THE PFOS AND PFOA—HAS ENOUGH OF THOSE CHEMICALS IN IT TO CONTAMINATE A WATER SUPPLY FOR 27,000 PEOPLE FOR AN ENTIRE YEAR.”**

#### The future of “forever chemicals”

Mines’ partners on the PFAS problem include the Colorado School of Public Health and Colorado Department of Public Health and Environment (CDPHE), both of which were represented, along with Bilott and Higgins, on the panel at the Young Environmental Issues Symposium.

The current EPA health advisory limit for PFAS in drinking water is 70 parts per trillion—a “really low level” when you’re talking about the firefighting foams that have been linked to contamination south of Colorado Springs and elsewhere, Higgins said. “One five-gallon bucket of this foam—of this historical foam

containing the PFOS and PFOA—has enough of those chemicals in it to contaminate a water supply for 27,000 people for an entire year.”

Manufacturers are moving away from the worst offenders—C8s—but the replacement foams still contain PFAS that are just as persistent in the environment while less accumulative in the body, Higgins said. “There’s been a movement to this as a potential Band-Aid until we get to a point where we have fluorine-free foams.”

Colorado is working hard to limit PFAS exposure throughout the state, said Tracie A. White ’98, remediation program manager at CDPHE. Potential state legislation introduced this year would give CDPHE the authority to require public utilities to test for PFAS in both their source and finished water. Under the bill, facilities with PFAS-containing foam would also have to register with the state and prove they are properly capturing and disposing of the foam.

On the remediation side, researchers at Mines and other institutions are making headway on a number of promising technologies that could treat contaminated water while it’s still in the ground. White said, “We

### A BREAKDOWN OF “FOREVER” CHEMICALS

#### What’s the problem?

PFAS molecules are made up of a chain of linked carbon and fluorine atoms. Because the carbon-fluorine bond is one of the strongest, these chemicals don’t degrade in the environment or human body and can accumulate over time, leading to adverse human health effects, such as cancer and developmental, endocrine, renal and metabolic problems.

#### How are humans exposed to PFAS?

Most people have been exposed to PFAS by using certain consumer products, such as nonstick cookware and stain- and water-repellent fabrics. Scientists have also discovered PFAS-contaminated groundwater near airports and military bases from firefighting foam used in training exercises or near manufacturing plants that use PFAS in their operations.

#### How are we solving this problem?

Mines is a leader in research in PFAS remediation, fate and transport, and exposure. While some are determining exactly how humans are exposed to PFAS, other Mines researchers are actively working on methods to remove and destroy “forever” chemicals in drinking water.

▶ To learn more about the PFAS research happening at Mines, visit [research.mines.edu](https://research.mines.edu).

are excited to be pilot testing a couple of these different technologies at Peterson Air Force Base during this upcoming year.”

▶ Listen to Colorado Public Radio’s coverage of the panel discussion about “forever” chemicals on our website at [minesmagazine.com](https://minesmagazine.com).

#### CONNECTIONS

▶ MLB pitcher Trevor Bauer from the Cincinnati Reds visited campus in November 2019 and received a “CS@Mines” T-shirt. Next thing you know, he’s proudly wearing the shirt in his February 7, 2020 #FanFridays video. •

▶ Renee Ereckson ’04, MS ’06 is the project manager for Spruce Hall, one of Mines’ new residence halls. She previously was involved in the preliminary designs of Elm Hall and the CoorsTek Center for Applied Science and Engineering. •



# SAME EDUCATION, DIFFERENT METHOD

## Teaching future generations of petroleum engineers

BY MARK RAMIREZ

Having earned three degrees from Mines, Linda Battalora '87, MS '88, PhD '14 has seen firsthand how petroleum engineering education has evolved over the years.

Now, as teaching professor and Ben L. Fryrear Endowed Chair for Innovation and Excellence, she's helping her department further refine the training of future generations of petroleum engineers.

"We're incorporating new topics required by industry and also addressing environmental, health, safety and sustainability issues," Battalora said. The department now offers a minor in data analytics, as well as a "midstream" minor.

Battalora teaches a variety of courses at all levels, including introduction to the petroleum industry, reservoir fluid properties and field session.

Her training and experience as a lawyer has been vital for courses on environmental law and sustainability, but she's also brought that expertise into other classes for a well-rounded learning experience. "Everything we do as engineers is, in some shape or form, regulated," Battalora said. "When I'm teaching tech topics, I'm also incorporating



awareness of the regulatory framework in which students will be working."

The way the department instructs students is also evolving, including offering online courses. "We're also doing more project-based learning in our classes, and student

### "WHEN I'M TEACHING TECH TOPICS, I'M ALSO INCORPORATING AWARENESS OF THE REGULATORY FRAMEWORK IN WHICH STUDENTS WILL BE WORKING."

feedback is very positive," Battalora said. "They work in teams to solve open-ended problems, and they're also addressing social, environmental, health, safety and sustainability issues."

As a Fryrear Chair, Battalora is also working on increasing alumni engagement and bringing alumni

into the classroom. While alumni have a long history of supporting Mines, more recently, graduates have looked to engage directly with current students, whether through Oredigger Camp, assisting in lab activities, teaching communication workshops or conducting mock interviews.

But even as Mines' infrastructure has grown and student resources have expanded, Battalora still relishes meeting with students one-on-one. "I love it when my

students come to see me," she said. "After talking about course material, we digress and talk about current events—the future of the oil and gas industry, job opportunities."

"I always encourage my students to think broadly about their careers," Battalora said, "and remind them that they are in charge of their futures."

## THOUGHT PROCESS

### What should robots do if they're given a command that's immoral?

That's the question we asked Tom Williams, assistant professor of computer science, whose research focuses on human-robot interaction. Here's what he said:

"Language-capable robots have unique persuasive power due to their naturally high levels of perceived social and moral agency. When a robot receives an unethical command, it not only needs to reject that command, it needs to reject it in the right way.

"Our work on moral language generation has shown that humans are sensitive to the phrasing robots use when rejecting commands. Robots must carefully tailor the strength of their responses to the severity of a human's violation to be effectively persuasive and avoid being perceived as overly harsh—or not harsh enough. To achieve this balance, we're exploring how robots can use different politeness strategies and moral frameworks to ground their rejections.

"We're currently focusing on Confucian role ethics and the ways it might be used by robot designers. There are at least three ways designers can employ Confucian principles when developing this technology:

- Designing knowledge representations and algorithms that consider roles and relationships.
- Explicitly enabling robots to reject inappropriate commands by appealing to roles rather than notions of right and wrong.
- Assessing whether the robot's design encourages its teammates to adhere to moral principles."



## IN TECH WE TRUST — TO A POINT

BY MARK RAMIREZ

### Autonomous robots are on the rise but still require significant human oversight

Once a novelty, robotic vacuums are now a common sight in homes. Chances are, you've seen or used one, and manufacturers have even expanded to produce automated mops and lawnmowers.

While exponential growth of such devices in our daily lives seems a foregone conclusion, the technology still needs to mature and earn the trust of humans—much like a teenager asking to drive the family car.

That hurdle will be tougher to clear than any technological challenge, according to Xiaoli Zhang, associate professor of mechanical engineering.

Take self-driving cars. The technology simply can't guarantee reliability yet, Zhang said. But even more important, the technology raises many concerns for the people who will use them.

"It's not just whether you can achieve 100 percent safety," Zhang said. "Humans have to understand how it's done—if an AI can explain how decisions are made, it makes humans feel safer."

Robotic vacuums are everywhere because the stakes are lower and the technology is easier to explain—with

fewer ethical questions. That's also true for carts that follow shoppers around or robots that deliver food and other products—applications Zhang has seen from startups.

With the challenges of full autonomy, Zhang sees human-robot cooperation as the immediate future, particularly in industry, and rejects the idea that robots will eliminate existing jobs.

"In manufacturing, robots will take on the repetitive work, such as assembly, but humans will be the supervisor," Zhang said. "A robot could be sent into dangerous environments for mining exploration or search-and-rescue, but a human will provide high-level decision-making."

As the field of automated robotics grows, "to commercialize automated robots and bring practical, wide impact on everyone's daily life, the key for robotics companies will be identifying pain points and finding those well-validated technologies, not necessarily the cutting edge, to meet those needs," Zhang said. "The technology has to actually solve problems—otherwise, it's just in the demo stage."

## CONNECTIONS

▶ 11 local Mines alumni gathered on campus in January 2020 for the monthly Golden Lunch Bunch event, where President Paul C. Johnson talked about campus expansions, programs, graduation requirements, new initiatives and more. •

▶ Kurtis Griess '08, MS '10, program director of Upward Bound Math and Science in Albuquerque, N.M., brought 40 high school students to Mines in summer 2019 to take college-level math courses. •



# WHAT GOES UP...

Microgravity experiments take materials research to new heights

BY ASHLEY SPURGEON

Some experiments can't be carried out on Earth. But it's also impractical to send every experiment that requires microgravity to the International Space Station. Instead, many experiments are conducted in drop towers that provide a microgravity environment.

Martin Castillo '99, PhD '04, head of material science at University of Bremen's Center of Applied Space Technology and Microgravity (ZARM), works with the world's most capable drop tower (pictured right) to synthesize materials in this specialized environment. We sat down with Castillo to talk about how drop towers work and the benefits of microgravity research.

### What happens to materials in microgravity?

**Martin Castillo:** Two things happen in microgravity: number one, you suppress gravity-driven buoyancy forces. We're able to suspend really heavy, dense objects and produce a very homogeneous material.

The second thing is that you suppress gravity-driven convection. The way heat is passed through materials is a little different than on Earth, and you can use this to create novel materials.

### Walk us through what it would be like to carry out an experiment in the drop tower.

**Castillo:** Let's say I have a chemical mixture I wanted to react. I measure out the amount of chemicals inside a glove box. I assemble the materials



Photos courtesy of ZARM, University of Bremen

I want to react in microgravity and put them into combustion chambers. I put the chambers in a capsule which goes into the tower.

