

MINES MAGAZINE

For Colorado School of Mines Alumni and Friends • Spring 2023

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CONSTRUCTING THE FUTURE OF URBAN LIFE

With the U.S.'s infrastructure in dire need of updating to keep up with a rapidly changing world, Mines engineers are providing the skills and expertise to find and build the right solutions

PLUS:

Mines alumni are making an impact by finding new solutions to manufacturing supply chains and developing augmented reality technology that is being tested on campus.

Mines' new director of federal relations is working to maximize the university's impact and influence on federal partners.

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Around 200 Mines alumni participated in this spring's Career Days—both as recruiters and attendees—returning to campus to share information and learn more about jobs and internships, build their professional network and more.

- ➔ 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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With the U.S.'s infrastructure in dire need of updating to keep up with societal demand, Mines engineers are providing the skills and expertise to find the best solutions. **18**

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On the cover: Mines students Mimi Clot De Broissia, Herbert Hafenrichter, Dayanira Gallegos and Sarah Gifford and construction engineering faculty member Karen Gupta review blueprints at the Beck Venture Center construction site on the Mines campus. Photo by Cyrus McCrimmon

STUDENT EMERGENCY FUND, BLASTER'S BASKET HELP STUDENTS IN NEED

Mines students are known for their grit and resilience. But sometimes, life's circumstances take the focus away from school. Through the generosity of supporters—including faculty, staff and alumni—and funding from the school, Mines is there for students in need.

Blaster's Basket

About 35 percent of Mines students report being food insecure. Not knowing where their next meal will come from—and being hungry—is a complex problem that can derail anyone's ability to learn and can tank their mental health. As the cost of living increases, the student-run Fighting Hunger@Mines (FH@M) expects student needs to increase.

Blaster's Basket is Mines' food pantry, an anonymous resource available to all students. It's stocked through campus and alumni food drives and by FH@M, which applied for and received local grants and funding from the City of Golden.

- In Fall 2022, the Faculty & Staff Giving Committee donated more than 1,500 nonperishable items to Blaster's Basket.
- The Fall 2022 alumni food drive brought in over 500 items and raised \$740 for future needs.
- FH@M has brought in more than 1,300 pounds of local fresh produce, 400 pounds of meat and 3,000 pounds of grocery staples.
- When the pantry is stocked, the food is often gone the next day.

Student Emergency Fund

During the 2021–2022 academic year, the Student Emergency Fund awarded \$148,878 to 106 students, with grants for urgent costs like:

- Travel to their father's funeral
- Extraordinary medical expenses
- An apartment security deposit to leave an abusive situation
- Extensive car repairs so they could commute to school

In spring 2023 alone, supporters donated over \$13,000 to the Student Emergency Fund.



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CHECKING IN ON WELLNESS

Mines' Fresh Check Day gives students resilience skills to care for themselves and support others

Mines hosted its second Fresh Check Day this spring, a concept created by the Jordan Porco Foundation designed to bring the campus community together to “check in” on the mental health and wellness of college students. The free event offered information and activities that examined different aspects of wellness to remind students and the Mines community how to take care of themselves and look out for each other—while gaining skills before crises happen.

The booths focused on areas such as physical health, body positivity, drug and alcohol abuse prevention, veterans' services, sexual assault survivorship, LGBTQ+ inclusivity, suicide prevention and more. Students were encouraged to participate in engaging activities such as sharing their wellness tips, fishing for prizes, petting therapy dogs and more.



CONTINUING A TRADITION OF LEADERSHIP IN PREPARING INDUSTRY-READY GRADUATES

Mines' academic programs evolve to meet industry demand and student interests

Mines has long prided itself for producing industry-ready graduates and leaders critical to the world's prosperity. As those industries and their needs change, so must the academic and research programs and the experiences we offer.

If you've been following our MINES@150 progress the past few years, you have seen this happening—perhaps more rapidly than ever before. We've added new undergraduate and graduate programs, offered new courses and concentrations within existing programs and expanded the ways we deliver them. The new programming is not only driven by industry needs, but it also reflects where students and working professionals want their careers to go.

When we think about new programs and courses, we like to strategically target areas where Mines has unique expertise and partnerships to build from. The foundational characteristics of our academic programs (rigor, practical and hands-on experiences, learning-to-learn, etc.) have remained constant for nearly 150 years, but the specific knowledge and skills needed for professional success have changed. For example, in this issue you'll read about our new bachelor's degree in construction engineering (page 18). I've had one company tell me that they alone would hire every graduate from this program.

We've also added bachelor's degree programs in ceramics engineering, business engineering and management

science, quantitative biosciences and engineering and design engineering. We've launched 20+ new master's and doctoral degree and certificate programs, with online learning options to help support working professionals. You may have read about our first-in-the-universe space resources program and our new quantum engineering, advanced energy systems, carbon capture use and storage and advanced manufacturing programs.

Mines alumni play a critical role in these programs through student mentorship, taking part in the design and delivery of the programs and being connectors to companies and agencies. Many Mines alumni are also students in these programs.

