

MINES MAGAZINE

For Colorado School of Mines Alumni and Friends • Winter 2024



INTO THE NEXT ERA

Building on an indelible legacy, Mines continues to provide industry with the technology needed for the next 150 years and beyond.

PLUS:

Orediggers are embracing new technology to enhance the educational experience, improve energy efficiencies and find new production methods.

Mines alumni are influencing new advancements and finding more ways to create opportunities for all in their careers.

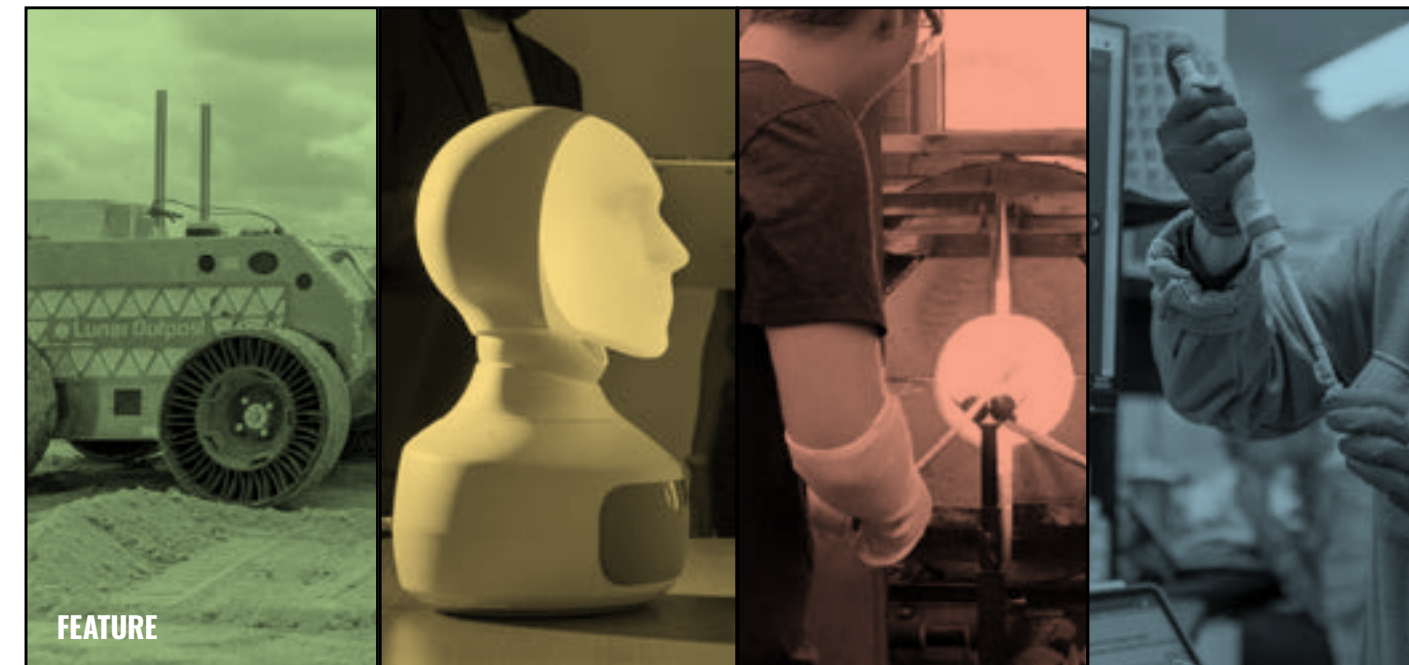
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➔ Follow Mines on social media for more great shots of the Mines community and Golden and to keep up with everything happening with your fellow Orediggers.



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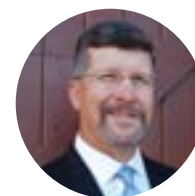
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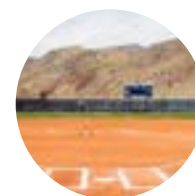
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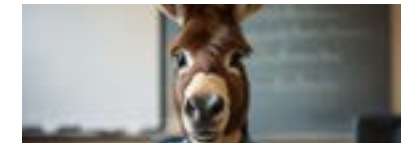


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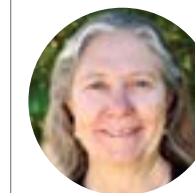


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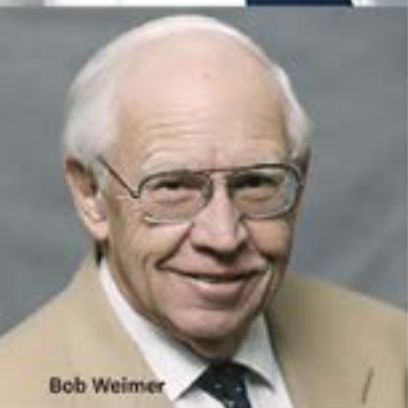
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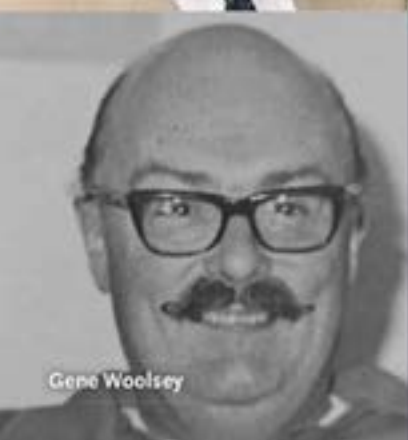
Marv Kay



Ramona Graves



Bob Weimer



Gene Woolsey

HONORING THE FACULTY AND STAFF WHO MAKE ALL THINGS POSSIBLE

For 150 years, Mines faculty and staff have left an indelible mark on our students. They're the backbone of what makes Mines extraordinary.

Mines alumni recently shared stories about the professors, coaches and staff who taught them invaluable lessons. Here are a few of their replies:

- "He got me my first job as an intern and that spurred my entire career."
- "He taught me the importance of talking to everyone involved in a process and respecting everyone regardless of their position."
- "They taught me to think critically and problem solve, which has been invaluable in my career."
- "They were tough but instilled a desire to learn and explore new things. I feel like they didn't just teach us but prepared us to handle anything."
- "Without them pushing me to to my best, I wouldn't be where I am today."

Alumni are embodying the values they learned from Mines faculty and staff by volunteering; sharing their knowledge and expertise with today's students; connecting Orediggers with jobs and internships; and giving to funds that support the people who help make all things possible at Mines.



Read about how Mines graduates are honoring the teachers and mentors who changed their lives. And tell us: Who made the biggest impact on you?



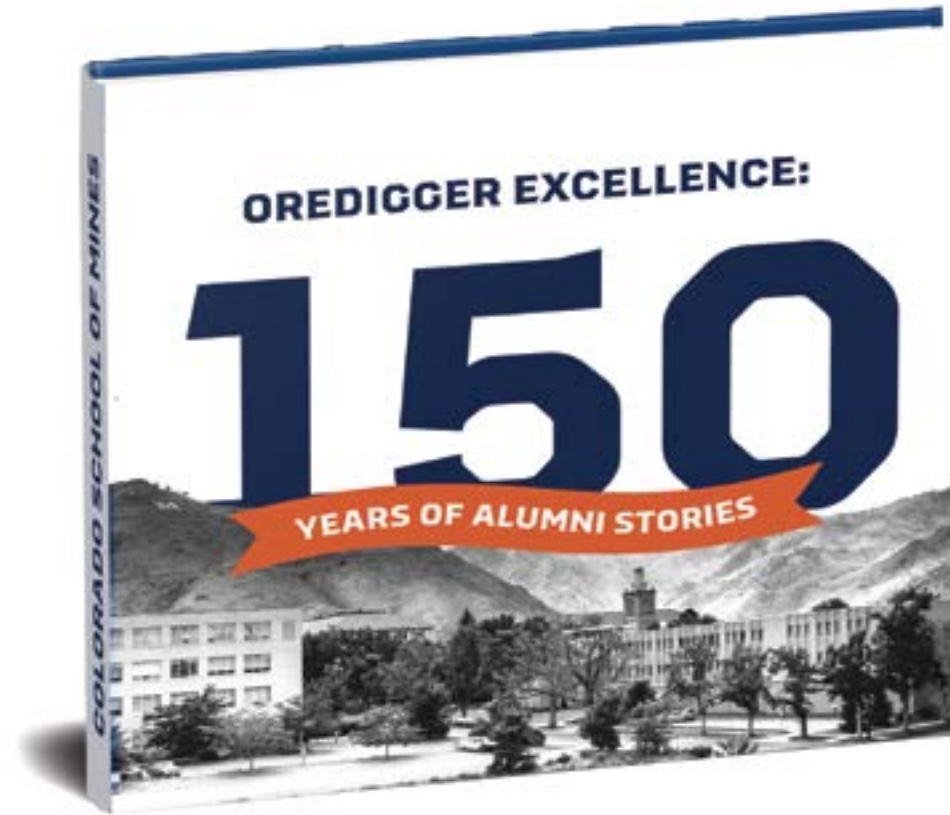
OREDIGGER EXCELLENCE: 150 YEARS OF ALUMNI STORIES

Celebrating the voices and legacy of Mines alumni

As Mines celebrates its sesquicentennial this year, the school is also celebrating the indelible legacy of its alumni—the mark they've made on Mines, industry and the world—with a publication of oral histories to mark the occasion.

Mines partnered with Publishing Concepts, Inc. to collect memories and hopes for Mines from alumni to ensure the rich Oredigger history will be preserved for generations to come. About 1,500 stories were compiled into the book *Oredigger Excellence: 150 Years of Alumni Stories*, which will be distributed in Summer 2024.

While every story couldn't be included in the print version, the remaining 5,228 recorded stories are all featured in the audio version.



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HAPPY 150 YEARS, OREDIGGERS

2024 is the year to celebrate Mines pride and our shared experience

There are many experiences that unite all Orediggers, whether you graduated from Mines last spring or 50 years ago. It's the three-mile, early-morning hike up to the M with a 10-pound rock. It's the burro galloping from the end zone to the 50-yard line and back after an Oredigger touchdown. It's the ride down a nearly frozen Clear Creek in a hastily built cardboard boat during E-Days.

For the past 150 years, we have built traditions and signature events that reflect the uniqueness of Mines and celebrate who we are as scientists, engineers, entrepreneurs and business leaders. As we kick off Mines' sesquicentennial celebrations this year, I hope you will look back fondly on your Mines-connected experiences, reflect on the impact Mines has had on your life and look ahead to being part of Mines' future.