All the air gets pumped out of the tower, which is 147 meters tall—the tube itself is around 120 meters, and the fall distance is 110 meters. If it's not windy outside, which causes the tower to shake, I'll be able to do a drop and obtain 4.74 seconds of microgravity.

We also have the world's only capability for doing a catapult. We can shoot our capsule from the bottom of the tower, and it'll go up and down approximately 212 meters. This vertical parabola gives you 9.3 seconds of microgravity.

### What will microgravity research enable us to do in the future?

**Castillo:** A lot of people are reinventing what was done 30 to 40 years ago. We're advancing materials and trying to implement new techniques. Now that we have such great control and precision

with these instruments and doing measurements on atomic scales, we can do quite a bit more. We can evaluate what we couldn't in the past and make new steps.

### What are you working on?

**Castillo:** I'm making an advanced semiconducting material that emits light. LCDs don't work in space, but I can make a two- to three-color display that works in extreme environments. This would be a good replacement for the printed flipbooks that astronauts use on external missions. They would now just have a screen on the outside of their suit and connect with the Wi-Fi to upload or download new commands for what they're doing on the space station. I'm also working on improving the energy efficiency of screens and displays so that you only have to charge your phone once per week.

## CONNECTIONS

► Julye Nugent '86 visited an "American" bar in Singapore with university pennants on the walls. In between Ohio State and San Francisco State was a familiar blue-and-silver pennant proudly displaying Mines pride 9,000-plus miles from campus. •

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# YOU ASKED, OUR EXPERTS ANSWERED



### Grant Miller '99 asked:

Is it true that we don't have the minerals available (unless oceans are mined, and even that's not guaranteed) to switch to electric cars globally?

### Rod Eggert, Viola Vestal Coulter Chair in Mineral Economics, answered:

Demand for some mineral resources will increase significantly as adoption of electric vehicles (EVs) increases globally—for example, demand for certain rare earth elements for magnets in EV motors and for copper in electrical wiring, as well as for battery materials such as nickel, lithium and cobalt. Production capacity will have to increase for these and other mineral-derived raw materials.

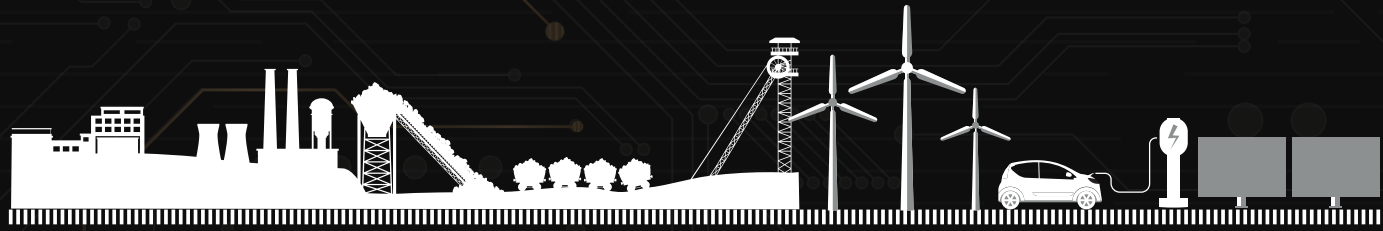
The availability of these materials is not so much about geologic occurrence (known resources are significant) but rather about costs, environmental and social impacts and process technologies. What will it cost to produce these materials, and how will these costs influence the affordability of vehicles? What are the environmental and social impacts of increased production? Can we develop improved process technologies that increase the efficiency of production, lowering costs and environmental impacts? Moreover, there is a timing issue—will capacity expansions keep pace with increased demand for EVs?

The biggest risk to long-term mineral availability is insufficient investment, especially in technological R&D and in education of professionals needed for activities over the entire life cycle of a material—from basic geoscience and mining to recycling and reuse of a material.

### Have a question about science, engineering or anything else?

► Submit it at [minesmagazine.com/contact-us](http://minesmagazine.com/contact-us) for a chance to be featured in this column.





# THE FUTURE IS (STILL) UNDERGROUND

The demand for earth metals and skilled engineers isn't waning—it's growing.

By Jenn Fields

## THE EVOLUTION OF MINING



**3.3 MILLION YEARS AGO**  
Flint

Easily breakable stone, such as flint, was used to make arrowheads and knives.



**9000 B.C.**  
Copper, tin

Copper was one of the first metals extracted by humans and shaped into tools, such as ax heads and other technology.

29	50
<b>Cu</b>	<b>Sn</b>
63.546	118.710
Copper	Tin

“The energy landscape globally is changing dramatically. It appears almost certain that there’s going to be significantly more technologies like batteries, electric vehicles, photovoltaics and wind turbines deployed. All of those are mineral-intensive. Thus, the future energy system will be more mineral-intensive than the past.”

**Morgan Bazilian**

**Director of the Payne Institute for Public Policy**



AFRICA



The Democratic Republic of Congo has large deposits of cobalt, important for technology such as rechargeable batteries.

ASIA



About 85 percent of the world's neodymium—used for permanent magnets in wind turbines and electric vehicle motors—comes out of a few mines in China.

AUSTRALIA



Australia is a major contributor of mined minerals critical to modern technology, with large reserves of neodymium, lithium and copper.

SOUTH AMERICA



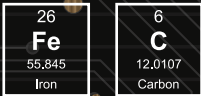
The world's largest source of lithium—the main mineral used for lithium-ion batteries—is Chile's Salar de Atacama.



**"THERE'S BEEN A SHIFT IN WHAT MINERALS ARE IMPORTANT. BUT THAT'S NOT UNUSUAL. OVER TIME, SOMETHING DISRUPTIVE COMES ALONG, AND WHAT MINERALS WE NEED CHANGES."**  
 -Amy Jacobsen '89

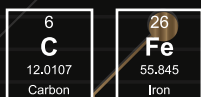
5000 B.C.  
Iron, steel

Iron was much more abundant than copper and tin, creating better technology like plows that spurred agricultural growth.



1800s  
Steel, coal

The prevalence of coal and steel propelled the invention of the steam engine and railways. The internal-combustion engine was invented in 1876, giving rise to automobiles.



1954  
Copper, gallium, iron, tellurium

The invention of the first Bell Solar Battery gave rise to modern solar panels and the future of solar energy, which relies on minerals such as aluminum, copper, gallium, iron, tellurium and more.



For 10 years, mining consultant Amy Jacobsen '89 lived on a sailboat. Wind and solar energy powered her living quarters, but she had a backup gas generator for when the batteries drained. "That's kind of the idea of how base power works when we mix it with renewables," she said. "It's got to be a mix, there's no way around it."

In this lower-carbon arrangement, all three power sources were essential. And all three require mined earth resources.

That slice of personal history mirrors a future envisioned in a report McKinsey & Company released in January 2020 that outlines what many in the mining industry already know: Though carbon is in decline, coal still accounts for half the global mining market. Meanwhile, renewables—and the earth resources they require—present a promising future for the mining industry.

From copper for wiring to lithium for electric-vehicle batteries to concrete for construction, mined materials are essential in modern life. "With our population growth, even if we became incredibly efficient, the demand would probably still exist for most materials we're mining," said Priscilla Nelson, professor of mining engineering.

And as the energy market shifts away from coal and toward renewables, the global demand for the earth resources they require is only expected to grow.

"The energy landscape globally is changing dramatically," said Morgan Bazilian, director of the Payne Institute for Public Policy. "It appears almost certain that there's going to be significantly more technologies like batteries, electric vehicles, photovoltaics and wind turbines deployed. All of those are mineral-intensive. Thus, the future energy system will be more mineral-intensive than the past.

"And the mining industry is starting to understand and be supportive of the clean energy transition, because they'll play a fundamental role in it."

Jacobsen, who runs Windward Consulting and is a senior associate at

mineral industry advising firm Behre Dolbear, said miners are doing what they've always done: refocusing as demand changes. "There's been a shift in what minerals are important. But that's not unusual," she said. "Over time, something disruptive comes along, and what minerals we need changes. Right now, the huge push for lithium, cobalt, copper and rare earth minerals—those are the big hot topics right now, and in the consulting world, everyone's out there trying to find lithium."

The industry regards the changes at hand as much more than just a trend, said Jacobsen, who is also the president of the Mining and Metallurgical Society of America, which plans to launch a series of webinars on this topic in the fall. "The industry will continue to adapt to the changes in our society—how we generate and distribute energy, how we preserve the environment and how we do all this safely and economically."

CRITICAL MATERIALS

Renewables, which accounted for 17 percent of energy generation in the U.S. in 2018, come with a heavy demand for metals.

Large amounts of aluminum and copper go into wind turbines. Storing the energy generated by wind and solar requires materials the U.S. has deemed critical to economic and national security, such as lithium and cobalt. The high-efficiency motors that wind turbines and electric cars use require rare earth elements, such as dysprosium and neodymium for permanent magnets. The federal government considers rare earths so critical to national security that the U.S. Army is now funding commercial-scale rare earths processing facilities. Another rare metal, tellurium, is used in a film in photovoltaic solar cells to make them more efficient—the U.S. Geologic Survey calls it one of the least-common elements on the planet.

"From a mining standpoint, it's a huge opportunity," said Timothy





**1975**  
**Steel, copper, neodymium, aluminum**

Materials such as steel, copper, neodymium and aluminum all play a role in the mechanizations of wind turbines.



**1980**  
**Cobalt, iron, lithium**

Cobalt, iron and lithium are just a few of the minerals essential for lithium ion batteries, propelling growth in electric vehicles and electronic gadgets.



Haddon '70, president and CEO of International Natural Resources Management. "We've got the various heavy metals—or rare earths—the requirements of those are going to go up significantly. We're currently getting the supply from China, and we need to diversify the source for practical reasons."

But it's an opportunity that comes with a few challenges, one of which is that many of the known deposits of these minerals are in places where it's difficult to mine. "I've heard this many times and I actually agree: All the easy deposits have been mined," Jacobsen said.