I'm very appreciative of our alumni and donors and their support of the expansion of our academic programs and delivery methods. We've accomplished a lot in a short period of time and our future is bright. If you'd like to be part of this, please reach out and we'll get you involved. If you'd like to enroll in any of the programs, we can help you with that too.

Keep learning, and go Orediggers!



Paul C. Johnson
President and Professor





SECURING A MAJOR MILESTONE

Mines' women's track & field bring home their first RMAC championship

BY TIM FLYNN

Mines' women's track & field has had plenty of national champions and all-Americans in its decorated history, but one major program milestone had eluded the Orediggers: A Rocky Mountain Athletic Conference championship.

That changed on February 25, 2023, when the Mines women captured the 2023 Rocky Mountain Athletic Conference Indoor Track & Field title in Alamosa, Colorado, marking a historic first for the program. The Orediggers' team depth contributed to dethroning three-time defending champion University of Colorado Colorado Springs as Mines outdueled the Mountain Lions to a 10.5-point victory. It was the fifth RMAC championship under head coach Matt Sparks, who had previously led the men's program to four conference crowns.

Among the individual highlights were a podium sweep of the pole vault led by champion Hannah Miller, silver medalist Avery Herbold and bronze medalist Dale Thompson. Lexye Wood won the long jump competition as well. The final event that sealed the championship was

a dominant five-second victory by the 4x400 relay that included Amena Nelson, Grace Galvin, Randi Higashi and Aryelle Wright.

It was a true team effort as Mines needed top-eight individual performances to score team points in addition to its medalists. Among the point scorers for Mines were five runners in the top seven of the 5,000m, including silver medalist Zoe Baker along with Jenna Ramsey, Brin Strouse, Holly Moser and Molly Maksin; the distance medley relay of Alex Raichart, Allison Comer, Mackenzie Duck and Clare Peters finishing fifth; Avery Wright coming in fourth in the pentathlon and fifth in the 60m hurdles; Nelson winning bronze in the 400m along with finalists Galvin and Higashi; Peters and Raichart individually scoring in the mile; and Aryelle Wright placing fourth in the 800m.

Two late events, the 3,000m run and the shot put, proved critical to Mines' winning margin as Baker added another silver medal and Maksin and Ramsey finished fourth and fifth on the track, while Kitt Rugar placed sixth in the shot put in the final field event.

MINES ALUM BECOMES TRACK & FIELD WORLD CHAMPION

It was quite a 2022 for three-time Mines grad Mark Husted '09, MS '10, PhD '19. The former Oredigger track & field star and Mines Athletics Hall of Famer was a six-time all-American and two-time NCAA champion as a student-athlete and a two-time national champion as a coach with the Mines cross-country program. In the summer of 2022, he added an even more impressive title: world champion.

Husted competed in the World Masters Athletics Outdoor Championships in Tampere, Finland in early July, which is a competition for athletes 35 years and older across a range of age brackets. Husted won the 5000m world championship in a time of 14:43.27, was the silver medalist in the 1500m in 3:52.55 and placed fourth in the 800m in 1:54.86.

As a result of his success on the global stage, Husted was named the 2022 Colorado Masters Track Athlete of the Year by USA Track & Field, a prestigious honor in a state known for its competitive distance racing.

As an assistant coach with the Mines distance running program, Husted also had a hand in three national championships in 2022. In late May, Mines distance star Dillon Powell captured the NCAA Division II 10,000-meter championship in Michigan, and in December he helped the Mines men's cross-country team win the team title and Powell the individual championship in Seattle.



TACKLING OIL AND GAS GREENHOUSE GAS EMISSIONS ACCOUNTING

Mines has partnered with the University of Texas at Austin and Colorado State University to stand up a new \$50 million multidisciplinary research and education initiative that will address the growing need for accurate, timely and clear accounting of greenhouse gas emissions across global oil and natural gas supply chains.

Data and analysis from this major new endeavor will help both public and private institutions develop climate strategies and actions informed by accurate data, identifying both opportunities for emissions reductions and verification.

Mines is one of the founding institutions of the Energy Emissions Modeling and Data Lab, and Dorit Hammerling, associate professor of applied mathematics and statistics, will help lead several cutting-edge data science research tracks, while Morgan Bazilian, director of the Payne Institute for Public Policy, will work on policy and regulatory implications of these scientific results.

“The complex data science aspects of emissions monitoring and measurement are still nascent, but we are making great strides in better informing decision makers in the U.S. and across the globe,” Hammerling said.

EEMDL will work with stakeholders to establish comprehensive, reliable, transparent, measurement-based greenhouse gas emissions assessments of oil and gas supply chains. The research products—consisting of protocols, software tools and emissions datasets—will be updated regularly. The lab will also offer education and



training programs to help oil and gas operators, government agencies and other stakeholders utilize the tools and data.

The first major initiatives will focus on methane emissions. Significant uncertainty remains about methane emissions from oil and gas supply chains, their locations and how emissions change over time. Accurate and real-time information about specific methane emissions is critical for prompt and cost-effective intervention and emissions reductions. More detailed mapping of oil and gas sector methane emissions can have a significant impact on global mitigation efforts.