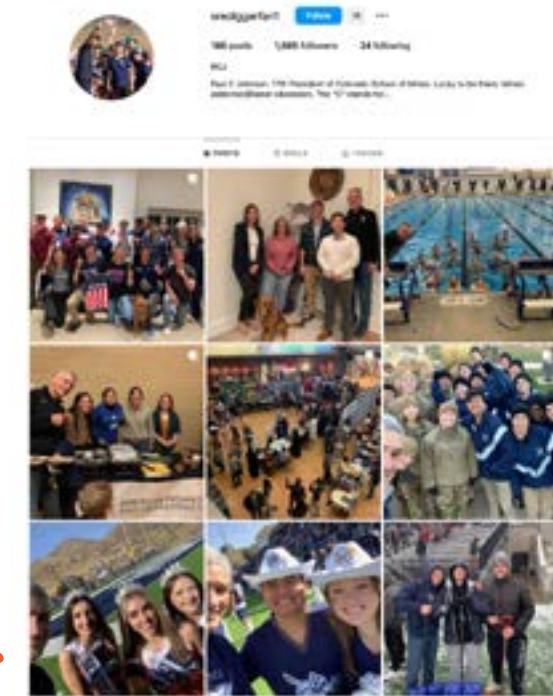
In this issue of *Mines Magazine*, you'll find stories about the many ways in which Mines alumni are propelling future progress through their unparalleled leadership, determination and drive to create lasting positive change. These stories remind us about the uniqueness of the Mines experience, the distinctiveness of our graduates, the impact you and Mines have had on the world and the Mines pride we all share. It's amazing that our little university in Golden, Colorado has done so much to make the world more prosperous and impacted so many lives in every corner of our planet.

Thanks to those of you who shared your stories, and thanks to all of you for following, supporting and advocating for Mines. I encourage you to stay involved, whether it be through volunteering, mentoring, investing or cheering on your fellow Orediggers—this year especially, there's a lot to cheer for! I look forward to seeing you at our anniversary celebrations and other signature events this year, such as E-Days in the spring and Homecoming in the fall.

Go Orediggers!



Paul C. Johnson
President and Professor



P.S. Follow me on Instagram @orediggerfan1 to take a peek inside life at Mines and meet the people who contribute to our amazing community. It's also a good way to keep up with Blaster sightings!

FIRST-EVER J. STEVEN WHISLER CHAIR FOR THE HEAD OF MINING ENGINEERING

Bill Zisch '79 now leads the Mining Engineering Department after four decades in industry

BY JASMINE LEONAS

Bill Zisch '79 is the new leader of Mines' Mining Engineering Department as the first-ever J. Steven Whisler Chair for the Head of Mining Engineering.

Zisch has more than 40 years of experience in international mining operations, serving in leadership roles overseeing operations in North America, Africa and South America. The chair was endowed as part of an historic \$7.5 million investment from alum J. Steven Whisler MS '84 and his wife, Ardyce, to ensure that the mining engineering program at Mines continues to be the No. 1-ranked program in the world.

"I am excited by the commitment to excellence embedded in the J. Steven Whisler investment in Mines' Mining Engineering Department," Zisch said. "The industry needs engineers who possess technical qualifications and have contemporary problem-solving skills to access mineral production in a safe, environmentally sound and socially responsible manner. Mines is uniquely positioned to meet these challenges, and I look forward to being a part of this effort."

Zisch brings a broad background in international mining and plant operation to the Mining Engineering Department. He served as chief operating officer for Argonaut Gold, a junior Canadian company with three operating mines in Mexico, and president and chief executive officer of Midway Gold, a junior development company with operations in Nevada. He was also the vice president of operations at Royal Gold and vice president of planning and vice president of Africa/Central Asia operations at Newmont Gold Company. Prior to his time as an executive, Zisch worked for various mining companies in different



capacities, including as an operations manager for the largest gold mine in northern Peru and as mine manager for a gold and silver mining operation in Nevada.

Zisch joined the Mining Engineering faculty in April 2023 as the J. Steven Whisler Professor of Practice. Prior to that, he has been involved in multiple strategic university initiatives since 2020. Those roles include director of Mines Mineral Model for the Global Energy Future Initiative, a position he has held since September 2021, as well as coordinator for the Climate Smart Mining Initiative, which led to the development and launch of the Mines Mineral Model.

"Bill is a great choice to be our first-ever J. Steven Whisler Chair for the Head of Mining Engineering. He brings leadership experience, a rich background in international mining and an excitement for expanding the impact that Mines has on the world," said Mines President Paul C. Johnson. "In addition, Bill has a unique experience-based vision for how universities can work with industry to help attract and develop their future leaders and how to bring new technologies and approaches to an industry that is challenged to more sustainably secure the critical minerals and materials needed for our nation's prosperity and security. The generous support from Steve and Ardyce Whisler, in combination with Bill's leadership and vision, will ensure that our program continues to be No. 1 for producing the leaders, knowledge and innovations that industry and the world need for the future."



MINES, CAPSTONE DEVELOPMENT PARTNERS BREAK GROUND ON \$151M MINES PARK RENOVATION PROJECT

On-campus housing for graduate and upper-division undergraduate students at Mines will more than double in 2025, with the completion of a \$151 million redevelopment and renovation of Mines Park.

Located off 19th Street on the west side of U.S. 6, Mines Park is an apartment-style community owned by the university that caters to upper-division undergraduates, graduate students and graduate-student families.

In partnership with student housing developer Capstone Development Partners, six aging buildings will be replaced with five new apartment buildings, with a total of 658 beds in a mix of studio, two-bedroom and four-bedroom units. The remaining 19 smaller apartment buildings will be renovated from top to bottom, bringing the total number of beds at Mines Park to 1,058, up from 495.

“We are thrilled to make this major investment in quality and convenient housing for our graduate and upper-division undergraduate students at Mines—at rents under the going market rate,” said Braelin Pantel, vice president of student life at Mines. “Mines Park is a diverse, vibrant community, and this investment will ensure it continues to thrive for years to come. Enhancing student housing options is an integral part of the MINES@150 strategic plan, playing a crucial role in attracting and retaining talent, fostering academic excellence and ensuring that all Mines students have the support and amenities needed for their success.”

Renovations will be complete for Fall 2024 occupancy, with the new buildings set to open in Fall 2025. Mines Park will include a fitness center for residents and common spaces both large and small, for gatherings, studying and more. All units will be equipped with air conditioning, and the buildings closest to the Survey Field on Infinity Circle will also have in-unit washers and dryers.

Starting in Fall 2025, all units will also be furnished, with all utilities included.

“These renovations will give Mines students even more options to find housing that reflects their needs here at Mines,” said Mary Elliott, executive director of residence life and auxiliary services. “Mines Park, under the Office of Residence Life umbrella, has resident advisors, and professional residential life coordinators, to help create a sense of community. The goal is to support all of the needs of our students the best way we can.”

MINES AWARDED CLARE BOOTHE LUCE GRADUATE FELLOWSHIPS TO SUPPORT 2 PHD STUDENTS

Mines is the recipient of a generous award from the prestigious Clare Boothe Luce (CBL) Graduate Fellowship Program, which will provide full support for two years for two students pursuing a PhD at Mines, followed by up to three years of continued support from university sources. The support provided by CBL fellowships includes graduate tuition, fees, a competitive annual stipend and a flexible benefits package.

The namesake of the fellowship, former Congresswoman Clare Boothe Luce (1903-1987), was a pioneering female leader in the arts, public affairs and journalism. Through her bequest, the Henry Luce Foundation has become the single largest U.S. source of private funding for women in STEM in higher education.

USGS, MINES BREAK GROUND ON NEW FACILITY FOCUSED ON ENERGY AND MINERALS RESEARCH

Representatives from the U.S. Geological Survey and Mines began a new chapter of their partnership in November 2023, breaking ground on an innovative USGS Energy and Minerals Research Building. The Bipartisan Infrastructure Law is providing \$167 million for construction of the new facility, forecast for completion in Fall 2026.

“Through the USGS and Mines’ enduring partnership and overlapping strengths, this new facility will allow us to build up America’s workforce in the energy and minerals sectors, helping us solve critical mineral and supply chain challenges,” said Principal Deputy Assistant Secretary for Water and Science Michael Brain.

“The Energy and Minerals Research Facility will bring USGS scientists and Mines faculty and students together to focus on solving the critical mineral and energy challenges of today and the future. With the combined expertise of the USGS and Mines, plus new state-of-the-art laboratories and analytical capabilities, this facility will be the top energy and minerals research center in the nation and the world,” said Mines President Paul C. Johnson. “We can think of no better home for this facility than the Mines campus, where we have already had a many-decades-long partnership with the USGS and where we’ve been dedicated to solving the challenges around energy and minerals for 150 years and counting.”

When completed, the 190,000-square-foot building will house the USGS Geology, Geophysics and Geochemistry



Science Center and the Central Energy Resources Science Center, both currently located at the Denver Federal Center. It will be occupied by about 250 USGS researchers and about 170 Mines faculty and students working side by side, expanding upon the two institutions’ long-standing partnership and history of collaborative research.

The USGS and Mines’ complementary strengths will advance new frontiers in strengthening critical minerals supply chains, developing a sustainable and just energy supply, innovating to modernize the nation’s mapping, tackling legacy pollution, and launching a hydrogen economy.

Designed by global architecture firm Perkins + Will, the shared research facility will be home to state-of-the-art laboratories and collaboration spaces for USGS and Mines scientists, as well as a café, classroom and spaces for Mines graduate students. A connection between the new facility and the existing USGS Geologic Hazards Science Center—home to the National Earthquake Information Center—is also incorporated into the design.

“We are excited to be partnering with the Henry Luce Foundation and their Clare Boothe Luce Program to increase opportunities for women to earn advanced degrees in STEM fields,” said Mines President Paul C. Johnson. “Based in part on the needs of industry and academia, Mines has been working hard for many years to attract women to STEM degree programs, support them as

they pursue their degrees and prepare them for successful careers after Mines. The limiting factor is often financial support, and that is why prestigious fellowships like these are so important. We look forward to welcoming our Clare Boothe Luce Program Fellows to campus next year as we also celebrate our 150th anniversary.”





IMPROVING A SOFTBALL FIELD AND BUILDING CONNECTIONS

Mines alumni come together to raise funds and provide support for a better-quality softball field

BY LYNN CLARK

Kerry Siggins '01, Kari Gonzales '02 and Kim Alanis '04, MS '05 have many things in common. They all grew up playing softball in Colorado, then played together at Mines with the help of athletics scholarships. They're all moms with successful careers—Siggins and Gonzales are company CEOs, and Alanis is a geological consultant and head softball coach at Mountain Vista High School in Highlands Ranch, Colorado.

And they credit the sisterhood and skill sets they found on the Oredigger softball team not only for keeping them at Mines through tough personal struggles but also for building the lives they lead today.

"We're all executives because we stayed at Mines and learned about leadership, teamwork and resiliency on the softball team," Siggins said. "Mines softball can put out some pretty amazing women, the ones who will be leaders and engineer innovative products and services all over the world."

Now, they are collaborating on a \$140,000 fundraising campaign that's not only aimed at replacing the grass field with turf but also at reconnecting softball alumni with the program.

"Alumni are as important to our program as our current players are," softball head coach Mike Coutts said. "They're our history. I want our kids to meet and learn

Current Oredigger infielders Hannah Roberts (second from left) and Sidney Wilson (second from right) pose for a photo with alum Kerry Siggins '01 (center), Head Coach Mike Coutts and Assistant Coach Barb Duran.

about as many alumni as possible. I believe this campaign will create those opportunities."

Siggins, Gonzales and Alanis played on a grass field during the late 1990s and early 2000s. That meant shoveling the muddy, rock-strewn grass field after it snowed to prepare it for practice, which was beholden to the sunset because the field had no lights.