Just one of these metals provides a case study for the challenges ahead. "Cobalt is a real issue," Jacobsen said. Cobalt is a crucial component of rechargeable lithium-ion batteries and the permanent magnets that give wind turbines their efficiency. "The biggest deposits occur in the Democratic Republic of Congo—a challenging place to work, a challenging place, as a company, to go in and try to build a mine."

Meanwhile, researchers at Mines are tackling the question of how to meet the demand for critical materials from many angles, from policy to production.

"There will certainly be increased demand for these materials, and the question is, how well positioned is the world economy to satisfy this increased demand?" said Rod Eggert, Viola Vestal Coulter Chair in Mineral Economics and deputy director of the U.S. Department of Energy's Critical Materials Institute.

Mining more could help meet the demand, but recycling and reducing waste in mining processes will help as well. For example, researchers in the Metallurgical and Materials Engineering and Mining Engineering departments are working on ways to separate rare earths from other materials more efficiently. "There are 15 or so rare earth elements that tend to be found together in nature, and historically, that separation has been really inefficient," Eggert

said. "So there's room for dramatic improvement."

The mining industry will need to make other advancements in extraction and exploration as well, and a project at Mines that won National Science Foundation funding last year promises to bring more efficiency to both through artificial intelligence and data analytics.

"In comparison to oil and gas, the geology of metal deposits is very complicated, and metal deposits that can be mined economically are difficult to find," said Thomas Monecke, associate professor of geology and geological engineering.

Monecke is the site director for the Center for Advanced Subsurface Earth Resource Models, a research collaboration between Mines and Virginia Tech that brings geologists and mathematicians together to work on subsurface modeling techniques to make mining more precise and efficient, from exploration to development. "Ultimately, big data is going to be transformational in mining," Monecke said. "If you think about other industries, like the car industry or airplanes, they don't build models anymore—it's all computational."

**ADAPTING TECHNOLOGY TO MEET NEW DEMANDS**

The McKinsey report also outlined industry risks related to climate change (primarily water stress and how increased temperatures will affect the workforce), as well as how the mining industry can decarbonize itself.

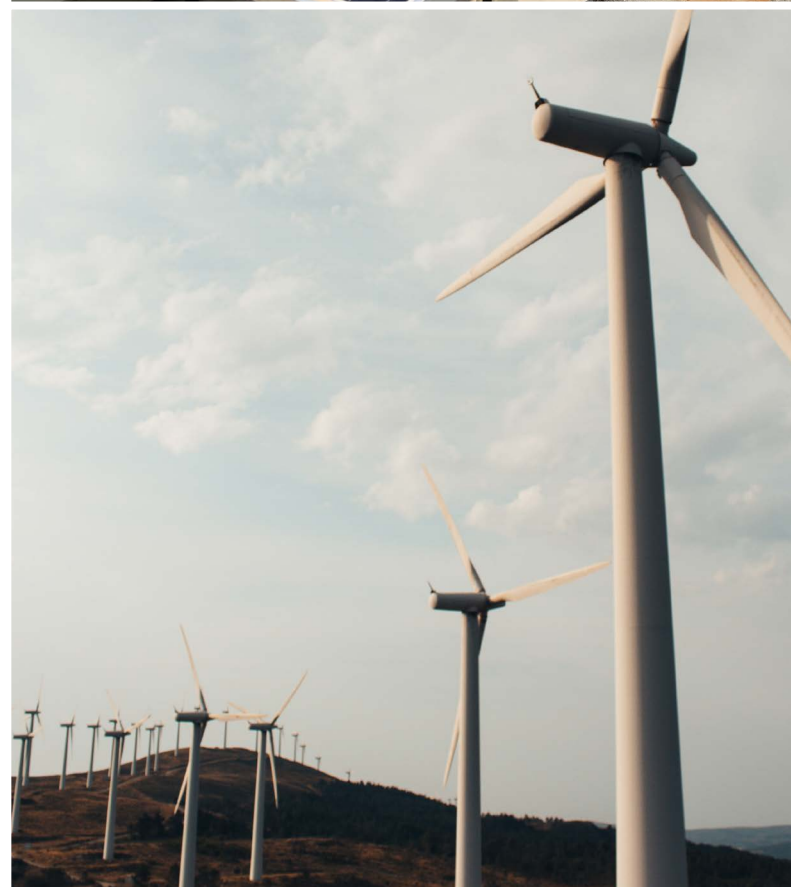
The industry is already adopting innovations to keep workers safer and reduce its own carbon footprint.

"Through my career I've watched different innovations come in, and sometimes I'm astounded," Jacobsen said. She recalled visiting Kennecott's Bingham copper pit, outside Salt Lake City, in the 1990s. The mine's trucks were using a relatively brand-new technology. "They had implemented GPS on the trucks and the shovels so



**"I THINK THE INDUSTRY WILL ADAPT TO WHATEVER THE CHANGES ARE—IT ALWAYS HAS. AS LONG AS THERE'S BEEN HUMAN CIVILIZATION, THERE'S BEEN MINING."**

**-Jaume Martinez Calvo, mining engineering student, Class of 2021**



if a shovel broke down, they could send a truck to a shovel that was working. It was how they could efficiently keep the pit running—because every time you fire up one of those trucks and move it, it costs money."

"GPS was little heard of at the time, so I was like, wow!" she said. "A decade later, it's an everyday term. Mining's always ahead of the curve." Now, she said, drones are active at mining sites, keeping people away from dangerous situations, and the industry is switching from diesel to electric vehicles.

"We're always trying to be the lowest-cost and most profitable miners," Haddon said. "So we're instituting things like blockchain, drones, AI, remote mining. Most people think of mining as a stodgy, slow-to-change industry, and that's not the truth."

He cited Rio Tinto's remote-operated trucks, shovels and drills in Western Australia. "You've got people sitting in Perth, 1,000 miles south of the mines, remotely operating this equipment so they don't have to pay for the remote living expenses, and they have a better quality of life living in the cities," he said.

It's another sign that beyond the shifting demand for critical materials, the industry itself is changing, Nelson said. "I think the

mining industry is going to go increasingly toward the use of renewables. It's going to go away from the use of diesel, it's going to go toward the increasing use of electric vehicles underground, the use of robotics, and, I hope, the use of selective mining."

All of these changes present a unique opportunity for students. "In the mining industry itself, a lot of senior people are getting ready to retire, and there aren't enough people to come up in the ranks," Priscilla Nelson said. "We're getting into mines that are going deeper and deeper, and we don't want to put people there, so we need more robotics. In mineral processing, we need more people in chemical engineering." And with big data promising to transform the industry, she said, "We need people who understand how to write Python code."

Current Mines students see all of these changes as a positive for their careers. Martina Gilbert, a junior in mining engineering, president of Mines' Women in Mining chapter and chief technician for the Mine Rescue Team, said she sees a bright future ahead. "Mining is what makes America possible," she said. "The increasing number of minerals needed to produce every laptop, every cell phone, every home—the demand is just going to grow."



## THRILLS, CHILLS AND CAREFUL ENGINEERING

For Anya Tyler '11, designing roller coasters is a walk in the (amusement) park

BY SARAH KUTA

When Anya Tyler '11 was young, she knew exactly what she wanted to do when she grew up: design roller coasters.

Today, Tyler is doing just that. She works as a design engineer for Skyline Attractions, an Orlando-based company that designs and manufactures theme park rides and games.

"We spend so much time at work, and if it isn't something you find interesting and enjoy, why are you there? When you are passionate and interested in what you are doing, your results—ideas, work, products—all show it," Tyler said.

Tyler first became fascinated with roller coasters during annual summer vacations to Kings Island, an amusement park between Cincinnati and Dayton, Ohio. A family tragedy—the death of her brother Daniel in a private plane crash when he was 19—solidified Tyler's resolve to chase the life she wanted.

"He was one of the biggest cheerleaders in my life and encouraged me to make roller coasters," said Tyler, who grew up in Centennial, Colo., and studied mechanical engineering at Mines. "[His death] taught me earlier



Photo by Nick Leyva

than most that life is short and precious, not to take it so seriously and, most importantly, to do something you love."

When she started applying for internships and, later, full-time jobs, Tyler quickly learned she'd have to be persistent if she was serious about designing coasters. She networked, attended conferences and sought advice until she finally got a job making play structures for water parks.

Tyler eventually landed a position with Great Coasters International, which makes wooden roller coasters. Several of her colleagues there later branched off to form her current employer, Skyline Attractions.

When designing a coaster, safety is always the first and most important consideration, Tyler said.

Engineers must consider the forces a coaster will put on both passengers and its own infrastructure. Will the

ride make someone sick? Will the force put too much stress on the ride's mechanical components? How fast can a coaster safely go around a hairpin turn?

"We have to do the calculations to prove that it's not going to break, that it's not going to wear out after thousands of cycles or vibrations from the ride," she said.

Roughly a year ago, Tyler gained a new perspective on coasters, her career and the relentless pursuit of her dreams: she became a mom. Her family's mantra, "arms up," became all the more significant with the birth of her daughter, Alyssa.

"It's like riding a roller coaster—you put your arms up and lean into the experience, enjoy the ride and just go for it," she said. "That's something I hope to embrace and pass down to her as she grows. And to be the one reminding her 'arms up' for whatever her path might be."

**"WE SPEND SO MUCH TIME AT WORK, AND IF IT ISN'T SOMETHING YOU FIND INTERESTING AND ENJOY, WHY ARE YOU THERE? WHEN YOU ARE PASSIONATE AND INTERESTED IN WHAT YOU ARE DOING, YOUR RESULTS—IDEAS, WORK, PRODUCTS—ALL SHOW IT."**

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### CONNECTIONS

- ▶ Peyton Gibson '17 served as the chair of the American Society of Civil Engineers' Colorado Infrastructure Report Card, released in January 2020. Several other Mines alumni authored the report, "grading" 14 infrastructure sectors in Colorado. •



# GENEROSITY REAPS MANY BENEFITS

BY LORI FERGUSON

## Universities need support of all kinds to thrive

Bill Zisch '79 came to Mines on an athletic scholarship in 1975, joining the Orediggers on the football and baseball fields for the four years of his undergraduate education. That initial support not only allowed him to succeed academically but also set him up for a successful career as a mining engineer.