The efforts to build tools and data sets for methane accounting are already underway, and EEMDL will build on this work. In its first year, EEMDL will:

- Publish a **U.S. Methane Census** that integrates up-to-date

measurement data across U.S. oil and gas operations. The census will be updated annually and will help serve as a benchmarking tool for various stakeholders.

- Develop **emissions reconciliation and measurement integration protocols and tools** that help companies close the gap between direct measurements and engineering estimates of emissions. This tool will integrate data from monitoring systems such as satellites, aerial flyovers, continuous monitors and operational data.
- Create **supply chain emissions analysis tools** that provide estimates of methane emissions across individual oil and gas supply chains. Investors, customers and the public can use this tool to better understand emissions associated with the production and transportation of oil and gas resources.

CONNECTIONS

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

MINES, AMERICAN GEM TRADE ASSOCIATION UNVEIL STRATEGIC RELATIONSHIP

Mines and the American Gem Trade Association (AGTA) have formed a long-term strategic relationship with an unparalleled multiyear research project that examines colored gemstone supply chains in Kenya, Tanzania, Madagascar, Nigeria and Sri Lanka.

The goal is to identify best practices specific to the colored stone industry and improve transparency and traceability, ethics, environmental sustainability and human rights within it.

“AGTA and Mines recognize that guidelines developed for responsible sourcing of diamonds and precious metals do not fit the colored gemstone supply chain,” said John W. Ford Sr., CEO of AGTA. “Both AGTA and Mines share the common goal of improving the transparency and traceability within the international mining community and desire to identify and cement best practices at sites worldwide. AGTA plans to expand the project in future years to include South American and Asian supply chains.”

International site visits will take place through November 2023. Different types of mining and sizes of operations will be examined as well as different environmental and social contexts. In each location, data on the top colored gemstone export will be analyzed—a minimum of 10 different colored stones will be scrutinized. Analysis of findings and report writing will culminate in the spring of 2024.

“Consumers want transparency more and more when it comes to the sourcing of all sorts of goods, and colored gemstones are no different,” said Nicole Smith, assistant professor of mining engineering. “We’re excited to partner with AGTA and have this unique opportunity to

examine some of the best practices along colored gemstone supply chains and how consumers can be sure the stones they’re purchasing are produced in an ethical way and that they’re not being ‘greenwashed.’”

A gemstone trader in Tanzania shows the colored stones he plans to sell at local markets.

Photo courtesy of Nicole Smith



MINES FACULTY WIN CAREER AWARDS FOR IMPACTFUL RESEARCH

Two Mines faculty received a National Science Foundation CAREER Award this spring: Dong Chen, assistant professor of computer science, and Matthew Siegfried, assistant professor of geophysics.



Chen was recognized for research that aims to give users of smart home devices more control over their data privacy. He will work to create a family of algorithms, mechanisms and prototypes that will strengthen Internet of Things (IoT) security and privacy for smart homes. He will also develop IoT cybersecurity workshops for middle and high school teachers at public schools in Colorado, with an emphasis on districts with significant populations of students from backgrounds underrepresented in STEM.



“I hope to have a long-term impact on IoT device privacy,” Chen said. “If successful, this project will open the doors for me to expand my long-term research and education agenda.”

Siegfried’s research aims to improve our understanding of Antarctic ice streams and their potential impact on global sea level change. He will focus on Whillans Ice Stream in West Antarctica, whose flow has been slowing over the course of several decades. The goal of his research is to leverage decades of existing Global Positioning System (GPS) and seismic field data to illuminate what causes the slowing and ultimate shutdown of ice streams like Whillans.

“Any process that speeds up or slows down the rate at which these ice streams move adjusts the balance between ice gain and loss in Antarctica, impacting coastal communities worldwide,” Siegfried said. “We often focus on processes that make ice move faster—ice-stream stagnation, which most recently occurred in Antarctica about 180 years ago, is studied less often, particularly from an observational perspective.”

► Mines alumni joined the Multicultural Engineering Program after the spring Career Days event in February 2023 to network and enjoy each other’s company. ▲



SECURING THE FUTURE OF MINING

A historic \$7.5 million investment in Mines' mining engineering program sets future engineers and the industry up for success

BY LYNN CLARK

Mines' No. 1 world-ranked mining engineering program has received a historic \$7.5 million investment from alum J. Steven Whisler MS '84 and his wife, Ardyce. It's one of the program's largest gifts since Mines was established in 1874 to support Colorado's booming mining industry.

"Mines has the best mining engineering program in the world, and Ardy and I are pleased to provide meaningful support to create an even better mining engineering educational experience for students," said Steve Whisler, a retired mining executive.

The investment creates the J. Steven Whisler Chair for the Head of Mining Engineering, the J. Steven Whisler Professor of Practice and the J. Steven Whisler Scholars Program, which funds scholarships for mining engineering students.