Gonzales recalls seeing the softball field on her first campus visit: "I played on better fields in high school. But the girls and the coach were amazing, and I had my heart sold on being an engineer and staying in Colorado. Mines was my top choice."

Twenty years later, the field still hasn't been updated to artificial turf—which not only requires less maintenance but also is safer to play on. With no lights, the team can be limited to two hours of practice. Both concerns put the Orediggers at a disadvantage.

"While the field had some renovations since I graduated 20-some years ago, it's not enough," Siggins said. "Mines softball players deserve more. I made a commitment to act."

Coutts worked with the athletics department to secure a chunk of university funding to upgrade

the field surface. Siggins worked with the Mines Foundation to design a fundraising campaign to cover the rest of the cost. She recruited Alanis and Gonzales to help inspire other softball alumni and the community to join in.

"Kerry literally dropped out of the blue and made a significant donation to the program," Coutts said. "She's showing our alumni and current players how much she values what the program gave her and how they can do the same. With enough support from alumni and the community, lights will be next."

Coutts said having a turf field will give the team more opportunities to practice outside and keep home games at Mines.

"We've had to move games to other locations in the past because of our field conditions," he said. "The upgrade will obviously put our current players in a better position and impact our future players as well. They'll know that softball is a priority, and much will be expected of them. But it will have a far greater impact on our school. Mines' teams have experienced unprecedented success recently, and we want to be part of that."

When Siggins, Alanis and Gonzales played, the team wasn't great, but it was improving. Alanis and Gonzales played on the first Mines team to go to the RMAC tournament. Today the team has been RMAC regular-season champs four times, won the RMAC tournament once and made three NCAA Division II tournament appearances.

"After we went to the tournament, things started to change," Alanis said. "The coaches could bring in talent because we weren't just a nerdy school, we had a good softball program. They've come a long way. To keep a winning team, you have to have a place where people want to play."

Siggins said the fundraising campaign is about more than upgraded facilities. "We need women to feel like they belong at Mines—that they can stay at Mines and that they have the support they need," she said. "We believe in their futures, and these are just small ways that we can invest in those futures."

- ➔ To support the softball field renovations, visit goldmine.mines.edu/softballfield.
- ➔ Looking for info about Mines Football? Check out page 42 to see highlights from their journey to RMAC National Championship.



Mines makes it easy to create your legacy

New! Mines has made it as easy as pie to create your will with a new tool called Giving Docs.

Regardless of the size of your estate, you can create a will to support the causes that are most important to you.

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For more information, go to plannedgiving.mines.edu



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SCAN ME!

INTEGRATING GENERATIVE ARTIFICIAL INTELLIGENCE INTO THE CLASSROOM

Mines students are increasingly using GenAI tools to learn, and Mines is helping them understand the technology's nuances and best uses

BY EMILIE RUSCH



This image was generated with AI using Imagine Web and edited using generative fill in Adobe Photoshop.

Picture a campus where the timeless traditions of Mines seamlessly blend with the latest advancements in technology—welcome to the new era at Colorado School of Mines, where generative AI is shaping the future of education.

Sound like a story you might want to read? The first sentence of this article was actually written by ChatGPT 3.5, the free version of the generative artificial intelligence chatbot that has taken the world by storm since it was released by OpenAI in November 2022.

The prompt we gave the large language model (LLM)-driven tool was simple: “Give me four options for the first sentence of a magazine article about how generative AI is being used at Colorado School of Mines. The readers of the magazine are alumni of Colorado School of Mines.”

This was just our favorite of the four options, but the power of the popular generative AI (GenAI) tool can be both awe-inspiring and unsettling.

That power has also prompted conversations across higher education about how to address GenAI use in the classroom—and a wave of headlines prophesying the end of education as we know it amid a tsunami of GenAI-fueled cheating.

At Mines, those conversations began in earnest in summer 2023, when the Office of Academic Affairs convened a group of faculty members, administrators and students to determine a path forward. The results of those conversations are the “Guidelines for Using Generative Artificial Intelligence at Mines,” released to campus in August 2023.

The guidelines are just that—guidelines, not requirements—that offer Mines instructors three suggested paths for the use of GenAI in their classrooms. Faculty can generally permit the use of GenAI tools, generally forbid their use or permit their use for certain purposes on certain assignments but not others.

At the heart of the guidelines is what the committee calls the TEACH approach: rather than homing in on cheating only, faculty should put their focus on building **Trust** and community with students; interrogating the **Ethics** of GenAI; ensuring equitable **Access** to GenAI; explicitly **Communicating** expectations and relevance of course tasks; and (re)designing assignments to center the **Human** in learning by tapping into student motivation, iteration, agency, lived experience and creativity.

“All of this is about AI, but it’s also not about AI,” said Carter Moulton, faculty developer at the Trefny Center for Innovative Instruction. “It’s about practices that support students and learning and build trust and clear expectations.”

That trust-centered approach was informed by a review of best practices in pedagogy and how other universities are tackling the issue—as well as data on how Mines students are actually using these tools.

Over the past year, C. Estelle Smith, assistant professor of computer science, has surveyed Mines students both in the Computer Science Department and across the university on their use of ChatGPT and other GenAI tools. More than 600 students responded to the university-wide survey, and the runaway No. 1 reason why Mines students use GenAI? Concept exploration, Smith said.

“That hadn’t even occurred to me to use ChatGPT that way: ‘Tell me about this thing and now tell me about it from a different perspective or about another subdetail you just mentioned,’” said Smith, an expert in human-computer interaction. “That wasn’t possible in the past. You only had access to what your instructor says during class or during office hours. This radically increases access to information. You can get really good information on topics that are both covered in class and not covered in class. It triggers curiosity.”

The survey data also reinforced what faculty already knew about Mines students: By and large, they really care about their learning.

“ChatGPT use really depends on people’s motivations,” Smith said. “If you’re motivated to cheat, you’re going to find a way to do that, and ChatGPT is going to make that easier. If you’re motivated to learn, then ChatGPT is something you’re going to use to improve the quality of that learning.”

In her own classroom, Smith allows students to use GenAI tools however they want as long as they cite it in their work. The assessments for her Fall 2023 graduate seminar, though, were designed in a way that made it almost harder for students to use ChatGPT than to just do the work on their own.

Personally, Smith has used the image generator DALL-E for her lecture slides to create conversation-provoking images. ChatGPT can also be helpful when you’re writing a paper about a certain topic and need supporting examples outside your area of expertise—so long as you always verify the answers the chatbot provides, she said.

“One of the challenges with ChatGPT is that anyone can use it and it creates meaningful human utterances—without any instruction manual required. With other tools, you are not able to use them, period, unless you have domain knowledge of the structured ways you have to write code to get something meaningful—otherwise you’ll just get errors,” Smith said. “This is a new paradigm—you can say whatever you want and you’ll get a response that looks meaningful. But we know it makes things up—ChatGPT makes up the most likely response. That’s what it does.”

And that’s where Mines has an important role to play, said Deb Jordan, director of the Trefny Center.

“In industry, workers are going to be using GenAI—industry is already adopting the technology like crazy,” Jordan said. “We can either help students become proficient in using this tool—and using it for good—or we can not work with them at all and then they’re going to be behind when they go out and get jobs.”

“The nuances of being literate in GenAI, including critiquing outputs and ethics and understanding when and when not to use these tools—all those considerations are going to be what sets Mines students apart,” Moulton added. “We want our students to develop that nuanced understanding so they can be leaders in the workplace and as citizens. Here at Mines, we lean into new things together and learn from one another as a community.”

CREATING A ZERO-CARBON STEEL FUTURE

A molten oxide electrolysis process could be the key to cutting emissions from steel production

BY JENN FIELDS

Steel is one of the most important construction materials in the world, giving buildings and bridges a sound structure and adding strength and stability to the most common construction material globally: concrete. Global crude steel production reached nearly 2 billion tons in 2022, and demand is expected to continue to grow in the coming years. But the steel industry creates 11 percent of global carbon emissions and 7 percent of greenhouse gas emissions annually. Though many companies are working toward reducing the industry's outsized carbon footprint, two Orediggers are lending their expertise to an innovative zero-carbon method of producing the material at green steel startup Boston Metal.



Steve Sparkowich '89 and Daniel Wright '21 work on the inert anode team at the heart of Boston Metal's molten oxide electrolysis process.

Photo courtesy of Boston Metal

Rather than converting ore to steel through the traditional multi-step, high-heat blast furnace and basic oxygen furnace processes, which are typically powered by coal, Boston Metal's technology converts ore to steel through electrolysis, which can run on renewable energy. Mines alumni Steve Sparkowich '89 and Daniel Wright '21 work on the inert anode team that is at the heart of the molten oxide electrolysis process that the company has patented to eliminate carbon from steel production.

"It's a unique opportunity to have a lot of impact as a metallurgist," Wright said.

Molten oxide electrolysis, or MOE, cuts out many of the steps in traditional steel production. In a MOE cell, an inert anode is immersed in electrolyte containing iron ore. Then, it's electrified. "When the cell heats to 1,600 degrees Celsius, the electrons split the bonds in the iron oxide in the ore, producing liquid metal," according to a statement from Boston Metal. "Unlike some alternative solutions being developed, MOE does not require process water, hazardous chemicals or precious metal catalysts."

The inert anode is key to fully eliminating carbon from the process: Unlike traditional graphite anodes, which produce CO₂ as a byproduct, the inert anode's only byproduct is oxygen.

It also provides room for adjustments to the quality of steel the MOE produces. "The inert anode allows us to take feed stocks and convert them to low-grade, or even high-grade, steel in a single step," said Sparkowich, who is a senior advisory process engineer on the inert anode team. "It's very elegant, it's lean, it's clean and it's green."

"We get to try a lot of new alloys that the world's never seen before—really advanced alloys, pushing the temperature limits. It's really exciting to move on to the next frontier in materials in this way," Sparkowich said.

The MOE cell is designed to be both modular and scalable, bringing the steel-making process to where the ore itself is mined and at a scale that makes sense for the operation. Thus the inert anode team's goals include both manufacturing the anodes for scalability as well as optimizing alloy properties as Boston Metal works toward its goal of bringing the process to the mass market by 2026.