Zisch is the former COO of Argonaut Gold Ltd. and CEO of Midway Gold, both companies engaged in exploration, mine development and production activities, and he's honoring his time at Mines by paying it forward.

In addition to serving as president of the Mines alumni board, Zisch also finds ways to pay tribute to his roots in Mines Athletics. "I attend games and matches throughout the year and contribute to the athletics department financially. I also take part in discussions related to meeting the needs of current student athletes and increasing the engagement of student-athlete alums."

"My participation in Mines' sports teams played a big role in my education, so it's enjoyable to continue my involvement with athletics at the university," Zisch continued. "Sports give you a chance to learn teamwork, set objectives, get a plan and then execute, all skills that transfer into industry."

This spirit of giving back is what helps universities thrive, and it's the personal touch that makes it truly meaningful.

"It's important for alums to understand that their contributions are appreciated, whatever form they take," Zisch explained. "Our alums are welcome on campus anytime, to give lectures, sit on panels, judge competitions, meet with students—in short, to engage in whatever activities speak to them."

Of course, it's not just the personal interactions that are important to a university—private support is essential to ensuring the best opportunities are available for current students.



In 2018, Joe Coors '77 opened the CoorsTek Center for Applied Science and Engineering, which was supported by the largest private donation in Mines history.

State funding provides a portion of the university's budget, but at less than 10 percent of the total operations, schools can't count on it for the future. And the answer isn't in raising tuition fees, as Mines is sensitive to the growing financial burden that a college degree can represent to students and their families. To close the gap, the university must rely on private support. This lesser known, but equally important, funding source is key to ensuring Mines' continued fiscal health and sterling reputation as a world-class educational institution.

"Many institutions have size on their side and can address budgetary issues by just adding more students," said Brian

Winkelbauer, president and CEO of the Mines Foundation. "We're a lean institution—we don't have a lot of fluff that we can cut, and we can't continue to fund things that students want and need on the backs of tuition. So, if we want to continue to deliver the unprecedented educational experience for which we're known, we simply must garner additional private support."

But public institutions operate on a very different business model from private institutions, Winkelbauer continued, and although

financial opportunities for future students. "I had to take out student loans to attend Mines, so I want to make it easier for someone else," she said.

Now a reservoir engineer with the private equity team of Arcadius Capital Partners, Nelson created the Pillar Endowed Scholarship to support out-of-state petroleum engineering students through the McBride Honors Program. "I'm from Houston, so I know out-of-state tuition costs are higher, and I got a lot out of participating in the

**"WHEN I GO BACK TO CAMPUS, I FEEL LIKE I'M VISITING FAMILY AND FRIENDS, NOT JUST MY UNIVERSITY. EVERYTHING I'VE GIVEN TO MINES, I'VE RECEIVED BACK AND MORE."**

many don't realize it, Mines is a public university. "Mines looks a lot like a private institution—for example, we maintain a smaller size that's conducive to offering rigorous degree programs in a supportive environment, and we're tightly focused on engineering and applied science."

Mines' small size is exactly what persuaded Aprill Nelson '08 to earn her degree from the school. "I wanted to be a person and not a number," she said. "I felt valued as a student, and I still feel that way as an alumna."

But paying for her education wasn't easy, and Nelson was inspired to provide better

McBride program, so I'd like to afford other students that opportunity."

Nelson is also a member of the Mines Alumni Board and feels strongly about the rewards to be gleaned from continued involvement with the university. "Through my work with the alumni board, I've had the opportunity to connect with both current Mines students and alumni—interactions that have helped me grow professionally and further develop my skills. When I go back to campus, I feel like I'm visiting family and friends, not just my university," she said. "Everything I've given to Mines, I've received back and more."

## MEANINGFUL CONTRIBUTIONS

Alumni leave their mark on Mines by volunteering, mentoring, hosting events in their local communities, donating to a program or department, engaging on social media and countless other ways. No matter what alumni are passionate about or where they are in their lives and careers, the way they choose to give back has a lasting effect on the Mines campus and community.

### Here are a few ways alumni choose to support Mines:

#### Kurtis Griess '08, MS '10

- Recruits bright STEM high school students for Mines
- Brings students to Mines to experience the campus culture and learn more about college
- Attends local M Club events in Albuquerque, N.M.

#### George Puls '75

- Leads M Club San Antonio to build support for local alumni and affinity for Mines
- Financially supports the football program and scholarships

#### Kinzie Beavers '10

- Supports the Mines cheerleading program through her company's matching gift program in honor of her fond memories on the squad
- Attends M Club Denver events to connect with fellow Orediggers

#### Kathryn Morse Stricker '95

- Recruits Mines students for Texas Instruments at Career Day and throughout the year
- Attends alumni events in Dallas to grow Mines pride

#### Olivia '03, MS '05 and Forest '03, MS '05 Bommarito

- Created an endowed scholarship for students to provide them with the same financial opportunities they received as students

## CONNECTIONS

► M Club Midland hosted an event in January 2020 where local alumni connected with Jennifer Miskimins, interim petroleum engineering department head, and learned about upcoming plans for the department and other campus updates. •

► M Club Midland also recently said goodbye to Bryce Swinford '07, who they'd like to emphasize is not dead but simply moved to Houston. •



# FROM MECHANICS TO BUSINESS OWNERSHIP: THE VERSATILITY OF ENGINEERING

Evan Schertz '19 takes on the challenge of owning an independent bookstore in Durango, Colorado

BY AMANDA SCHUSTER

In the age of the e-book and one-day delivery, the independent bookstore industry faces multiple challenges. Rising overhead costs, razor-thin profit margins and fierce competition from larger sellers who can undercut prices make owning a brick-and-mortar bookstore a formidable undertaking. But Evan Schertz '19 is ready to take on that challenge.

Since graduating from Mines with a degree in mechanical engineering last May, Schertz has been learning the ropes at Maria's Bookshop in Durango, Colo. He's preparing to take over ownership from his parents, Andrea Avantaggio and Peter Schertz, by learning the ins and outs of the business, making connections in both local and national communities and taking the lead in planning for the store's upcoming remodel.

While owning a bookstore is an unusual career choice after graduating with a degree in mechanical engineering, Schertz said his scientific background and experiences at Mines



Photo by Ben Brashear

have prepared him perfectly for this role. "I think what I got out of my education at Mines is more than just the nuances of fluids or statics—it was the mindset I learned regarding how to solve problems, think critically and work hard," Schertz said. "And I'm realizing now just how well that all translates into business ownership."

He's in the process of restructuring the organization to be able to withstand the loss of its two most knowledgeable employees as his parents transition out. Schertz said he's tackling the challenge by using the creative thinking methods he learned at Mines. "I'm approaching it as a really complicated problem I know I can solve," Schertz said. "It just

takes looking at all the right pieces and putting it all together in the right way. It feels more manageable the more rationally I can think about it."

And that's on top of trying to remain competitive against the convenience of online sellers, such

**"I THINK WHAT I GOT OUT OF MY EDUCATION AT MINES IS MORE THAN JUST THE NUANCES OF FLUIDS OR STATICS—IT WAS THE MINDSET I LEARNED REGARDING HOW TO SOLVE PROBLEMS, THINK CRITICALLY AND WORK HARD. AND I'M REALIZING NOW JUST HOW WELL THAT ALL TRANSLATES INTO BUSINESS OWNERSHIP."**

as Amazon. "For a brick-and-mortar bookstore to survive in this era, it really takes a community that values it enough to support it over the obvious alternatives." And Maria's has that support, Schertz said.

"The Durango community is pretty incredible. People have always cared about Maria's a lot, and I think me being there has brought new energy to a classic store."

For Schertz, both the connection to the community and the opportunity to apply his degree in creative ways were part of the reason he chose such an unconventional career path for an engineer. But mostly, he said, it's just what he wanted to do. "Once I got over the hurdle of actually considering [bookstore ownership] as a real possibility, it felt like a no-brainer," he explained. "It's an incredible opportunity and exactly what I could see myself doing for a long time."

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Patent Attorney,  
Shareholder

*B.S., Engineering, with honors, 2003; M.S., Engineering Technology Management, 2005 Top Graduating Electrical Engineer*

**Bruce Kugler**  
Patent Attorney,  
Shareholder

*B.S., Petroleum Engineering, 1981*

**Doug Swartz**  
Patent Attorney,  
Shareholder

*B.S., Mining Engineering, Minor in Metallurgical Engineering, 1982*

**Brad Knepper**  
Patent Attorney,  
Shareholder

*B.S., Electrical Engineering, 1998*

**Kristen Gruber**  
Patent Attorney,  
Associate

*B.S., Chemical and Petroleum Refining Engineering, 2000*

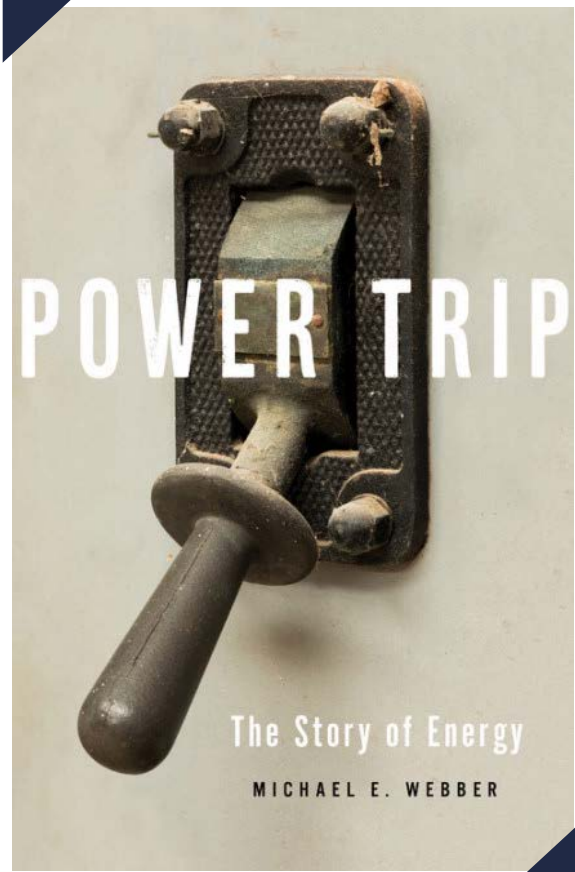
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## CONNECTIONS

► M Club San Antonio completed a service project in January 2020, packing 1,200 boxes of food for seniors at the San Antonio Food Bank. •





## THE POWER EVOLUTION

A conversation about our energy future

BY ASHLEY SPURGEON

Michael E. Webber's book, *Power Trip*, examines humanity's relationship with energy over time, calling energy "humanity's most important resource." *Mines Magazine* sat down with Webber and Gregory Clough of the Payne Institute for Public Policy for an episode of the institute's podcast and talked about the energy transition and the future of energy innovation.