"We want to support the department's evolution under a visionary leader and a faculty member who will develop and lead forward-looking strategic initiatives, while giving students financial support to enable them to pursue careers in the mining industry," he said.

AS THE NEED FOR MINING EXPERTISE GROWS, THE NUMBER OF GRADUATES IS SHRINKING

The Whislers' investment comes as the number of U.S. mining engineering students is shrinking—by nearly half from 1,449 in 2015 to 736 in 2020, according to a story in the December 2021 issue of *Mining Engineering*. And fewer than 200 students on average are graduating each year.

As a result, there simply are not enough graduates with expertise to meet the rapidly escalating demand for minerals and materials used in construction, transportation, electronics and energy production,

CONNECTIONS

- ▶ The Mining Department hosted a coffee and networking opportunity in February 2023. ▲

or to address the coming onslaught of retirements across industry and academia. In the United States alone, the Bureau of Labor Statistics projects about 500 mining and geologic engineer jobs openings each year for the next decade.

“Mining companies not only have to compete among ourselves for the best talent, but with other industries such as tech firms in the Silicon Valley,” Whisler said. “It’s critical that we continue to create a positive reputation and work environment for the industry that will attract and retain new talent to the profession.”

“MINING TODAY DEPENDS ON PEOPLE WHO ARE PREPARED TO WORK ON A PROBLEM UNTIL THEY SOLVE IT. THAT’S WHAT I’VE SEEN MINES GRADUATES DO AND DO WELL.”

He said Mines students go through a trial by fire that prepares them for a career that requires resilience.

“They have a stick-to-it attitude that’s refreshing,” he said. “Mining today depends on people who are prepared to work on a problem until they solve it. That’s what I’ve seen Mines graduates do and do well.”

Whisler spent his career in the mining industry, working his way up from a summer intern to chairman and CEO of Phelps Dodge Corporation, where he retired in 2007 after overseeing the company’s \$26 billion sale to Freeport-McMoRan Inc.

He said today’s mining engineers must develop nuanced business acumen alongside their technical aptitude, and that he is impressed that Mines is integrating business education throughout its curriculum.

“The industry needs engineers who possess not only the necessary technical qualifications but also have contemporary and astute cost/benefit analysis and problem-solving skills to assess mineral production opportunities both from a company viewpoint and, as importantly, a societal perspective,” he said. “This is particularly important as the production of key minerals will drive and ultimately determine the success of the world’s alternative energy policies and strategies.”

THE GIFT IS A CATALYST FOR MINES’ VISION FOR THE FUTURE OF MINING EDUCATION

Mines President Paul C. Johnson said the Whislers’ historic investment gives the department resources to be the exemplar and leader that all other universities will want to emulate, not only because of the quality of its graduates, but also because its expertise and education align with industry’s future needs.

ABOUT THE MINING ENGINEERING PROGRAM

The mining engineering program at Mines offers bachelor’s, master’s and doctoral degree programs with specialized expertise in underground construction and tunneling, explosives engineering, hydrological science and engineering, earth resources development engineering, and mining beyond Earth for space resources. Renowned for its education and applied research in the field, the program has been ranked No. 1 by QS World Rankings since 2016.

➔ Learn more about the mining engineering program at mining.mines.edu and take a look back at *Mines Magazine’s* Spring 2020 cover story about the need for skilled extractive engineers to obtain the materials essential to modern life at minesmagazine.com.

“The mining engineering program’s world-renowned reputation reflects our graduates’ capabilities and successes, the program’s strong connection and relevance to industry, our faculty’s expertise and leadership and the program’s unique resources, such as the Edgar Mine,” he said. “The Whislers’ support shines a spotlight on our program and will catalyze its evolution in a way that could not happen without it.”

Johnson said the gift will continue to elevate Mines as top-of-mind and first-choice for industry, students and faculty.

“Their gift will help Mines produce more technical and business leaders for industry and government than any other mining engineering program, including PhD graduates to fill faculty positions in other schools’ mining programs,” he said. “We want to produce the next generations of future-looking leaders like Steve Whisler.”

Alumni-owned New Terrain Brewing Company hosted a happy hour and ski wax event in February 2023, and alumni could check out the custom Mines skis and snowboard designed by Meier Skis. ▲



FeedBack Earth takes discarded material from food manufacturers, such as discarded hamburger buns that don't make it to a restaurant, and turns it into a high-quality, nutritious animal feed.

Photos courtesy of Eric DePinto

FROM FOOD WASTE TO ANIMAL FEED

Manufacturer FeedBack Earth is creating high-quality livestock feed from discarded food with an emphasis on sustainability and value

BY ASHLEY SPURGEON

Food production is the largest source of global waste, often ending up in landfills and incinerators. Concurrently, animal feed production is the world's most resource-intensive industry, taking up billions of acres of land. But manufacturer FeedBack Earth is working to mitigate both of these problems by turning food waste into high-quality animal feed.

FeedBack Earth—a manufacturer based in Massachusetts—takes unwanted, discarded food product and safely converts it into a high-quality, nutritional feed that farmers and mills in the New England-area can use to feed their livestock.