"The goal of the whole technology is producing steel, and though we're metallurgists, we're hyper-focused on this anode," said Wright, a manufacturing program

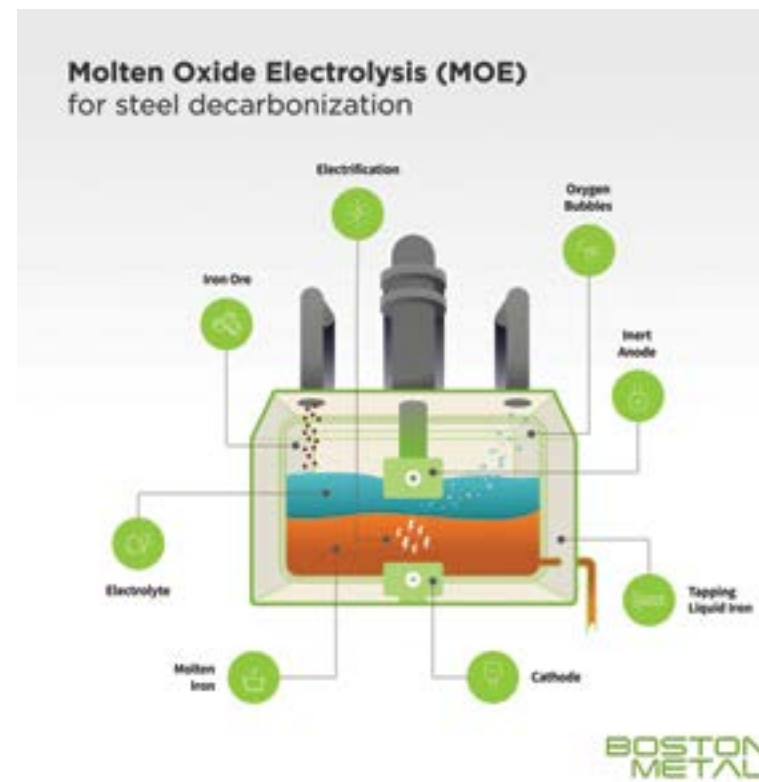
lead whose team is responsible for the manufacture of the anode and improving its performance.

"We have an alloy development team that's part of our group and then process group—how to make these refractory materials into anodes," Sparkowich explained. "And then scaling it up, which Daniel's involved in on the manufacturing side."

Both alumni said it's exciting to work in a startup environment that allows them try out new ideas immediately. "Daniel and I can come up with an idea today and have a part on the floor to test tomorrow," Sparkowich said.

Though they graduated more than 30 years apart, Wright and Sparkowich both said their experience in Mines' Metallurgical and Materials Engineering Program provided the solid foundation for their careers in metallurgy.

"Colorado School of Mines has always included the fundamentals of metallurgy in their program," Sparkowich said. "There are very few schools in the U.S. still teaching these things. It's the core, which we use every day."



This illustration shows the molten oxide electrolysis process Boston Metal has patented to eliminate carbon from steel production.



WORK WITH US

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



Hiring for internships or full-time positions?

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



Interested in volunteering?

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



Looking for your next career move?

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

[MINES.EDU/CAREERS](https://mines.edu/careers)



COLORADO SCHOOL OF
MINES
@ 150 | 1874-2024



Associate Professor Paulo Tabares-Velasco explains indoor air quality sensors to two Leadville, Colorado residents who received energy efficiency upgrades in their homes.

ENERGY EFFICIENCY AT ANY INCOME LEVEL

A home battery storage solution and new heat pump water heater to help low-income communities in Colorado

BY JASMINE LEONAS

It's getting more expensive to live in Colorado. The U.S. Department of Energy estimates heating bills for those with natural gas will go up 28 percent and electricity costs will rise 10 percent compared to last year. One way to combat the rise in utility prices is to have a home that's optimized for efficiency. But for many in lower income brackets, the cost to make their houses more energy efficient is just not something they can work into already tight budgets.

Paulo Tabares-Velasco, associate professor of mechanical engineering at Mines, is focused on bringing energy efficiency within reach for everyone. Now, with funding from the DOE Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) program, Tabares-Velasco is working on two projects specifically aimed at

- making energy efficiency, electrification and resiliency possibility for communities in Colorado:
- A home battery energy storage system for retrofitted housing in Colorado
 - A new heat pump water heater with latent heat storage in low-income housing

"I want to make the case that energy-efficient systems and net-positive carbon emissions can really work for low-income housing," Tabares-Velasco said. "Is there a way we can make the best technologies work for them? I think we can."

HOME BATTERY ENERGY STORAGE

Through a grant from the Alfred P. Sloan Foundation, Tabares-Velasco and his team have partnered with the Colorado Energy Office to retrofit and partially electrify an entire neighborhood of manufactured houses in Lake County. The retrofit includes changing systems that rely on gas to electric, general energy

upgrades and installing batteries, smart controls and sensors.

With the funding from the DOE, Tabares-Velasco will be working in three neighborhoods, including the same neighborhood in Lake County, to assess how batteries can help reduce CO₂ emissions from the electric grid and provide resiliency in the case of a power outage, and about 20 homes in the Denver area that will also get batteries. Tabares-Velasco said he and his team were particularly looking to provide the batteries to families needing a consistent electrical supply, like those with medical equipment that runs at all times. Mines faculty involved in this project are Professor Amy Landis (Civil and Environmental Engineering), Associate Professor Qihua Huang (Electrical Engineering), Professor Alexandra Newman (Mechanical Engineering), Professor Tyrone Vincent (Electrical Engineering) and Associate Professor Steven DeCaluwe (Mechanical Engineering).

The grant will also fund several upgrades to a multifamily housing community in the Denver metro area. The multifamily building will be retrofitted and switched to all-electric systems, but for this community, an electric vehicle rideshare will also be established. The battery inside the electric vehicles—shared among the building's residents—will also be used to power the building.

HEAT PUMP WATER HEATER

The second DOE grant will fund the development of a new heat pump water heater that could eventually replace gas water heaters. Heat pump water heaters can be incredibly efficient, but often take up a lot of space—something families in low-income housing don't always have to spare.

Tabares-Velasco and his team will develop an efficient, reliable heat pump water heater that can fit in small spaces like a closet. The heaters will consist of a water tank with piping inside and a compressor on top, smaller than the standard heat pump water heaters.

One way the team will be creating these smaller heat pump water heaters is by utilizing 3D printing with phase change materials (PCMs). PCMs can store more energy (latent heat) when changing from solid to liquid phase than water at the same temperature range. Combined with the 3D printing manufacturing process they'll be able to create complex geometries for the heat exchanger that can store a lot of energy (with the help of PCMs), increase how fast the heaters can transfer energy from the water to the heat exchanger, and vice versa.



Graduate students Karlyle Munz and Daniel Safronov and Associate Professor Paulo Tabares-Velasco install an outdoor particulate matter (PM_{2.5}) sensor in a low-income neighborhood in Colorado to compare indoor and outdoor PM_{2.5} concentrations and measure air temperature.

PARTNERSHIPS AND IMPACT

Both projects are receiving DOE funding for three years and will be made possible through partnerships with local companies and organizations.

Energy Outreach Colorado, a non-profit based in Denver, provides home energy assistance to low-income Coloradans and has been assisting Tabares-Velasco in finding the right sites for his projects. Emporia, an energy equipment company, and WattTime, a nonprofit that champions reducing emissions and clean energy, are assisting in the home battery energy storage project. The U.S. Department of Energy National Renewable Energy Laboratory and 3D-printer material company TCPoly will be assisting with the 3D-printing capabilities needed for the heat pump water heaters. AO Smith, a water heater manufacturer, will also help with that project. Xcel Energy will provide technical assistance to the battery project.

"These grants allow us to do the work that I like to do, which is to combine cool science and engineering with great societal impact: helping communities, improving the quality of life, reducing carbon emissions, energy use and bills, and support more energy efficient housing and communities," Tabares-Velasco said. "If we can do both, then that's great. If we want to decarbonize our entire nation, we need to start thinking at the community level and about solutions for everybody. Most of the time, the people who will benefit the most are those who cannot afford it, and I want to change that."



INTO THE NEXT ERA:

Building on a legacy of confronting challenges

BY JEN A. MILLER

Mines continues to provide key industries with skilled leaders to advance the technology needed for the next 150 years

When Mines first opened in 1874, Colorado was still a territory and the course of study was narrow: on gold and silver, and the knowledge and skill in mining, geology, chemistry and more needed to support the extraction and refinement of the precious metals.

As the school became a college then a university, its focus expanded to understanding the Earth, harnessing energy, sustaining the environment and more.

Now, 150 years later, Mines has a diverse array of degree programs at the undergraduate and graduate levels and continues to grow and evolve to meet industry needs, innovate in emerging areas of technology and prepare graduates to lead the way in continuing to solve the world's most pressing challenges.

“Mines is always working to position itself, not only to maintain the role it’s been playing in higher education for 150 years but also to expand and adapt as the world is changing,” said Sam Spiegel, assistant vice president of online education at Mines.

That means constantly and consistently speaking with alumni, industry leaders and policymakers about what they see as vital educational components. As a result, Mines graduates are prepared for the workforce they will enter and grow into and have the tools to become its leaders in due time. “Future proofing” a career isn’t just a concept at Mines—it’s reality.

That includes meeting students where they are and creating learning opportunities that match how they can best learn and be part of the Mines community, such as offering online courses and expanding degree offerings into new areas.

“Online education gives Mines an opportunity to reach student populations that we normally wouldn’t have been able to access—and do so easily,” Spiegel said. “It breaks down geographical as well as some of the time barriers that might have kept students from studying here.”

That’s to the benefit of Mines students and beyond. In Spring 2024, Mines is launching new, expanded short courses, workshops and boot camps with a large library of self-study, self-paced modules and workshops. This means that working professionals can access this critical information on their own schedule instead of having to attend a live seminar set at a fixed time and date.

“This allows us to focus on adaptable learning opportunities that are condensed and very targeted to current and future needs of industry,” Spiegel said.

But offering online education opportunities is just one part of the equation. With new degree programs and expanded emphasis areas, Mines is also positioning itself to be a key player in the future of several growing industries to solve emerging challenges and train skilled engineers and scientists to lead this future. Here are just a few examples.

Mechanical Engineering graduate student Brendan Kearney operates the impact hammer on the Outpost Digging System on the third day of durability testing at the Colorado Air and Space Port. Mines students from all disciplines had the opportunity to volunteer to help during the 15-day durability demonstration as part of the NASA Break the Ice Challenge in 2023.



Emerging trends beyond our atmosphere

While Mines started its mission focused on understanding the Earth, that mission, much like human exploration, has expanded up—way up—to space and beyond.

From contributing to projects such as the Moon landing and the Mars Curiosity Rover, Mines has continued to pave the way to space exploration—and space living. Mines' Space Resources program, with the Center for Space Resources, grew out of this work to meet the demand for resources to further our knowledge and exploration in this area. It was the first program in the world focused on educating scientists, engineers, economists, entrepreneurs and policymakers in developing the field of space resources.

And that work continues and is growing faster than ever. Through the Artemis V program, NASA is preparing to send people back to the Moon and build a base camp there, and private investment in space exploration is expanding the idea of who is going into space. Getting to Mars is not outside the realm of possibility either.

"It's human evolution to keep expanding and growing and exploring," said Bailey Burns '18, MS '21, an aerospace systems engineer at Blue Origin. The company is building a lunar crew lander for Artemis, and she's working on ways to make life easier and more comfortable for astronauts. "As we evolve, we need to figure out how to do things more efficiently, and through exploration, that is what space is forcing us to do."

Figuring out how to live and explore in space benefits life on Earth, too. Research on "how we keep human consumables in space clean so we don't have to keep shipping water and oxygen from Earth will directly play into climate change and how to be more sustainable," Burns, who has also participated in two simulated space missions to get a better understanding of what that kind of confined living experience is like, said. "There's a lot of progress that's happening on Earth that space will also force us to do, sometimes even faster. It expedites that development on how to be better human beings to our home planet."