Here's an excerpt of the conversation:

**Mines Magazine:** Michael, *Power Trip* details several energy transitions throughout history, so the transition we're experiencing now isn't a new phenomenon. Will you expand on this idea that energy is always transitioning and how we must always look for new ways to meet our energy demands?

**Michael Webber:** The point I'm trying to make is that the only constant is that energy has changed. There's nothing that really stays steady—it's always in a state of flux. There are a couple of examples from history we can point to that look familiar to what we're going through today and perhaps offer some lessons learned. We've been in these transitions, at least in terms of what the dominant fuel is—from wood to coal to oil and perhaps natural gas—

and I don't know what's next after that. Maybe nuclear or renewables. And that reveals that we can do this and have done this.

**MM:** What are some of the major concerns you hear most often about the energy transition, and how do we begin to address them?

**Webber:** We have a lot of technological solutions on hand for a low-carbon future, but we don't have the infrastructure, or they cause social disruption. We have a lot of challenges, but they're mostly nontechnical. They're mostly behavioral, economic, political, cultural, and those things together create the technical road map for people like me, which is: OK, how do I use technology to solve those nontechnical problems by driving down the cost or increasing the performance



GREGORY CLOUGH

Clough is the strategy and operations manager at the Payne Institute for Public Policy at Mines. He has more than 20 years of professional experience in operations, finance, administration and project management.



MICHAEL E. WEBBER

Webber is the Josey Centennial Professor in Energy Resources and professor of mechanical engineering at the University of Texas at Austin and chief science and technology officer for Engie, a global energy and infrastructure services firm. He is the author of two books: *Power Trip: The Story of Energy* and *Thirst for Power*.

"WE HAVE SUCH A BREADTH OF EXPERIENCE AND KNOWLEDGE AROUND SOME OF THESE TECHNICAL SOLUTIONS. BUT WE NEED TO START BRINGING THOSE INTO THE POLICY WORLD SO POLICYMAKERS ALSO HAVE A MORE NUANCED UNDERSTANDING OF WHAT THE ENERGY TRANSITION LOOKS LIKE AND THE COMPLEXITIES IT BRINGS."

of solutions, for example. But there remain all sorts of hurdles, that's for sure.

**Gregory Clough:** I think one of the biggest challenges is there's a huge disconnect between a lot of the technical advancements that are happening in energy right now and the policy decisions. As a lot of us have seen, this grand challenge of it's either we continue with fossil fuels and provide energy or we're going to renewables and a Green New Deal—I think there's a lot of complexity that's missed in the debate. I think that's why Mines is a great university to start participating in that, because we have such a breadth of experience and knowledge around some of these technical solutions. But we need to start bringing those into the policy world so policymakers also have a more nuanced understanding of what the energy transition looks like and the complexities it brings.

**MM:** Michael, in *Power Trip*, you suggest that we need a combination of new production, increased energy access, smarter solutions and a cultural emphasis on efficiency and conservation. What major innovations do you think need to happen to help solve our energy challenges?

**Webber:** There's all sorts of technologies we need to get better at. But the challenge I find most vexing and the most difficult for society is around low-carbon fuels. We mostly know how to decarbonize the power sector. You shut down coal and replace it with gas, and

then you'll eventually shut down gas with wind, solar or nuclear or you'll add carbon capture and offsets and other things. We just need to do it at a faster rate and more extensively.

**MM:** Greg, how do we begin to cultivate that emphasis on efficiency and conservation while acknowledging and being respectful of our past and the carbon-intensive industries and resources that have spurred energy growth and opportunity for so long?

**Clough:** We see a lot of progress happening, but we see a lot of division as it relates to the conversation. We need to cultivate a conversation to address these issues and bring together some of the policymakers and some of the people who provided those traditional energy sources and start having constructive conversations. Again, that's where Mines can play a leading role—we have this expertise on fossil fuels, but we also have these other experiences, and we need to bring those into the public sphere so we can contribute our knowledge and technical expertise to that conversation.

\*This conversation has been edited for clarity and brevity.

► Visit [minesmagazine.com](http://minesmagazine.com) to listen to the full conversation. To keep up with the latest news and discussions related to the energy transition and public policy, go to the Payne Institute's website at [payneinstitute.mines.edu](http://payneinstitute.mines.edu).

**The Payne Institute for Public Policy** informs and shapes public policy on earth resources, energy and the environment, fostering collaborative partnerships with other universities, industry and government agencies around the world.

Initiatives include:

- Advanced Energy Systems
- Earth Observation Group
- Future of Oil & Gas
- Mineral Foundations of the Energy Transition
- Space Resources

### CONNECTIONS

► Ken Snodgrass '80 hosted a welcome party for new Orediggers in summer 2017, where he met Dante Ramirez and introduced him to the Mines community. With Dante graduating this year, his mother sent Ken an email thanking him for the early connection. •

► The Denver Mining Club has been around since 1891 and currently has several Mines graduates as club members. The club meets every Monday for lunch and invites guest speakers to talk about the mining and oil and gas industries. •



# STUDENT EMERGENCY FUND



# RISE UP, MINES!



When our students are in need, Mines is here for them.

## Reduce the impact of COVID-19 for our neediest students

Your generosity will help Mines continue to provide resources to Orediggers facing financial hardship because of the COVID-19 pandemic, the loss of a family member, natural disasters, an unhealthy living situation or food insecurity.

- **Just-in-time relief** for Mines to respond to students impacted by the COVID-19 pandemic
- **Funding for clothing and supplies** lost to a fire, flood, natural disaster or other emergency
- **Grocery money** or a meal plan
- **Improved virtual learning resources** and digital crisis support services
- **Lost wages**, travel expenses or living expenses
- **Counseling services**
- **Testing services** for disabilities

### TOP DOLLAR

Mines alumni are among the highest-earning CEOs in Colorado

■ We take pride in the fact that many Mines graduates find success in their careers, achieve big goals and earn top dollar for their work. And in October 2019, *Denver Business Journal* confirmed that fact when three Mines alumni made the list of the highest-earning CEOs of Colorado public companies, making Mines the most popular school for undergraduate degrees among the 25 CEOs featured.

#### #10

**Thomas Jordan '80, MS '87**  
Chairman/President/CEO,  
Cimarex Energy Co.

**\$9.73 MILLION\***

#### #15

**James Kleckner '81**  
President/CEO,  
Jagged Peak Energy Inc.

**\$8.5 MILLION\***

#### #21

**Javan Ottoson '80**  
President/CEO,  
SM Energy Co.

**\$6.95 MILLION\***

#### Did you know?

A 2019 *Forbes* study found that 89 percent of Fortune 100 CEOs who obtained undergraduate degrees did so at non-Ivy League schools.

\*based on total compensation in 2018

## A FORWARD-THINKING BUSINESS MODEL



For StoneAge Inc., employee ownership is key to success

BY ASHLEY SPURGEON

Business models are ever evolving to provide better opportunities

for employees and the industries in which they work. In recent years, there has been a shift to more employee-owned models, ushering in a new wave of business practices and changing company culture.

StoneAge Inc., which manufactures high-pressure waterblast tools and automated equipment for the industrial cleaning industry, has been an employee-owned company for many years and transitioned to an employee stock ownership plan (ESOP) in 2015. We sat down with StoneAge CEO Kerry Siggins '01 to talk about supporting a culture of ownership in the workplace and what it takes to be a leader.

**Colorado Gov. Jared Polis appointed you late last year to the Colorado Employee Ownership Commission. Why was this appointment important to you, and what do you hope to accomplish?**

**Kerry Siggins:** I'm a big believer in employee ownership. Being employee-owned has created a whole new level of opportunity for our employees and fueled our growth.

When I heard about the employee ownership commission, I was excited to throw my name into the hat. Because we've been employee-owned since the 1990s and recently completed the ESOP transition, I felt like I had a lot to contribute. I believed I could

help the commission understand the benefits of being employee-owned by sharing what we've gained from it as a company. I hope to help Gov. Polis achieve his goal of converting thousands of companies to some sort of employee-ownership model and help Colorado be known as innovative, pro-business and supportive of employee-owned companies.

**How do you promote a culture of ownership in your business?**

**Siggins:** We've been an employee-owned company for so long, it's largely ingrained in our company. But when we transitioned to the ESOP, we had many conversations about how to make sure our employees continue to feel a deep sense of ownership. We developed the "Own It Mindset" to inspire and guide the way we show up each day, how we treat each other, how we serve our customers and how we value our suppliers and business partners.

**What does a company or individual need to be successful in your industry today?**

**Siggins:** A company must be forward-thinking. The internet of things and industrial automation is going to dramatically change how we do business, and many companies in our industry aren't doing enough to prepare for it, much less lead the way. Good leaders need to peer around the corner, trying to make educated guesses on what they think the future will look like and then align their strategy and organization to create that future.