And at every point in the process, FeedBack Earth is using sustainable practices, from transforming the economics and environmental footprint of the industry to ensuring their operation is mindful of their impact on local communities.

We talked to Eric DePinto '13, director of operations and engineering at FeedBack Earth, to learn more about how the company is shaking up the traditional animal feed supply chain with sustainability and value in mind.

WHAT MAKES FEEDBACK EARTH UNIQUE IN THE MANUFACTURING INDUSTRY, SPECIFICALLY WHEN IT COMES TO PRODUCING HIGH-QUALITY ANIMAL FEED?

Eric DePinto: We're not the first company to do something like this, but our technology is a bit more unique. The waste industry is historically non-technological, and it's rooted in established traditions. We felt like we could take a technology that was underdeveloped and underutilized and layer on best practices in operations, manufacturing and technical ability from all our collective backgrounds and really make something that was way more efficient than anybody's ever seen. Higher volumes than anybody's ever seen. Create a better product than anybody's ever seen. And we felt that could be scaled into not just siloed little companies but this big corporation that can expand nationally and globally to build something that has a great impact.

CONNECTIONS

- ▶ February's Lunch Bunch event provided alumni with updates and insights into Mines' spring sports: men's basketball, men's and women's swimming, and baseball. ▲

WHAT HAS BEEN THE CUSTOMER AND INDUSTRY RESPONSE TO YOUR PRODUCT AND PROCESS?

DePinto: We have customers on both ends. The customers on the final animal-feed product end love it. They love the consistency in both appearance and nutrition. Competitors in the region that apply a similar technology tend to have less control over nutrition and how the final product looks. We've been able to develop something that's nutritionally consistent and visually consistent, which has a lot of appeal for the farmers and mills that feed it or blend it for their animals.

On the other end of the customer side, we have the food manufacturing facilities that generate waste product. A lot of them never had the option of bringing it to a facility that sustainably reuses it. They were often giving it away for free to farmers out the back door or sending it to a landfill.

We really pride ourselves in offering a one-stop shop to handle all food waste from the facility and being able to bring that into our facility and create an end-product that has a ton of appeal to customers on both sides.

HOW DOES YOUR PROCESS DIFFER FROM CONVENTIONAL METHODS OF CREATING ANIMAL FEED?

DePinto: A lot of places don't actually cook the material. They will take it in—and they have a very narrow range of what they can take in—and then they will de-package it, grind it up and feed it directly to the animal. Our process is unique in that we can take in a much wider array of materials. We have the ability to handle select types of meat as well because we pasteurize the material and then we dehydrate it. That gives it a longer shelf life, and that gives us a broader spectrum of what we can take in, and we can have the biggest impact.

HOW DO YOU ENSURE YOU'RE REMAINING COMPETITIVE WITH CONVENTIONAL METHODS WHILE PRODUCING A HIGH-QUALITY PRODUCT?

DePinto: No business is going to be successful if the bottom line doesn't work, right? We try to have tight control over the cost of goods that we have to put into the product, whether that's labor, energy, cost of material acquisition, trucking. There's a ton of components that go into getting and processing the material. And then like a lot of manufacturing, we are subject to a commodities market. We're always trying to be efficient with what we have to put into the product to get the same product out.

➔ Learn more about FeedBack Earth at feedback.earth.

FeedBack Earth's end product is a material that is nutritionally consistent and can be blended with other feed or fed directly to animals.



HOW FEEDBACK EARTH'S PROCESS WORKS

- 1** FeedBack Earth supplies enclosed dumpsters and trailers to some of the largest manufacturers of products such as frozen breaded fish and fast-food hamburger buns. These manufacturers have a 10–20-ton-per-day waste stream that gets collected and brought back to the FeedBack Earth facility.
- 2** That food waste is processed through a de-packaging machine, sent through a massive shredder and gets roughly sorted by nutritional “likeness.”
- 3** The material is then homogenized further to reach a desired nutrition level before it's sent into a fluidized bed dryer that cooks and dehydrates the product from about a 40 percent moisture level to around a 10 percent finished moisture level.
- 4** The product is ground into a fine grain-like feed and is screened out for any remaining trash and passed through a magnet to remove any metal.
- 5** The resulting product is packaged and loaded into trucks that take 20 to 30 tons of feed at a time to a farm or mill in New England.

▶ Alumni donned their Mines gear and brought their families out to the last home men's and women's basketball games of the season. They also collected donations for Blaster's Basket Food Pantry to help students in need across campus. ▲



STUDYING THE UNIVERSE'S HIGHEST ENERGY PARTICLES

Mines astroparticle team prepares a 3000-pound NASA balloon payload to launch this spring

BY JASMINE LEONAS

A specialized 3,000-pound payload that was integrated and tested at Mines is scheduled for launch in Spring 2023 from Wanaka, New Zealand on a NASA balloon to study the highest energy particles in the universe.

The Mines astroparticle team is central to the mission, with Lawrence Wiencke, professor of physics, serving as international deputy primary investigator and project manager for the Extreme Universe Space Observatory on a Super Pressure Balloon II (EUSO-SPB2).