The kind of education Mines provides, which is focused on technical skills but also problem solving, makes it an ideal institution to continue to lead in this field, Burns said, because space presents new problems that people will have to solve by working together. For example, uncrewed projects to Mars have sent back reams of data about the journey there and conditions on Mars to prepare for crewed missions. But it's still unknown territory and unknown problems will unfold, in both getting people there and keeping them alive when they arrive.

That kind of handling of uncertainty, through teamwork, is what Mines prepares its students for. Burns cites an old adage to show why: "If you want to go fast, you go alone. And if you want to go far, you go together," she said. "Mines is teaching engineers how to go together."

Advancements in robotics and AI to improve lives

Robotic technology and artificial intelligence are becoming part of everyday life, and the technology is becoming more and more advanced. Today, these technologies are helping with everything from voice-activated assistants to enabling faster supply chains and getting online deliveries to homes quickly, rapidly changing day-to-day processes and systems.

"There are so many opportunities in automation and AI and machine learning," said Elissa Himes '21, MS '22, a robotics simulation engineer at The Toro Company, which makes lawn, snow and irrigation technologies for the private, public, commercial and agricultural sectors. "It's more prevalent in everything that we do."

And she truly means everything—from enabling voice-powered assistants to powering autonomous forklifts to making manufacturing lines more efficient.

According to the Industrial Robotics Federation, 553,052 new industrial robots were installed in 2022, an all-time high. The group expects that number to cross the 600,000 mark in 2024. The future of robotics is inextricably tied to that of artificial intelligence, as robots are often called "embodied AI," according to global consultancy EY.

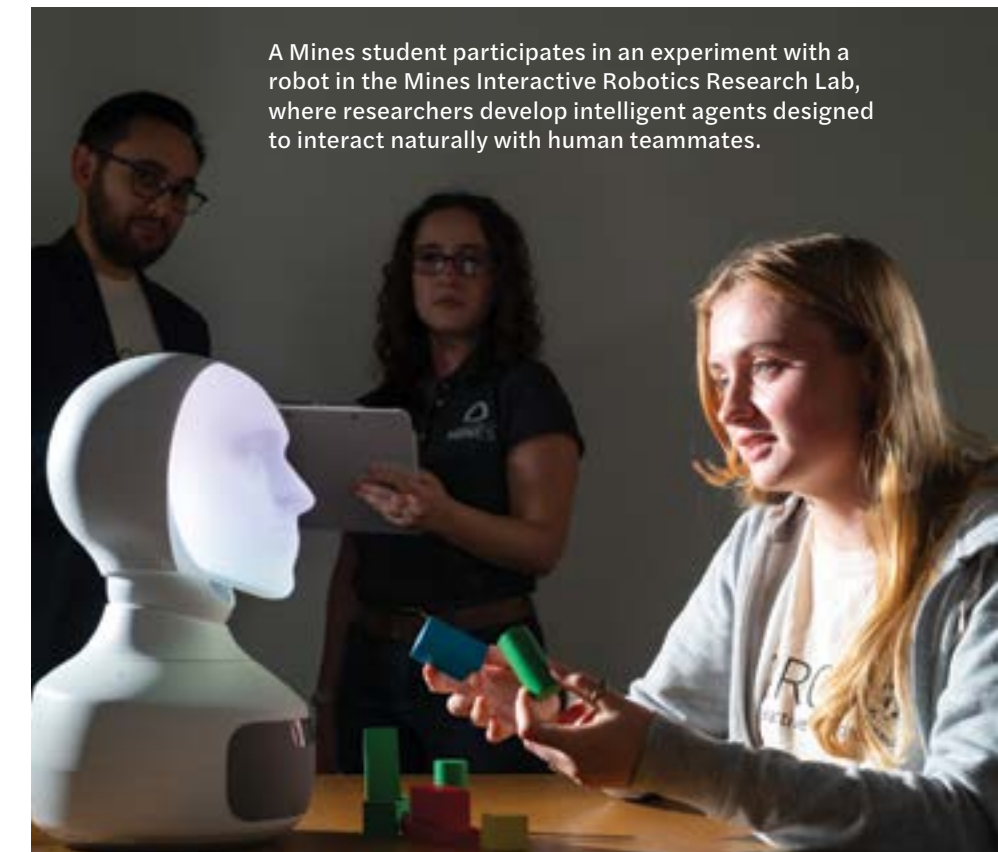
And while AI is not new, it's reaching new heights. Large language model ChatGPT had one million users within its first five days of launch—it now has more than 100 million. A report from Forbes Advisor found that 64 percent of businesses expect AI to improve productivity. Overall, the AI market overall is expected to hit \$207 billion by 2027, according to research group MarketsandMarkets.

Because the potential in robotics and AI is seemingly limitless, industry needs skilled engineers in all industries who can approach the challenges, and potentials, of both technologies, from all angles. For example, Himes is working on creating simulations for an autonomous lawn mower, which feels like a normal extension of robotics and AI to anyone who's seen a Roomba, but would most likely not have been in the wildest dreams of J.S. Clapper, president of what was then called the Toro Motor Company in 1914.

And future advances may be surprising, but Mines graduates are taught to lead the way, whatever those ways

may be. Moving ahead with exploration and development of robotics and AI is going to take professionals who understand the capabilities, potential and implications of what they can do, which Mines provides.

"Mines prepared me in terms of how to figure stuff out," Himes said, which is critical to her current project. She also was able to structure her master's degree so she could take classes in "everything I possibly could," she said. "Robotics is such a broad area, and it gave me an idea of what I wanted to focus on. When I hear certain terms, I can at least say, 'Oh yeah I know a little bit about that,' and I know where to start looking."



A Mines student participates in an experiment with a robot in the Mines Interactive Robotics Research Lab, where researchers develop intelligent agents designed to interact naturally with human teammates.

Ceramics enable new technology and capabilities

While most people first associate ceramics with basic porcelain, pottery and dinnerware, it's also a vital material in the manufacturing and industrial realms and is part of everything from semiconductors to petroleum refining processes.

Ceramics are so malleable and adaptable to so many situations that the material will continue to be key in technological advancements. They fill in gaps where materials common in industry production or products don't work.

"Customers usually come to us after they've tried plastics, after they've tried metals and they don't work," said Timothy Coors '01, CEO of CoorsTek, a company that specializes in engineered technical ceramics.

"Some need our material to be electrically conductive, or some need it electrically isolating. Some need it to be harder, some need it to be temperature resistant.

"Why do bakers bake so many types of bread?" he added. "Being able to alter the recipe, we're able to get harder materials, we're able to get materials that are able to flex, we're able to get materials that withstand higher temperatures versus lower temperatures. It's almost endless."

By changing the make-up of the actual ceramic, a material can become that missing component and either solve a problem or open the door to new potential.

As such, the global ceramics industry is expected to be worth \$219.12 billion by 2028, according to Fortune Business Insights.

As a response to this growing industry and the need for highly skilled engineers in the field, Mines launched a new Bachelor of Science in Ceramic Engineering program in Fall 2023, which was developed in consultation and partnership with industry experts and partners, like CoorsTek. In addition to enabling the construction of the CoorsTek Center for Applied Science and Engineering on the Mines campus and investing in a research partnership with the school, CoorsTek also endowed graduate research fellowships in ceramics at Mines to propel this work forward.

"Mines goes beyond producing exceptional careers—it cultivates individuals capable of independent thinking. These engineers don't just solve problems, they proactively identify them. They evolve into leaders who



Students majoring in ceramic engineering have access to innovative undergraduate research opportunities and makerspaces, including Mines' on-campus glass hot shop.

actively contribute to shaping tomorrow," Coors said of the reasons CoorsTek has invested in this area at Mines and for providing unique opportunities for those in the fellowship program.

Fifteen doctoral candidates have benefitted from the fellowship program since its inception, working with state-of-the-art equipment and world-renowned Mines faculty and engineers and scientists from CoorsTek to create the next generation of high-performance materials to enable new technologies and possibilities in industry.

"As engineers and creators keep exploring and keep creating, we continue to push the boundaries of science in general but particularly material science," Coors said, adding that we're already beginning to realize the benefits of what these advances can do, especially when it comes to the automotive industry.

"If we think about electric vehicles 20 years ago, you could create one but it just wasn't practical because the batteries were too big," he said. "As battery sizes are coming down and the capacity of those batteries increase, it's a material science challenge on display for all of us to see. Those things are happening in real time right in front of us."

Personalizing, and smarting up, medicine through engineering

Some of the most transformative science and discovery happens at the intersections of biology and the mathematical, computational and engineering sciences. Whether it's advancements in oncology, immunology, genetics and more, the possibilities are seemingly endless for skilled engineers in the field.

In Fall 2021, Mines launched a new undergraduate degree in Quantitative Biosciences and Engineering, which is training the next generation of engineers who are skilled in the intersections of biology and the mathematical, computational and engineering sciences.

Having a combination of these skills is necessary to keep pushing the field forward, because the next generation of medical advances can't come from doctors and medical researchers alone.

That's because personalized, tailored treatments, where what treatments will or won't work is determined by studying each individual rather than treatments that apply to everyone, isn't just fantasy. It's now reality, thanks in part to more expertise and advancements in bioscience technology, said Bob Reddy '95, vice president of global marketing for medical device company Medtronic.

These technologies are making surgeries quicker, safer and more precise. Technology is also being added to optimize devices that are already common in medical practice. "The miniaturization of technology is allowing for us to move forward and put sensors into smaller spaces that are then implanted into the body," Reddy said.

For example, pacemakers can now tell healthcare providers that a battery needs to be replaced or that a lead is misfiring. These kinds of implants "can now be a smart implant to give information back," he said.

In the future, patients with hydrocephalus, a condition where cerebrospinal fluid doesn't drain from the brain properly, can have smart-enabled cerebral shunt implant. Patients or their parents can check on their implant themselves instantly to make sure it's still working properly.

With more skilled engineers that specialize in this area, the growth in these kinds of technologies and

the industry itself could be exponential. And Mines is key in leading this future because of how students are taught to work through problems.

"It's not always about you personally solving a problem, but it's about you working with a network of colleagues or employees at hand," Reddy said. "There's a bit of resilience that Mines teaches you, that no problem is too big. It might just take a little bit more time. You keep going after things."

A Mines student works on a project during the 2023 Quantitative Bioscience and Engineering field session.



FINDING WHAT'S CRITICAL IN MATERIAL SUPPLY CHAINS

Braeton Smith MS '14, PhD '18 assesses critical material supply chains for better strategy and decision-making

BY SARAH KUTA

As the United States progresses toward a clean energy economy—incorporating more wind turbines, solar panels and electric vehicles—it will need a steady supply of the materials necessary to build those technologies.

To prepare for this future, economists like Braeton Smith MS '14, PhD '18 are studying critical material supply chains around the world—and possible disruptions—to help inform the nation's clean energy strategy.

Smith is an energy economist at Argonne National Laboratory and a co-author of the U.S. Department of Energy's new Critical Materials Assessment, which guides the department's research and development strategy moving forward.