► Mines alumni and current students from the Mines club Ultimate team competed in an ultimate frisbee tournament on the beach in Huntington, Calif., over Martin Luther King, Jr. weekend in January 2020. •



# FAST CARS, FASTER BRAINS

Engineers are the real heroes of Formula 1 racing

BY SARAH KUTA

The best drivers in the world compete in Formula 1 racing. But, no matter how well they drive, if their car isn't engineered to perfection, they don't have a chance at winning.

Formula 1 engineers design and build a new state-of-the-art race car from the ground up every season, considering every possible improvement—no matter how small—that could give their team an edge. The rapid pace of innovation means that Formula 1 teams are always looking for talented new engineers to add to their rosters.

“You can have an amazing driver but the best they can do is sixth because their car just isn't as good as the best car,” said Sabré Cook '17, a professional racing driver and mechanical engineer. “Because the cars make such a big difference on performance, that's why engineers really enjoy getting into Formula 1.”

Cook, who began racing when she was 8 years old in her hometown of Grand Junction, Colo., competed against thousands of applicants to land a coveted spot at the Infiniti Engineering Academy. She spent six months working at Infiniti and six months working with the Renault F1 team.

F1 teams need engineers of all specialties and backgrounds, relying heavily on their expertise in everything from aerodynamics to materials to batteries.

They design and manufacture custom-built parts, simulate and test changes and, ultimately, build a car with mind-blowing acceleration and braking capabilities, all while complying with F1 technical and safety regulations. Cook, for instance, helped improve the top rear wishbone for the Renault F1 team's 2020 car.

An engineer's involvement doesn't stop at the factory, either. On race day, engineers sit on the pit wall and in the garage, monitoring real-time conditions and communicating changes with the driver for optimal performance.

It's an enticing career path for engineers, particularly young professionals who thrive in a high-intensity environment and are eager to see their work in action.

“It's the pinnacle of engineering,” Cook said. “You're designing and building a car from scratch every single year. Every single area has been engineered and thought out and vetted a million different ways.”

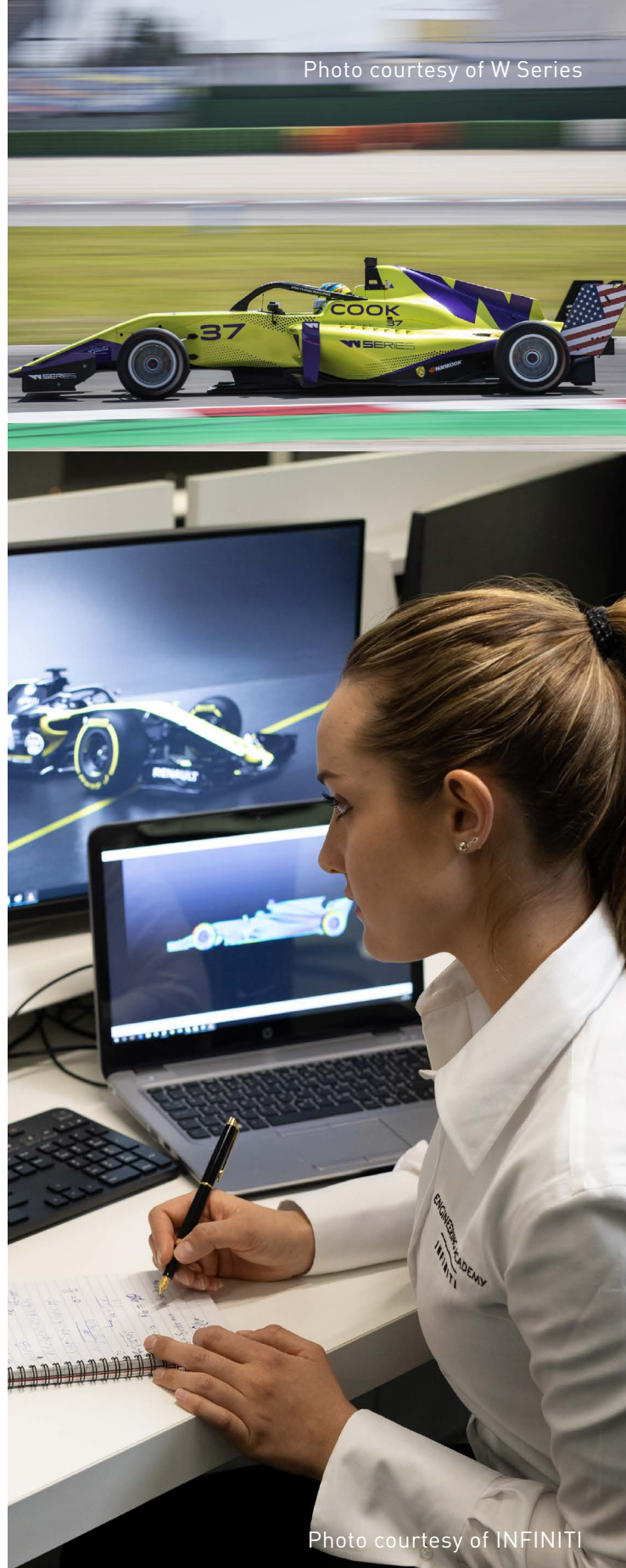


Photo courtesy of W Series

Photo courtesy of INFINITI

## CONNECTIONS

▶ Earl “Dutch” Clark, professional football player and Mines’ head football coach in 1933, was added to the National Football League’s 100th Anniversary All-Time Team in November 2019. •

## TECH TIP

Did you know your smartphone can save your life?

Many of us are never too far from our devices, something first responders are counting on in an emergency.

Most smartphones now have the capability to store your medical information—such as drug allergies and existing conditions—and emergency contacts that can be easily accessed if you get in an accident or someone finds you unconscious. It can even be accessed when your phone is locked, without needing your password.



### Here's how to set it up:

- If you're an iPhone user, set up your Medical ID in your Health app.
- Android users, fill out your emergency information in your phone's settings.
- If you have a Samsung device, you can fill out your vital information in your Contacts app.
- Google Pixel users, you will need to use the Google app to set up your emergency information.

Take a few minutes to set up your emergency contacts and enter any medical conditions you have that emergency personnel should be aware of. It just might save your life.

▶ 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](https://minesmagazine.com/contact-us).

# WHAT'S NEXT IN TECH?

A few technology trends that could have major implications for the future

Technology is evolving faster than ever, and companies and individuals have to keep up with all of the latest tech trends or run the risk of falling behind. Here, we've pulled together a few technologies to watch this year and stay on top of the opportunities they may bring.



## Augmented and virtual reality

Virtual reality provides a digital immersive experience where humans can view a computer-generated world using headsets, and augmented reality places digital objects in the real world through a screen or digital display. While this technology has largely been confined to video games and smartphone features, there are many possibilities for research and industry applications. Currently, Mines researchers are actively using AR and VR for projects such as mine mapping, human-robot interaction and more.

## 5G data networks

This new generation of mobile internet connectivity will bring ultrafast download and upload speeds and more stable connections all around. The



increased bandwidth will enable machines, robots and autonomous vehicles to collect and transfer more data than ever, and 5G could have huge implications for researchers working on innovations in every industry, particularly those working with the “internet of things” and smart machinery.

## Personalized medicine

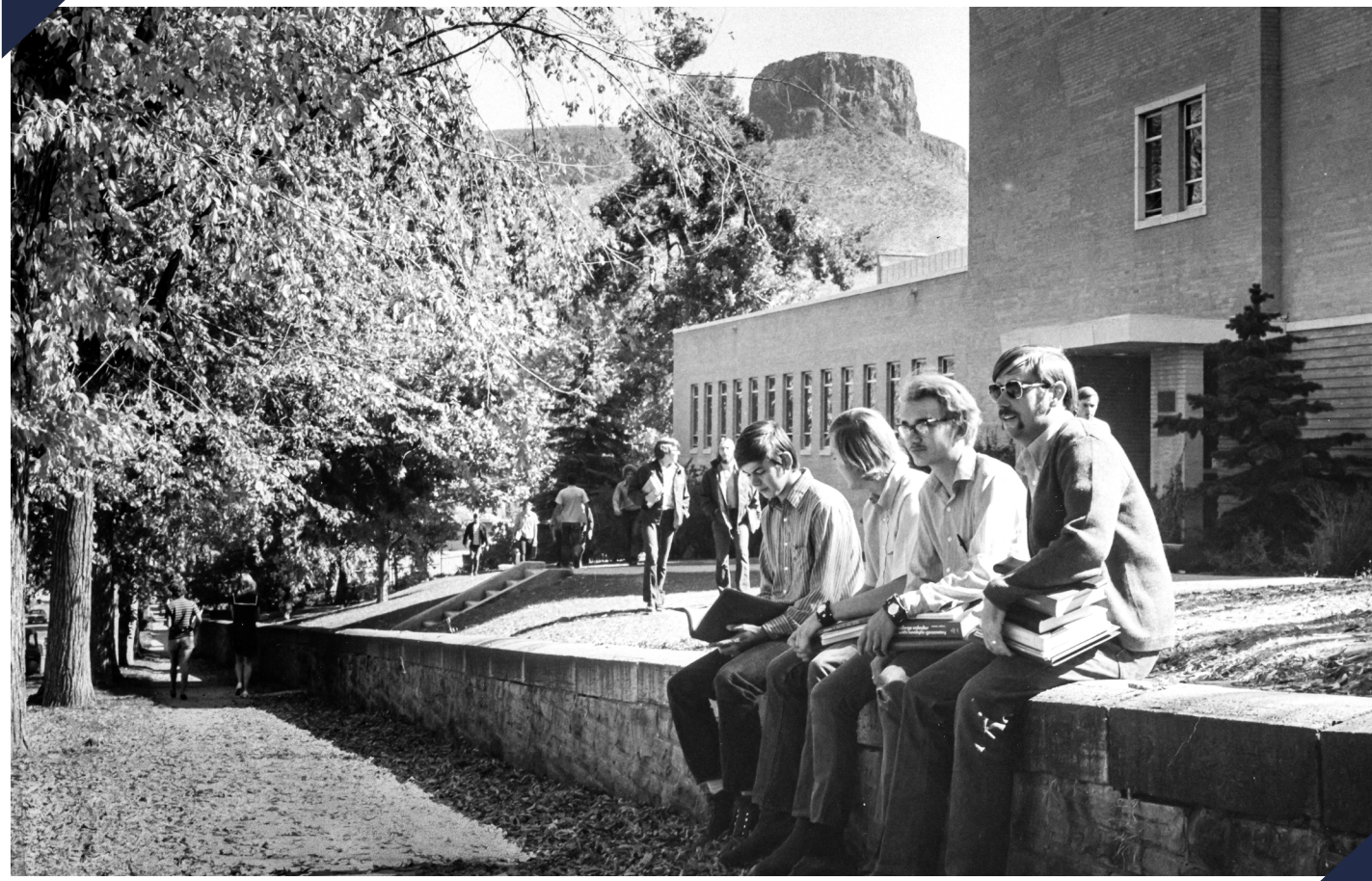
As health care moves away from a “one-size-fits-all” approach, medical technology is becoming more personalized.