“The complexity and scope of this mission is a good demonstration of the breadth of research going on in the Physics Department and at Mines as a whole,” Wiencke said. “Drawing on our experience from balloon flights in 2014 and 2017, Mines’ leadership in this particular mission really puts us on the map in research from sub-orbital altitudes.”

The Mines team has worked on the project in collaboration with 30 institutions from around the world over the past five years. The goal, Wiencke said,

is to make the first measurement of high energy cosmic rays from suborbital altitude using optical techniques, something that has never been done before. Ultimately, EUSO-SPB2 is a pathfinder toward the creation of a satellite instrument that could view a huge area of atmosphere from the vantage point of space.

“We use the Earth’s atmosphere as a calorimeter to look at the highest energy particles in the universe,” said Wiencke.

The EUSO-SPB2 payload includes two one-meter diameter telescopes with wide field of view optics and specialized high-speed custom cameras systems.

“One telescope will point down to record fast streaks of UV scintillation light from high energy cosmic rays that interactions below the balloon,” Wiencke said. “We tried this in 2017, but that telescope didn’t catch any before a problem with the balloon forced an early termination. The collaboration has since developed a more sensitive 1-meter telescope with a much wider

CONNECTIONS

- ▶ The Mines Entrepreneurship Showcase was back for a second year on February 23, 2023 with a full lineup of speakers and networking opportunities. ▲

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field of view, and we figured out a way to fit two of them into the mass budget that NASA can fly on this mission.”

Mines PhD student George Filippatos is leading the operations and data analysis groups for this instrument. Mines PhD student Viktoria Kungel led the effort to bond the mirror segments for both telescopes to meet the focusing requirements and also meet strict NASA safety requirements and characterize their properties.

The other telescope will point toward the Earth’s limb, or edge, as seen from the balloon. It will record extremely short flashes of beamed Cherenkov light from cosmic rays that interact in the atmosphere above the limb, another first. Searches for optical signatures of elusive sub-atomic particles called tau neutrinos that interact in the Earth’s crust will also be performed by tilting the telescope to look below the edge of the Earth.

“Although our models indicate we will need to be rather lucky to catch neutrinos with this mission, we will break new ground by being the first to try this way

and NASA has configured a payload rotator that will slew the telescope to help us look,” Wiencke said.

A small group in the collaboration, including Mines PhD student Tobias Heigbes and master’s student Hannah Wistrand, are refining a target list of astrophysical objects and international alert streams from optical, gamma-ray and gravitational wave observatories.

The balloon’s flight should last between 50 and 100 days, orbiting the Earth at 110,000 feet. Because of the time of year, the balloon will be launched into a current of cold air that circulates the Southern Hemisphere and drift at a speed of about 100 kilometers an hour.

What the students are working on with this super pressure balloon may have larger implications for the future of space research, too, Wiencke said.

“One of the things that has gotten us really excited about this mission is that we’ll be overlapping with gravitational wave experiments, which measure things like black holes that cause ripples in space time,” he said. “We’re contributing to finding out more about the highest energy processes in the universe.”

SAVE THE DATE: FALL 2023 CAREER DAYS

SEPT. 12 & 13, 2023*

For more information, contact Associate Director of Employer Engagement Rebecca Martinez at [303-273-3205](tel:303-273-3205) or rebeccamartinez@mines.edu.

*different employers each day



COLORADO SCHOOL OF
MINES

ADAPTING TO EVERY (VIRTUAL) SCENARIO

Mines' police officers turn to augmented reality to prepare for emergency situations

BY JENN FIELDS

The Mines Police Department is always ready to protect and serve the Oredigger community, but when an alum called on them to test his new augmented reality training platform for first responders, they were ready for that, too.

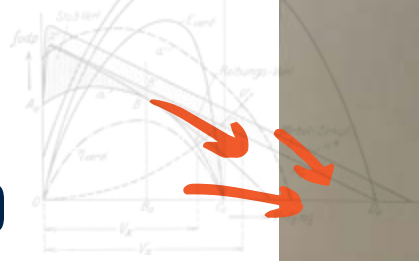
Mik Bertolli '06, MS '07, chief science officer of Avrio Analytics, reached out to Dustin Olson, Mines' Director of Public Safety and Chief of Police, with an idea: He thought the AR training Avrio had developed could be used by police officers, but he needed help testing it for this new purpose. Would the campus police department help?

Bertolli brought one of Avrio's augmented reality-enabled headsets by for Chief Olson to try. "Basically, it was a chemical spill, the scenario I was observing," Olson said. "And then Mik talked about real facilities and how he can bring that into the technology."

Wearing the headsets, Mines police officers would be able to run any training scenario happening in any building on campus—whether they are physically in that building or not. The platform has the ability to recreate any space on campus. "One of the cool things we offer on the platform is to have a tabletop of the actual building, on the actual Mines campus, and then go directly into an active shooter or de-escalation drill that's maintaining context," Bertolli said.