The assessment explores the criticality of materials that are expected to contribute to decarbonization, like nickel for electric vehicle batteries and lithium for stationary battery storage technologies. "Criticality" means materials that are not only important, but are also at high supply risk.

One such material is dysprosium, a heavy rare earth metal used to



produce neodymium iron boron magnets. These magnets are used for a wide array of clean energy technologies, from wind turbine generators to electric vehicle motors. But dysprosium is primarily mined and processed in China, which means its supply chain is at risk of disruption, depending on physical, economic or political factors.

The assessment doesn't provide policy recommendations but, rather, spells this all out for Department of Energy leaders, who can then use the information to shape their decisions.

"Decision-makers might choose to invest in discovering substitutes for dysprosium or even investigating alternate magnet technologies," said Smith. "Or they might look at other avenues of achieving decarbonization that don't use magnets at all. They could also look at recycling the magnets we already have, like those from hard drives, decommissioned wind turbines or magnetic resonance imaging machines."

Because of his Mines education, Smith has seamlessly blended his passion for minerals with his curiosity about economics into

a fulfilling and meaningful career. And, based on his experience studying mineral and energy economics at Mines, he's confident that current and future graduates will be well-prepared to help the nation tackle its energy challenges.

"Mines brings together people from around the world who are focused on important energy and material supply chain issues," he said. "It's this intersection of researchers from economics, engineering and geoscience thinking about these same questions through a different lens. It facilitates an environment that you just can't find anywhere else."

Looking ahead, Smith believes critical materials will continue to play an important role in clean energy—especially if the U.S. wants

"WE NEED TO HAVE A DIVERSIFIED ENERGY SYSTEM WITH DIVERSIFIED PARTNERS TO GET THE MATERIALS THAT WE NEED. WE NEED TO BE NIMBLE, AND WE NEED TO THINK VERY CAREFULLY ABOUT WHERE WE'RE GETTING MATERIALS."

to achieve its goal of net-zero emissions by 2050. He predicts a continued focus on carbon-neutral energy sources, like nuclear energy, as well as environmentally sound ways of extracting and recycling materials domestically.

"We need to have a diversified energy system with diversified partners to get the materials that

we need," he said. "We need to be nimble, and we need to think very carefully about where we're getting materials."

He also hopes decision-makers will continue to view the energy system holistically, with an emphasis on both individual technologies as well as broader systems.

"Don't just think about engineering a better electric vehicle, let's think about transport in general and how technologies fit into a larger system," he said. "Let's not just think about how to make the most efficient wind turbine, but how do we make the most efficient grid and secure electric power grid? With big-picture thinking, we can end up with an optimal solution that meets our many needs while addressing national security challenges."

SHERIDAN ROSS PC ATTORNEYS AT DIFFERENT PERSPECTIVES



Patent



Trademark



Commercial Litigation



IP Litigation

BUILDING A BRIGHT FUTURE

Mines' new alumni board president shares what's ahead for the alumni community

Few people know Mines better than its alumni, acting as the connective tissue that seamlessly links the university's past, present and future. Their presence on campus and interconnected relationships with the global Oredigger community stand as a defining feature of the Mines experience, fostering robust connections, innovative collaboration and philanthropic support that are vital to guaranteeing Mines' vibrant future.

We asked Melanie Westergaard '87, newly elected as the Mines Alumni Board's president, about the role alumni will play in Mines' future, particularly as the Oredigger community celebrates a milestone year and looks ahead to where the university is headed next.

MINES MAGAZINE: WHAT ARE THE BIG GOALS THE ALUMNI BOARD IS FOCUSED ON THIS YEAR, AND HOW WILL THEY HELP STRENGTHEN THE MINES COMMUNITY?

Melanie Westergaard: Our three key goals are to:

1. Create future Mines alumni by encouraging potential students to commit to Mines.
2. Build and develop engaged Mines alumni by complementing the signature student experience while at Mines.
3. Sustain and foster engagement of Mines graduates by offering networking, connection and development opportunities.

Specific pillars include stewarding the student to alumni transition, continuing to support and grow our special interest groups and affinity programs, and furthering lifelong learning and development for alumni.

MM: WE TALK A LOT ABOUT THE CONCEPT OF "LEGACY" AT MINES. WHAT DOES THIS LEGACY MEAN TO YOU, PARTICULARLY THROUGH AN ALUMNI LENS?

Westergaard: To me, legacy is how we carry on the Mines name, reputation and traditions as leaders across the Mines community—professionally, technically and socially. Some examples include involvement in continuing education and development opportunities, such as professional organizations, interest groups, classroom and panels; volunteering; participating



philanthropically; mentoring; and supporting Mines athletics.

MM: AS WE CELEBRATE MINES' 150TH ANNIVERSARY THIS YEAR, WE ARE REFLECTING A LOT ON MINES' PAST BUT ALSO LOOKING TO WHERE WE'RE HEADED NEXT. WHAT ROLE DO ALUMNI PLAY IN MINES' FUTURE AND SUPPORTING THE SCHOOL'S CONTINUED SUCCESS?

Westergaard: We embody the Mines brand by ensuring that Mines is a top-of-mind and first-choice university now and in the future. We do this by assisting with outreach to attract future students, by demonstrating career/professional achievement and supporting existing, as well as new, areas of knowledge as employers.

MM: WHAT VALUE DO MINES ALUMNI BRING TO CAMPUS—WHY SHOULD THEY GET INVOLVED, EITHER ON CAMPUS OR WITH OTHER OREDIGGERS IN THEIR LOCAL COMMUNITIES?

Westergaard: Alumni bring immense value in a number of ways. First, alumni can offer technical support, mentorship, give guest lectures and serve on panels. Second, they can share business experience through Career Center events and offer program support, career planning and professional advice. And finally, their presence on campus promotes Mines' affinity through their visibility and involvement in programs and events. Alumni can enable students to see what is possible with a Mines education by sharing their professional paths, career direction and success stories.

MM: ALUMNI INVOLVEMENT OFTEN SPANS VARIOUS ACTIVITIES. WHAT ARE SOME OF THE WAYS ALUMNI CAN CONNECT AND FOSTER STRONGER CONNECTIONS WITH THE OREDIGGER COMMUNITY WHILE MAKING A LASTING IMPACT ON STUDENTS AND OTHER ALUMNI?

Westergaard: There is no shortage of ways in which alumni can connect and foster connectivity across the Oredigger community. My personal involvement has modulated over the years to fit with what I can offer, what I value and what is most needed. My initial reconnection with Mines on a formal level was hosting an "E-Days 'Round the World" event while living in Scotland. From there, it evolved into mentoring, serving on a number of panels, sharing my career story in the classroom, giving talks on interviewing skills and offering career and recruitment advice, to becoming a director on the Mines Alumni Board in 2017 and most recently, elected as the board's president.

There are numerous opportunities for us to connect to the broader Mines community—it is simply a matter of determining our interests and desired impact. A few opportunities that come to mind are:

- Join your local M Club and regularly meet up for social events with other Orediggers in your area.
- Share your expertise on campus by giving a technical talk, serving on a panel, becoming a professor of practice or industry advisor and more.
- Attend welcome parties in your city to connect with incoming and current Mines students and celebrate the Oredigger spirit before the academic year begins.
- Volunteer at signature events with opportunities such as weighing rocks and cheering on new students at the annual M Climb, helping with Oredigger Camp or engaging with students at the senior barbeque, to name a few. We have a volunteer platform at volunteer.mines.edu that makes finding the right opportunity easy.
- Support Mines Athletics or help or advise one of Mines' 160+ student organizations.
- Join an alumni interest group, such as Aerospace, Women of Mines, Entrepreneurship and Innovation, or start a new one.
- Engage with an alumni affinity program, such as the Mines Black Alumni Network, the Mines Veterans Alliance, the Former Football members, among others.



NEW ALUMNI OFFICERS AND ADVISORS

The Mines Alumni Board appointed a new executive committee this year, with four new officers serving a two-year term.

Melanie Westergaard '87, President
Santana Sanchez '17, Vice President
Nahjee Maybin '18, Treasurer
Mitch Kruse '85, Secretary

Three special advisors also serve on the executive committee:

Luz Falcon-Martinez '05, MS '09, Special Advisor-Communications
Linda Battalora '87, MS '88, PhD '14, Special Advisor-Faculty
Tim Saenger '95, Special Advisor-Bylaws

TRANSFORMATIONS IN THE FIELD

Judy Bolis '82, MS '92 found inspiration and passion in the mining industry

BY SARAH KUTA

Today, runners, cyclists and cross-country skiers flock to the Trail of the Coeur d'Alenes, a picturesque 73-mile multi-use path in Northern Idaho's Silver Valley. But the scene wasn't always so idyllic. For decades, the area was covered in debris and contaminants from uncovered rail cars traveling back and forth between nearby mining operations.

This transformation—from toxic dumping ground to scenic recreation destination—would not have been possible without Judy Bolis '82, MS '92. It's just one of the impactful projects she's worked on throughout her career as a mining and environmental engineer.

"It offered a challenge," she said. "And it was exciting because you were building something. You were taking something that had been damaged and you weren't just fixing it and closing it, but you were actually creating something new and beneficial for the public."

Beyond her mining waste cleanup work, Bolis gives back to the community in other ways. She volunteers for Women in Mining USA, a nationwide nonprofit that aims to support the mining industry in becoming more inclusive.

Bolis' passion for diversity and equity in the industry traces back to her time at Mines, when she had the opportunity to study under ecologist Beatrice "Bettie" Willard. In the 1970s, Willard helped establish Mines' environmental science



program and became the first woman to chair a department at the university.

"She was the foundation of much of the environmental reclamation and stakeholder relations for mining in the western U.S. in the 1970s and '80s," Bolis said. "She had a huge influence on me. I saw her as a successful woman in our industry, ahead of her time."

As an undergraduate at Mines, Bolis completed two summer internships at operating uranium mines—one underground and one surface. At that time, it was rare for women to work underground—they were considered bad luck—but Bolis held her own and tried to learn as much as she could.

A few years after graduation, inspired by Willard, she returned to Mines for a master's degree in environmental science and engineering. From there, she carved out a path for herself as a successful consultant, working primarily with mining clients in the western U.S. on potential startups and closures.

She's now semi-retired, and in addition to volunteering with Women in Mining USA, Bolis works part-time with Brooks & Nelson, a boutique mining and mineral industry recruiter based in Golden, Colorado. She remains passionate about the industry and loves

touting its benefits to job candidates, such as travel opportunities, working with cutting-edge technology and early-career managerial opportunities.

"IT OFFERED A CHALLENGE, AND IT WAS EXCITING BECAUSE YOU WERE BUILDING SOMETHING. YOU WERE TAKING SOMETHING THAT HAD BEEN DAMAGED AND YOU WEREN'T JUST FIXING IT AND CLOSING IT, BUT YOU WERE ACTUALLY CREATING SOMETHING NEW AND BENEFICIAL FOR THE PUBLIC."

Whenever a Mines resume crosses her desk, Bolis knows she's considering a well-rounded, skilled and curious individual who's ready to tackle complex problems and help meet the needs of the industry. She's also optimistic about the future of mining more broadly, which she predicts will continue to play a vital role in society by supplying materials for many emerging technologies.