This allows doctors to more precisely prescribe medicines and apply treatments, thanks to a data-driven understanding of how effective a particular treatment might work for a specific patient. Mines researchers are already working in this field, developing technology such as “nanoparticles” that can be injected into the bloodstream for targeted drug delivery and “nanoparticle tattoos” that can read important biological markers in patients.



▶ When Mines moved to a remote learning model in March 2020 during the COVID-19 pandemic, Jacob Feldman '19, Tracy Gardner '96, MS '98, Willie Konishi '19 and Melanie Westergaard '87 shared messages of support in a video for students. •





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).

## 1970s

**John Coors '77** retired as chairman of the board of CoorsTek Inc. in January 2020. His 40-year career included leadership positions across three Coors family businesses: brewing, solar electric and engineered ceramics. Despite his retirement from CoorsTek, John will remain involved in Coors family businesses.

## 1980s

**Joseph Albi Jr. '82, MS '86** announced his retirement as executive vice president and chief

operating officer from Cimarex Energy Co. in January 2020, and will leave the company on July 1, 2020. Joe was with Cimarex for 18 years.

**Ross Bhappu PhD '88**, a senior partner of Resource Capital Funds, joined Canadian-based mining company TMAC Resources Inc.'s board of directors in December 2019.

**Linda Battalora '87, MS '88, PhD '14**, teaching professor of petroleum engineering at Mines, was awarded a Ben L. Fryrear Endowed Chair for Innovation and Excellence to lead efforts to increase alumni engagement on campus. Linda is the fourth Mines faculty member

to receive a Fryrear Chair since the position was endowed by Ben Fryrear '62 in 2017 to recognize and support highly accomplished faculty members driving institutional change.

▶ Read more about Linda on [page 14](#).

**Joseph Eazor '85** was named president and CEO of Conifer Health Solutions in January 2020.

**Mark Levin '87, MS '92, ME '94** recently acquired the former site of Elizabeth Mining and Development Inc. in Montrose, Colo., for his business, Mining Equipment and Supply LLC. At the new site, MES

will lease and sell underground mining equipment.

**Hugh Sanburg '83** was named the new vice chairman of the Cattlemen's Beef Promotion and Research Board in February 2020. As a member of the board's officer team, Hugh is responsible for guiding the national Beef Checkoff throughout 2020.

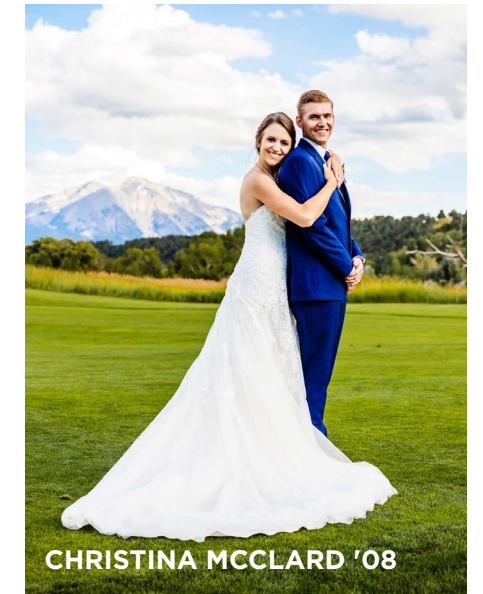
## 1990s

**Grover Coors '96, PhD '01** was named a Payne Institute Fellow on February 4, 2020. As a fellow, Grover supports the Payne Institute for Public Policy's work and vision

and brings valuable connections, speakers and resources to Mines.

**Nancy Flores MS '92** was announced as the executive vice president, chief information officer and chief technology officer of health care company McKesson Corporation on Jan. 30, 2020. Nancy previously served as the chief information officer for Johnson Controls.

**Samantha Holroyd '91** was recently nominated for election to the Firefly Value Partners board of directors. Firefly is an investment partnership focused on fundamental primary research and business analysis.



CHRISTINA MCCLARD '08



In the mid-1980s, Mines' geology and geophysics departments conducted several short courses in Colombia with Instituto Colombiano del Petroleo, taught by several Mines faculty and associates. Many of the students in the short courses went on to receive master's degrees or doctorates from U.S. universities, including Mines, and gained positions in middle and upper management at the Colombian petroleum company Ecopetrol and other Colombian startups.

Last year, the students held a reunion in Colombia, and former faculty sent video greetings.

Pictured from top left: **Edgar Baquero-Santa MS '94, Gerardo Garcia MS '91, Gabriel Perez MS '97, Gabriel Alvarez MS '96, Nestor Quevedo, Elkyn Obando, Trino Salinas-Garnica MS '97, Ivan Olaya-Lopez MS '97, Jaime Checa and Carlos Piedrahita**

Second row, from left: Hector Alfonso, Maria Carmenza Bowman, Juan **Pablo Reyes MS '93, Frank Gomez, Yolanda Aguiar, Mario Suarez and Saul Guevara**



EMMETT BIBLE



BRIAN BOUGHDADLY



## 2000s

**Casey Bernal '02** returned to Mines in 2019 as the instructional machine shop manager in the mechanical engineering department. His goal is to develop the machine shop into an enjoyable place for students to learn fabrication skills to create mechanically functional workpieces for their projects.

**Christina McClard '08** and Brian Pearson were married in July 2019 in Carbondale, Colo. Mines alumni in attendance included Katherine McClard '11, Caryn (Stefonik) Carruthers '08 and Bryan Carruthers '07, Renee (Rainguet) Jeffries '08, Darcy (Souta) Stingerie '08, Caitlyn (Stewart) Jackson '08 and Dwyatt Jackson '07, Erica (Pribble) Lawlor '08 and Phil Lawlor '07, Chelsea (Womble) Rickett '08 and Coree Javernick Truesdell '12.

**Andrew Ramcharan MS '05** was appointed the executive vice president of corporate development and investor relations for RosCan Gold Corporation, a Canadian-based gold exploration company, in December 2019.

**Laurie Rasmussen '03** was named a partner at Perkins Coie in Denver, Colo. Laurie is a member of the Patent Prosecution and Portfolio Counseling practice, helping clients procure, manage, assess and improve their intellectual property assets, and works one-on-one with inventors and in-house counsel to describe inventions and devise a forward-looking approach for cost-effective patent prosecution.

**Justin Stolte '02** joined the international law firm Latham & Watkins LLP in February 2020 as a partner in the corporate department and a member of the mergers and acquisitions practice.

## 2010s

**Kyle Bible '13** and **Cassie (Whalen) Bible '15** welcomed Emmett James Bible on January 13, 2020. Emmett weighed 8 pounds, 14 ounces and can't wait to be a future Oredigger.

**Lacy (Taylor) Boughdadly '10** and **Travers Boughdadly '10, MS '12** welcomed Brian Walter Boughdadly into their family on September 13, 2019.

**Brad Burback '15, MS '16** and **Katrin Gallup '17** were married on March 29, 2019, in The Woodlands, Texas. Orediggers in attendance included Krista Hickey '17, Sarah Berude '18 and Joseph Wolpert '15 and current student Paul Gallup.

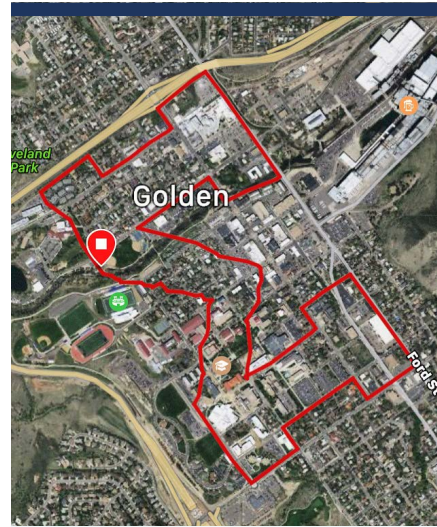
**Tony D'Esposito '18** and Katie Thomson were married on June 21, 2019, on Mount Evans, near where they got engaged the year before. Their wedding celebration in Erie, Colo., was attended by more than 35 Mines alumni and current students, including Ben Thomson '13, Bryan Morgan '18, MS '18, Erich Deutsch '17, MS '18, Nate Todtenhagen '18, MS '19, Cassie Calahan '16, Colton Aldridge '18, Evelyn Marchbanks '18 and Philip Oxford '18.

**Thomas Harris '13** and **Jennifer Harris '13** welcomed Roslyn Kay Harris into the world on Aug. 21, 2019.

After successfully defending her PhD thesis in March 2020, **Chelsea Panos '15** accepted a position as an assistant teaching professor at Mines.

**Thorn Svendsen '11** and **Chelsey Svendsen '12** are excited to announce the birth of Aribella Rose Svendsen on September 3, 2019. She joins big brother Xavior (2).

As a Peace Corps volunteer in Guinea, **Dot Walch '19** is teaching math to seventh- and eighth-grade students and cites her engineering background as an ideal source for creating tangible, real-world examples for her students to learn from.