But with an active-shooter training session, for example, a police officer can still see through the headset to the room around them. The platform then augments it, adding in virtual people they can interact with and making real-time changes. "As the officer is talking, the character actually responds to what they're saying," Bertolli said. An instructor with a tablet monitors the officer and can ramp up or scale back the virtual characters' aggression levels, but the training proceeds automatically. "There's a lot of machine learning that happens back there," he said.

This was a marked difference in how police officers typically trained, Olson said. "What's way more common is, you have a fixed room in a police training facility and inside you'll have 180 degrees of screens, and then the participant interacts with the screen and there are scenarios," Olson said.



Mines police officers Eric Drumm and Amara Arnold test out Avrio Analytics' training platform on campus. Photos courtesy of Avrio Analytics

"There's an instructor there that runs the scenario and grades the participants."

Officers had to go to the training facility, usually at a police academy, sometimes in another city or state. "It's better than nothing, it's pretty good," Olson said of the traditional training. "But that said, we can make this way more dynamic, and we can use facilities and the environment you're most likely going to operate in."

CONNECTIONS

- ▶ Mines alumni, faculty and friends gathered at the Society for Mining, Metallurgical and Exploration's annual convention in Denver, Colorado, at the end of February 2023 to network, mingle and share stories about their time at Mines. ▲

Over the next year, as Olson and other Mines officers began testing the headsets and scenarios Bertolli and his team programmed, they honed in on their de-escalation training needs. “We’re dealing with people—that’s our job,” Olson said. He explained some of the feedback they gave that would help Bertolli create conversation with a first responder. “Let’s say someone’s dealing with a mental health crisis.” Olson said. “Mik would ask, ‘what’s that like, what’s the dialogue you might encounter as an officer?’ Or in another case, maybe someone is really agitated to see you, they’re combative, potentially they’re holding a weapon.”

In addition to creating locations and infinite scenarios through machine learning, Avrio’s headsets give performance feedback via biometric tracking, following the user’s eye, head and hand movements. They can also track heart rate, oxygen levels and galvanic skin

response—in short, whether you’re sweating. Collecting this data lets an instructor and the platform itself give users specific, fine-tuned feedback. “We’re able to tell them things like, ‘you never looked at their hands,’ or ‘you only had your eyes on the subject for 10 seconds, so were you distracted?’” Bertolli said. He added that this data lets them calculate the user’s cognitive load—how stressed someone was during the training. “We’re able to get to nearly 90 percent accuracy on how mentally fatigued you are,” he said.

Before developing this AR platform, Bertolli and his colleagues had been using machine learning to analyze training data for the federal government. But when he started exploring the vast amounts of personalized data that the sensors on augmented reality headsets could collect, he said that as a scientist, he saw a lot of potential for improving training for first responders.

Now, Avrio’s training platform is being used by campus public safety departments at other universities and by metropolitan police departments around the country. For police, they offer three core types of training scenarios: active shooter, de-escalation and tabletop, which lets officers across departments and municipal authorities train for an event that requires high-level planning. With the latter, Bertolli said he hopes the remote capabilities of their platform will make it easy for a chief of police, a fire chief and a mayor, for example, to conduct a training for an emergency event without even leaving their offices.

“Not only are we super happy that Chief Olson and his officers could help us with it, but as an alum, I’m extremely happy to see them adopting it and using it,” Bertolli said. “Our hope as a company is that training will happen more often, and I wanted it to be better, and to do that, it has to be accessible.”

VOLUNTEERS ENRICH MINES

The Mines community and student experience greatly benefit from having alumni who volunteer their time, talent and treasure to and through Mines. Thank you to everyone who has volunteered already – your contributions have been integral to Mines’ success.

Volunteer opportunities range from participating in virtual career panels to being a guest lecturer for a class to supporting campus traditions such as the M Climb, Oredigger Camp, Capstone Design Showcase and many more ways.

Have fun, connect with your Oredigger community, make a difference and become one helluva volunteer.

weare.mines.edu/volunteer



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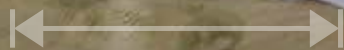


CONSTRUCTING THE FUTURE OF URBAN LIFE

BY JEN A. MILLER

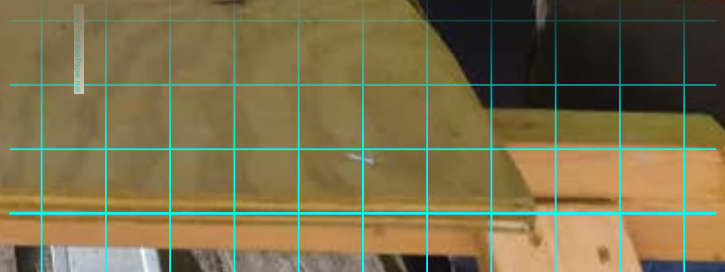
With the U.S.'s infrastructure in dire need of updating to keep up with a rapidly changing world, Mines engineers are providing the skills and expertise to find and build the right solutions

Engineers have long played an important role in designing the structures and systems that make our lives go. They enable things like providing clean water, energy, information and more, particularly in increasingly dense urban areas. These systems often require complex and elaborate infrastructure installations but often become outdated or can't keep up with today's societal demands.