"The industry is exciting and offers many opportunities—and not just for mining engineers, but all engineers, scientists and tradespeople as well," she said. "Mining is flourishing and will continue to be critical for supplying commodities in our constantly changing world."



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idig.mines.edu



ON THE FAST TRACK

Kari Gonzales '02 is leading technological advancement and driving innovation in the rail industry

Rail is among the most energy-efficient modes of transportation for freight and passengers today, making up a vital part of the global economy. And while it's one of the oldest transportation methods in use today, it's an industry that is constantly improving with technological advancements and safety, reliability and efficiency improvements to help meet ever-increasing societal demand.

Few are as familiar with the rail industry's continued evolution as Kari Gonzales '02, president and CEO of MxV Rail. Based in Pueblo, Colorado, MxV Rail is the world's leading talent for rail research, consulting, training and testing, focused on supporting the latest innovation and ideas to advance rail in the U.S. and around the world.

We asked Gonzales for her perspective on the future of rail and the lessons she's learned as a leader in the industry. This is what she shared.

MINES MAGAZINE: WHAT INTERESTS YOU ABOUT THE RAIL INDUSTRY?

Kari Gonzales: I was first hired into the industry as an intern, and I fell in love with the rail industry. I changed my major from chemical engineering to mechanical engineering after that summer. It's a wonderful industry with great people who are passionate about improving safety, reliability, efficiency and resiliency. Although it's a global industry, it's a very small community. There are a lot of people who are always very willing to share knowledge, and as long as you're willing to learn, there's really a lot of opportunity to grow in the industry.

The other thing I really appreciate is the heritage of the industry. Railroads have been around for nearly 200 years, and we are still seeing advancements. It's not a place where we get in a comfort zone and stay there—we're always looking for ways to improve the infrastructure and technology, which is where MxV Rail is a big contributor.

MM: YOU BECAME PRESIDENT AND CEO OF MXV RAIL IN 2021 AT A TIME WHEN THE COMPANY WAS REBRANDING AND GOING THROUGH MAJOR RESTRUCTURING. WHAT WERE SOME OF YOUR BIGGEST CHALLENGES WHEN STEPPING INTO THIS ROLE AT SUCH A CRITICAL TIME?

Gonzales: There was quite a transformation that was required over the past couple of years. MxV Rail was formerly TTCI, and we operated out of a federally owned facility for 40 years. In 2021, the government announced they were going in a different direction for management of the facility, so we had to figure out what our organization was going to be moving forward. We made the decision to relocate our facilities—40 years' worth of stuff and about 100 million dollars' worth of assets. And not only did we have to move that facility, we had to build a new facility with more than 20 miles of track infrastructure, new buildings and training facilities. The move in itself was a feat, but retaining our talented staff was also challenging. We had a lot of unknowns, and making sure people understood our vision and showing them action and results along the way was probably one of the most challenging parts of stepping into the CEO role.

MM: MXV RAIL FOCUSES ON RESEARCH AND TESTING. WHAT IS THE IMPACT OF THIS WORK?

Gonzales: MxV Rail has a long history as the premier research and testing partner for railways worldwide. Our new name, introduced in early 2022, is a bit newer but helped reaffirm our commitment to the rail industry. Our new name is based on the formula for momentum, mass times velocity. We chose this name because we've always focused on helping move the best ideas forward. One of the things I've always been attracted to is challenge. And when you're working in a research and testing environment, there is a high degree of variability in the work you do. When you tie that together with a company that is purpose-driven like MxV Rail, we have a lot of flexibility to explore, learn, adapt and apply our learnings to help make the industry better in the ways of safety, reliability, efficiency and resiliency. Because we operate in a controlled test environment, we get to do a lot of things that other people don't get to do. From our training school where we can train first responders on how to respond to an incident if it were to happen via rail to working on projects where we're looking at the crashworthiness of passenger cars, we really span from end to end on all things rail. Ultimately, the results from our work directly impact methods and

technology used in the rail industry to improve safety and performance.

MM: WHAT DOES THE FUTURE OF THE RAIL INDUSTRY LOOK LIKE?

Gonzales: I always say, this is not your grandfather's railroad anymore. People tend to get a visual of the steam engine, and that's not railroads anymore. When people ask about what I do, I always take the opportunity to provide better insight on how railroads run and how we use technology to safely and efficiently move freight across our country.

Moving forward, I think the industry will continue to work on a zero-derailment future. Leveraging new technology to keep our nation's railroads operating safely is a focus area for railroads worldwide. There's been a lot of news in the last year around some derailment events, but that's not how the industry prefers to operate. Especially when you're talking about hazardous material rail shipments. In fact, over 99.9 percent of those shipments happen without incident, but the industry is still exploring ways to improve upon those safety-performance numbers. We're looking a lot of new technology coming into the industry, and with the push for decarbonization, there's also a combination of technology efficiency and the materials we're using. That's one of the things that's very interesting to me. Rail is the most efficient way to move freight right now, but there are still a lot of people and organizations pushing to further reduce our impact on the environment. I'm excited to see how much more progress we see in both safety and overall resiliency of our network and operations.

MM: WHAT DO YOU THINK HAS BEEN THE MOST IMPORTANT LESSON YOU'VE LEARNED AS A LEADER?

Gonzales: The biggest lesson I've learned is that when you put people first, the business will operate better. Passionate people driven by a common purpose can succeed despite challenging circumstances. Always encourage input from your team, and use that input to drive change and transform the business. I've really tried to make sure I hear our employees' voices and ensure their knowledge can be used to best position the organization for success. As a team, we were able to achieve a successful transition on a tight schedule because we had an amazing set of people working side by side with a common goal. You'll see positive outcomes when you stay outside your comfort zone and place a high value on the people that contribute to making your organization great.

A DIRECT ROUTE TO A MINES EDUCATION

New Mines Academy launches at Front Range Community College for a new path to a four-year degree program

BY EMILIE RUSCH

Front Range Community College and Mines launched a new partnership to offer FRCC engineering students a direct pathway to earning a bachelor's degree at Mines with a new Mines Academy at FRCC.

Students accepted into the Mines Academy will begin their program at FRCC pursuing an Associate in Engineering Science (AES) degree. The relevant coursework for that degree will also apply to their Mines degree program—allowing Mines Academy students to seamlessly transfer to the university to complete the second half of their bachelor's degree. The academy will provide FRCC students the opportunity to earn guaranteed admission into any four-year degree program at Mines.

DIVERSIFYING COLORADO'S STEM WORKFORCE

More than 400 FRCC students are currently majoring in one of FRCC's AES programs. "With a student body that is 48 percent first-generation and 34 percent students of color, FRCC is proud to provide historically underserved students access and support on their path toward careers in engineering," said FRCC President Colleen Simpson. "By giving community college students a way to transfer seamlessly into the degree programs at Mines, we're helping to make these fields more inclusive and equitable for all budding engineers."



Mines President Paul C. Johnson and Front Range Community College President Colleen Simpson interact with FRCC students after signing the agreement to formally create a new Mines Academy at FRCC on December 7, 2023.

PREPARING STUDENTS FOR SUCCESS

"What's exciting to us about this partnership with Front Range Community College is that it will expand opportunities for students to earn admission to Mines and support them on their path to graduation and a successful launch to their careers," said Mines President Paul C. Johnson.

Throughout their time at FRCC, Mines Academy students will meet regularly with advisors from both colleges and be required to maintain a certain GPA. Students can also attend co-curricular events held at both schools.

"The program is intentionally designed to set students up for success as they pursue a pathway to Mines. They'll gain access to wrap-around support services, including career preparation and professional development, academic advising from both institutions and exposure to life as an Oredigger," said Mines Provost Rick Holz.

MINES ACADEMY BENEFITS

Students who participate in the Mines Academy at FRCC will:

- Pursue an economical path to a bachelor's degree at Mines.
- Find support through resources

like TRIO Student Support Services (for first-generation students, those with limited income and students with disabilities), accessibility services, academic supports, FRCC scholarships or STEM groups.

- Take high-quality math, science and engineering courses at FRCC with small faculty-student ratios.
- Engage with Mines' student success offices early and often, including the Center for Academic Services and Advising, Financial Aid and the Mines Career Center.
- Gain access to resources and events at Mines.
- Be part of an engineering community with supportive academic peers both at FRCC and Mines.

"Our students can now focus on studying and achieving academic success while at FRCC—and they can rest assured that they have a straightforward pathway to a bachelor's program at Mines in engineering," said FRCC Provost and Vice President of Academic Affairs Rebecca Woulfe. "We are excited about this progression in our longstanding partnership with Mines to meet the ever-growing need for more STEM graduates."

This engineering academy is the second of its kind in Colorado and is modeled after an existing Mines Academy at Red Rocks Community College.

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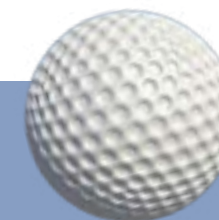
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ASSESSING NATURAL GAS SUPPLY AND DEMAND

The Potential Gas Committee is a key player in understanding natural gas' role in our energy future

BY ASHLEY SPURGEON

When turning up the thermostat to stave off the winter chill, boiling water for a cup of tea or even just turning on a lamp as the sun begins to set in the evening, do you think about the natural gas being burned to make those seamless parts of your everyday life function?

Natural gas is an essential part of the United States' energy portfolio, supplying nearly a quarter of the nation's energy, according to the American Gas Association, and is the cleanest fossil fuel on the market today. But assessing the resource's recoverable supply and ensuring we have the knowledge to make well-informed decisions about current natural gas usage and how it fits into the nation's future energy strategy is essential.

That's where the Potential Gas Committee comes in. The committee publishes a biennial assessment of the United

States' estimated natural gas resource base. The most recent report was led by Stephen Sonnenberg '81 with support from Cathy Farmer '79, MS '81.

We talked to Sonnenberg and Farmer and Eric Roberts, director of the Potential Gas Agency, to learn more about this work and its impact.

UNDERSTANDING THE POTENTIAL GAS COMMITTEE AND POTENTIAL GAS AGENCY

The Potential Gas Committee is made up of approximately 80 knowledgeable and highly experienced volunteer members who work in the natural gas exploration, production, transportation and distribution industries and the technical services and consulting sectors.

The Potential Gas Committee assesses the natural gas resource potential for 90 geologic provinces comprising six geographic areas of the Lower 48 States and Alaska, 56 of which are onshore and 34 offshore. The assessment captures the status of a dynamic system of drilling and appraisal. Potential natural gas resources transition into proven reserves and eventually into flowing natural gas production.

Although the PGC functions independently, the Potential Gas Agency at Mines, housed on the Mines campus since 1964, provides the PGC

with guidance, technical assistance, training, administrative support and assistance with member recruitment and outreach.

"Colorado School of Mines has a long history of doing assessments in energy-related businesses and extractive industries, so it was a natural fit for the Potential Gas Agency to be in Golden on the Mines campus since its inception," Sonnenberg said.

NATURAL GAS—AND THE PGC'S WORK—PLAYS AN IMPORTANT ROLE IN THE ENERGY TRANSITION.