### FIRST-EVER M RUN USING STRAVA AND GPS TRACKING

**Ted Archuleta '04, MS '05** and **Matt Mientka '06, MS '10** completed the first-ever "M Run" on February 2, 2020. Challenged by a friend to create a giant Mines "M" using Strava art, Ted spent two weeks on Google Maps planning out the course and trying different configurations around Golden, Colo., to make the "M." The diagonal stretches through the Mines campus were the hardest to achieve due to obstacles such as rivers, cars and even houses—he had to get permission from Golden residents to cross through their yards.

When the winter weather subsided for a 70-degree day, Ted called Matt to join him—without giving him many details—and the two set off, tracking their movements by GPS. They had to run as straight and precisely as possible to accurately capture the "M," and their attention to detail certainly paid off.

**Distance: 4.32 mi**

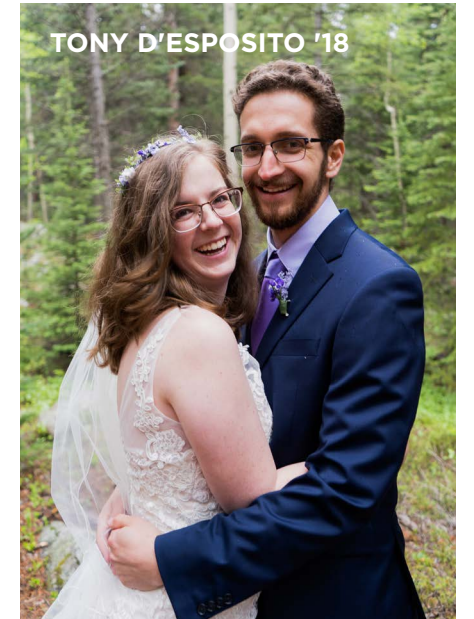
**Average Pace: 11:43 min/mi**

**Time: 49:59**

**Elevation Gain: 367 feet**



BRAD BURBACK '15, MS '16 AND KATRIN GALLUP '17

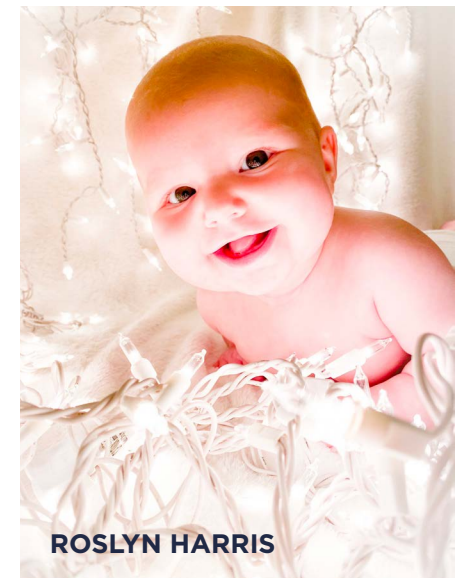


TONY D'ESPOSITO '18

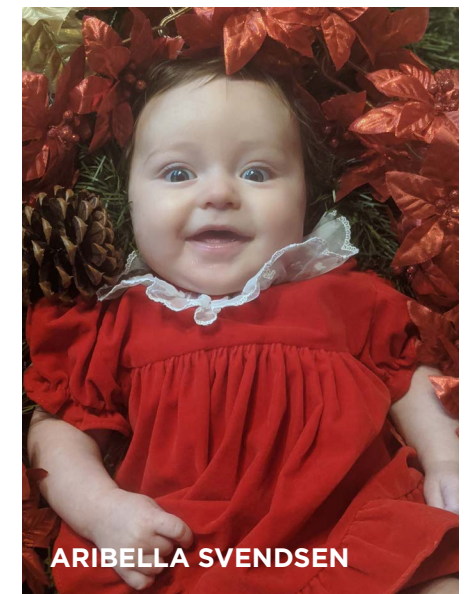


**Jack Hancock** was named an honorary Mines alumni on February 14, 2020, in recognition of his life-long contributions to Mines.

Jack was the head wrestling coach for Mines for 37 years, leading the Orediggers to many wins and NCAA achievements. He also served as an assistant football and tennis coach and assistant athletic trainer.



ROSLYN HARRIS



ARIBELLA SVENDSEN



# IN MEMORIAM

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

**Roshan B. Bhappu '50, MS '51, DS '53** died Dec. 28, 2019. Born in 1926, Roshan spent his career as a metallurgical engineer, serving as the mechanical engineering department head at the New Mexico Institute of Mining and Technology and working for Mountain States R&D International. He received the van Diest Gold Medal from Mines in 1968.

**Arthur F. Clark ME '67** died Dec. 23, 2019. Born in 1945, Arthur founded several companies during his career, including AET Environmental, which is contracted with Mines to assist in its Resource Conservation and Recovery Act compliance and inspections program and its hazardous waste management.

**Justin P. "JP" Hedley '86, MS '91** died Jan. 8, 2020. He was born in 1961 and graduated from Mines with two degrees in geophysics and wrote code for the Department of Physics in the early 2000s. Several Orediggers gathered in Golden, Colo., to raise a glass in JP's honor after his passing.

**Donald T. "Don" Klodt '52** died Nov. 3, 2019. Born in 1930, Don spent much of his career in academia, working for the University of Denver and later joining Mines as an associate professor of metallurgical engineering. He was a metallurgy and corrosion consultant later in his career.

**Frederick K. (Ken) Meitz '53** died Sept. 4, 2019. He was born in 1932 and was a member of Alpha Tau Omega, Tau Beta Pi, Theta Tau and ROTC as a Mines student. During his career, Ken served in the U.S. Army Corps of Engineers as a topography instructor and worked as an exploration geologist at Shell Oil Company.

**George A. Minick '53, MS '74** died Dec. 8, 2019. Born in 1917, George served in the U.S. Navy from 1943 to 1946 and was awarded two Bronze Stars. He worked for Atlantic Richfield on a seismic surveying crew and later went to work as a metallurgist for A.R. Wilfley and Sons.

**Herbert C. "Herb" Osborne '61** died Jan. 23, 2020. Herb was born in 1936 and spent his career in the mining industry, eventually becoming a consultant and advising on projects around the world.

**King Gillette Robertson '59** died Dec. 23, 2019. King was born in 1933 and was drafted into the U.S. Army during the Korean War. He spent the rest of his career working for Coors Brewing Company, where he helped improve aluminum packaging and recycling methods, and later became an aluminum consultant.

► To submit an obituary for publication in *Mines Magazine*, visit [minesmagazine.com/obituary](http://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](http://weare.mines.edu/givingguide).



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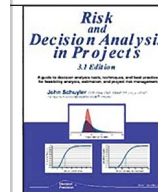
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# WHAT'S UP WITH OUR NEW LOOK?

A graphic designer's take on Mines' rich history, using 100-year-old design elements and the process behind *Mines Magazine's* new design BY CHRISTINA VESSA

With more than 100 years of stories, *Mines Magazine* has preserved Mines' rich history, providing unique snapshots of a tight-knit, incomparable alumni community. We knew this is where we had to start when designing the magazine's new look.

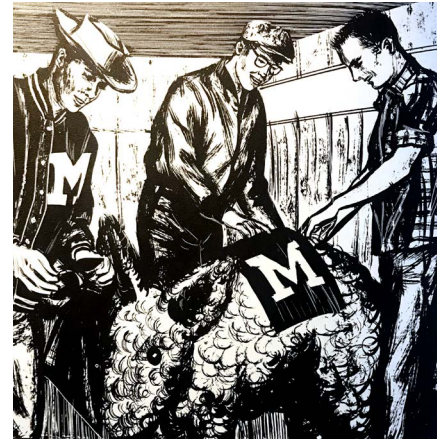
*Mines Magazine's* redesign channels both the university's past—using classic icons and fonts—and its present—a modern appearance reflected in this issue's wide

margins and clean headlines. We wanted a look that brought a century-old publication into 2020 to enhance our storytelling and the Mines ethos our alumni know so well.

Collected here are some of the design elements that inspired and guided the magazine's revamp, pulled from the *Mines Magazine* and *The Prospector* archives going all the way back to 1910.



The Prospector, 1930



The Prospector, 1962



Section break in the 1940s and 1950s issues of *Mines Magazine*

## Illustrations and icons

Images of a prospector pointing off into the distance and drawings of a burro carrying a full load on its back symbolize Mines' roots in the promise of the American West and

the hope of a prosperous future for so many. These images have evolved into the trademarks in use at Mines today, such as the familiar Blaster logo used in Mines Athletics.

## ICONS TURNED TRADEMARKS

Over time, icons found in archived publications have evolved into the official university trademarks used today.

### THEN



1910

### Legacy Triangle



### Blaster



### The M

### NOW



In addition to Mines' current trademarks, here are a few other icons that inspired us:



Illustrations showing the American West, a prospector and a burro from the 1932 edition of *The Prospector*

## Mastheads and font treatments

A masthead anchors a magazine, setting the publication's tone. In early *Mines Magazine* issues—including the very first in 1910—the masthead used a serif font, with some updates from decade to decade. However, over the years, the serif lettering shifted to the sans serif bold lettering used in the Mines logos today. When developing our new design, we knew we had to find a balance between the two.

In our redesigned masthead, "Mines" is stylized in the bold capital letters used by the university today and paired with a lighter "Magazine" to convey a sense of movement as Mines—and the magazine—transitions into a new decade. But to tie the magazine back to the traditional elements from our past, you'll notice "For Colorado School of Mines Alumni and Friends" and "Spring 2020" are in that serif font we were so inspired by.

That serif font and highly stylized cursive letters from the first half of the 1900s can also be found in other places throughout this issue, such as in numerals and subheadlines, to tie the publication back to those historic design choices.







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The 1940 edition of *The Prospector* features a series of illustrations showing Marvin the Miner and Blaster the Burro around campus and Golden, Colo. This image blends a current photo of the Mines campus with an illustration from that series.

Image by Wan Jun Aida Wan Ahmad Johari