"Natural gas is the cornerstone of our nation's energy future. It's readily available, it's clean burning and our whole energy grid is set up for natural gas power plants," Farmer said.

While much of the U.S. is implementing renewable technologies, such as wind and solar, they aren't always able to provide the reliable and consistent energy required today. "There are gaps," Farmer explained. "When it's dark, and the wind isn't blowing, you have to have something really reliable for the base load. Natural gas is very reliable for that baseload power generation, and we rely on it. We need to use every resource we have."

And this reliability even goes beyond the U.S. "Natural gas in the energy transition is definitely the most

reliable and available transition fuel for countries that don't typically have natural gas and rely on coal as their primary source of electricity generation," Roberts said.

MINES ALUMNI PLAYED AN IMPORTANT ROLE IN THE PGA'S 2022 ASSESSMENT, WHICH WILL HELP DRIVE INFORMED DECISION-MAKING.

The PGA's biennial assessment is a critical document used by Congresspeople and other policymakers to determine how resources are going to be used in the near future. But the PGA faced an unexpected hurdle in 2022 when the PGA's former director unexpectedly died, leaving the report unfinished.

Sonnenberg stepped in to serve as the interim director, and Farmer volunteered as a senior advisor to provide the statistical analysis and editorial work. Together, with a team of industry volunteers, they were able to finalize the assessment and meet the publication deadline.

Members of Congress and other stakeholders have requested copies of the report, which will aid in future policy decisions and inform how the country moves forward in the energy transition.

"With reports like this, we can understand the transition time period. What do we currently have, and how can natural gas help with all of this?" Sonnenberg said.

"It's important for policymakers to know that abundant supply is there. The people who are making decisions need to know we have enough that we can use quickly and not rely on imports as much," Farmer explained.

THE PGC IS A VALUABLE ASSET FOR EVALUATING THE FUTURE.

The PGC's work is not only critical for understanding the U.S.'s natural gas supply and its role in the energy transition but also for assessing exactly how those resources are going to be used in the future.

"There's a lot of uncertainty moving forward and a lot of uneven distribution in terms of energy," Roberts said. "The PGA's role in being an assessor of energy is really important and will remain important. Being able to put numbers to the future gas supply is really valuable to being able to bring online new technologies, knowing when to sell some of the resource and when to hold onto it is really important."

The agency can also play an important role in evaluating new gas-based energy sources. "We have newly important gases, like hydrogen and helium, that we haven't traditionally understood very well," Roberts said. "This seems like a really positive way that the agency can remain active and valuable."



A group of Mines alumni got together for the adventure of a lifetime in August 2023 on a Grand Canyon rafting trip. After having a blast on the same trip a few years ago, Jeff Wilson '86 booked a raft and called up a few interested Orediggers and other friends to join him.

The group completed a six-day trip where they set up and broke down camp each day, hiked to iconic spots, hit their biggest rapid called Hermit, rescued another raft that lost their motor above another of the biggest rapids known as Crystal and enjoyed the canyon and each other's company.

Alumni pictured include **Kim Mizenko '12, Clara Putzig Mizenko '85, Glen Mizenko '85, Jeff Wilson '86** and **Jim Thorson '85**.



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.

1970s

Robert Otto '74 retired from the United States Department of Veterans Affairs as an IT specialist (customer support) on May 1, 2023, after 15 years of full-time employment.

1980s

Jerry Strahan '84 won the 2023 Track Championship in the Corvette Connection Club Clash drag racing series at Bandimere Speedway in Morrison, Colorado. 2023 was the 65th anniversary and final year of operation for Bandimere Speedway. Jerry races for the Camaro Club of the Rockies team, and this was his second track championship, having won his first in 2018.

2010s

Renato Frimm MS '12 was elected as a board director for the Tax Increment Development District in a municipal finance position for Taos Ski Valley in New Mexico in November 2023.

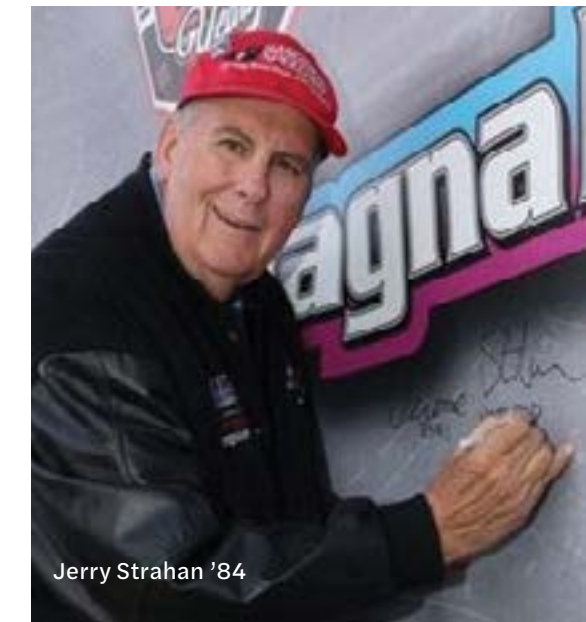
Jack McNamara '19 won the 2023 GE Healthcare Surgery President's Award recognizing outstanding contributions for his work as part of GE's service logistics team that developed and implemented a new automated system Harvest Plan program.

Peter Moschetti '19, MS '20 and **Benjamin Overholt '19, MS '20** started a company, Persistent Engineering, where they have

developed an electronic, wall-mountable wine tap called VineTap. Persistent Engineering has been working with the Mines Venture Center for mentorship and support and officially launched a pre-sale to develop their product's market validation. They will be crowdfunding in Spring 2024 to finalize some of their injection molding parts. More information can be found at myvinetap.com.



Robert Otto '74



Jerry Strahan '84



Peter Moschetti '19, MS '20 and Benjamin Overholt '19, MS '20



The Mines community turned out in force to cheer on the Oredigger football team in December 2023 at the NCAA Division II national championships. They gathered for watch parties in Golden, Colorado and in cities across the U.S., and those who were able to attend in person turned out for a tailgate in McKinney, Texas before the game. Here are some of our favorite photos from the tailgate.





More than 30 Mines students, faculty and alumni were inducted into the Order of the Engineer in 2023. The 53-year-old international honorary engineering society asks members to make an obligation to oneself to uphold devotion to the standards and dignity of the engineering profession. Mines' chapter was established in 1983 and currently includes thousands of members.



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IN MEMORIAM

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

Donald L. Berry '50 died Nov. 15, 2023. Born in 1926, Donald joined the U.S. Navy, serving as an officer. He spent his career as a geophysical engineer.

Theodore A. "Ted" Bickart died Oct. 20, 2023. Ted earned his bachelor's, master's and doctoral degrees from Johns Hopkins University. He served in the U.S. military before becoming an electrical engineering professor at Syracuse University. He later became Dean of Engineering at Syracuse and later was a dean at Michigan State. He was also a Fulbright Scholar at Igor Sikorsky Kyiv Polytechnic Institute and a visiting scholar at the Nanjing Institute of Technology and at University of California, Berkeley. Ted moved to Colorado in 1998 and served as president of Colorado School of Mines for two years until he retired.

Allan R. "Al" Cerny '63 died Sept. 14, 2023. Al was born in 1941 and was a member of several student clubs and organizations as a Mines student. He worked for several mining companies in his early years including Amax, New Jersey Zinc and Frontier Constructors. He also served in the U.S. Army for two years. He spent most of his career as a land and legal manager of Western States Minerals Corporation until he retired.

Franklin P. Frederick '52 died Sept. 17, 2023. He began his career with Humble Oil Refining and then moved to Bonner and Moore Associates. He was instrumental in developing chemical and petroleum refining modeling techniques and consulted worldwide.

Cecil D. Gritz '66 died Sept. 26, 2023. He was born in 1943 and spent nearly 60 years working in the exploration, drilling, completion and production phases of the oil and gas industry. He began his career with Shell Oil Company before working at various levels with several public and private entities. He also served in the U.S. Army Corps of Engineers during the Vietnam War.

Nicholas F. "Finn" Mahoney '21, MS '22 died July 9, 2023. Born in 1997, Finn was a prominent member of the Formula SAE club as a student at Mines. He spent his professional career working in oil fields in Wyoming.

Matthew W. Major '11 died Aug. 28, 2023. Matthew was born in 1987 and worked as a software integration and testing engineer for Canoe Ventures for 12 years.

Robert W. "Bob" Scheck '67 died Aug. 11, 2022. Born in 1945, Bob began his career at Stearns-Roger, a Denver-based engineering and construction firm. He also worked on the Hanford site cleanup in Washington and the Rocky Flats site cleanup in Colorado. When he retired, Bob started consulting business, Alpine Engineering of Colorado.

➔ To submit an obituary for publication in *Mines Magazine*, visit 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.



Mines football won their third straight regional title in the 2023 season.

Photos by Nathan Bryce and Shelby Tauber



A HELLUVA JOURNEY

Mines football advances to the NCAA Division II national championship for the second consecutive year

After an undefeated season, the Orediggers pursued an NCAA national championship once again in December 2023. Following 2022's national title loss to Ferris State, the Orediggers went up against Arkansas' Harding University, but their quest came to an end in a 38-7 loss.

However, the game—and the journey to get there—wasn't without some notable moments and accolades.

- A record crowd of 12,552 filled McKinney ISD Stadium in Texas to watch Mines and Harding face off.
- For the 2023 season, Mines set program records for wins (14), first downs (387), yards in a season (7,630) and scoring defense in the modern era (13.0).
- Quarterback John Matocha's superlative career came to an end with his name at or near the top of multiple national records. After 57 consecutive starts (a program record) and 51 wins, Matocha ended as college football's all-time leader in both passing (162) and total (191) touchdowns, throwing for 15,006 yards (third all-time in D-II history) and becoming only the second player in D-II history to cross 17,000 total yards with 17,006. All are Mines and RMAC records.
- Running back Noah Roper ended his one season with Mines with 20 total touchdowns (16 rushing, 4 receiving), rushing for 960 yards and catching 178.
- Two Orediggers, linebackers Adrian Moreno and Jaden Healy, had double-digit tackles, with Moreno achieving a career-high of 14 and Healy a career-best of 12.
- Safety Will Ramsey was named the NCAA's Elite 90 winner for football, holding the top GPA among participants in the national championship game. Ramsey is a sophomore computer science major with a 4.0 GPA.
- A record-setting six Orediggers were named Associated Press All Americans in the organization's annual NCAA Division II year-end awards.
- In his first year as coach, Pete Sterbick was named 2023 AFCA Regional Coach of the Year.



Ahead of the national championship game, the Oredigger football team spent some time with local elementary school students in McKinney, Texas.



➔ Read more about Mines football and the team's stellar year at minesathletics.com.



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Mines is celebrating its 150th anniversary in 2024 and is taking time to reflect on how far the institution has come. But Mines is also using that legacy to look ahead at the industries graduates will continue to lead in the near future, what research faculty and students will advance next and how Orediggers will continue to solve the engineering and scientific challenges of today and tomorrow.

→ Visit 150.mines.edu to learn more about celebrating Mines' enduring legacy and where the university is headed next.