Professor of Practice Karen Gupta and students Mimi Clot De Broissia, Herbert Hafenrichter, Sarah Gifford and Dayanira Gallegos review blueprints at the Beck Venture Center construction site on the Mines campus.

Photo by Cyrus McCrimmon



These problems are now widespread. According to the American Society of Civil Engineers, a water main breaks every two minutes in the U.S., and an estimated 6 billion gallons of treated water are lost every day. Nearly half of the country's public roadways are in poor or mediocre condition, and the nation has 10,000 miles of levees whose location and exact condition are unknown. Add to this climate-related pressures, like lower snowfall rates that affect drinking water and hydropower, increased demand for electric vehicle chargers at work and at home, hotter and longer forest fires in some pockets of the country and stronger and more frequent storms in others, and our infrastructure is strained beyond its limits.

Mines engineers are working to address our country's infrastructure problems and set the nation on a path to a more sustainable and resilient future. As state, local and federal governments grapple with how to maintain and upgrade these critical pieces of infrastructure to prepare for a future in a rapidly changing world, Mines engineers are stepping up to the plate.

"We recognize that the way we interact with the resources around us needs to become more intentional, and the way you become more intentional is by creating a plan and executing a plan and following and tracking whether or not that plan is being executed," said Adam Phipps '08, executive director of the Department of Transportation and Infrastructure for the City and County of Denver. "We need engineering, and our involvement, to align with the resources available to us."

FACING PHYSICAL INFRASTRUCTURE CHALLENGES WITH PUBLIC AND PRIVATE FUNDING

The Bipartisan Infrastructure Law, enacted in 2021, is historic in how it will help engineers re-envision how America lives in significant ways, said Phipps.

First is its sheer size and scope: \$1 trillion to support transportation, climate, energy and environmental projects and the expansion of broadband. "We haven't seen this substantial of an investment in infrastructure in our lifetimes," he said.

Second is that, instead of the federal government giving all of that \$1 trillion to states to decide what to do, 45 percent of the funding is being given out via grants directly to cities and counties. The investments are hyperlocal and enable local governments to fund projects that will make the most local impact.

"How we as a society most influence change and increase the quality of life is to invest at the lowest level

possible," Phipps said. "We have the ability to respond to the needs of our people and our communities."

It's especially needed in Colorado, which received a C- average on the American Society of Civil Engineers 2021 report card. The group found that the state had aggressively adopted renewables, made strides in transit and maintained roads at an above-rate average compared to other states. But Colorado also had not raised gas or diesel taxes in 30 years. Despite an added two cent per-gallon increase slated for July 1, 2023, three decades of resting at the same rate has forced Colorado to do more—for more—with less. In 1991, the last time gas and diesel taxes were previously raised, Colorado had 3.4 million residents. That's now up to 5.8 million, according to the U.S. Census Bureau.

An influx of federal money, distributed where local governments see best suited, will help address these infrastructure gaps and needs, said Phipps.

Mines engineers are also working in the private sector to meet increased infrastructure demands by redeveloping existing structures and building new ones to ensure that new systems and structures are built and designed to be as sustainable as possible. That's especially key in the West, where water is and will continue to be a challenge, said Randall Phelps '96, senior vice president and principal of Kimley-Horn.

"We have finite resources when it comes to runoff from snowmelt, so the availability of water is an everyday conversation here," he said. That's because managing water affects the design of just about everything, including roadways, sewer networks, stormwater management systems, water loops, parking structures, pavement grading in parking lots and landscape architecture.

The company also works on what Mikaela Moore '18, project engineer at Kimley-Horn, called "dry utilities"—things like electrical capacity, EV chargers at businesses and homes and meeting demand for at-home internet that has increased since the COVID-19 pandemic. "It's a big challenge across most of our projects," she said.

When building a new development, even if it's outside of the urban core, engineers often still deal with outdated infrastructure, like "very old sewer or water lines that we're trying to maintain or tap into," said Willie Konishi '19, a civil analyst at Kimley-Horn. "It's a challenge to work around those existing gaps in our infrastructure and then a lot of times having to update that infrastructure."

Engineers in this space are thinking about how to improve infrastructure constantly, said Moore. "How

Professor of Practice Karen Gupta, right, explains construction engineering techniques to Mines students Herbert Hafenrichter, Dayanira Gallegos, Mimi Clot De Broissia and Sarah Gifford at the Beck Venture Center construction site on the Mines campus.

Photo by Cyrus McCrimmon





do you deal with stormwater? How do we make these EV chargers work? How do we make things better for pedestrians? What about bike paths? We're engineering solutions every single day," she said.

↑ THE FUTURE OF URBAN LANDSCAPES

When thinking about how to make cities greener, more resilient, more accessible and easier to navigate, engineers know they are "restricted by how much the urban landscape is already built out," said John Courtney '07, program director for the City and County of Denver. "Whether it's transportation or new building construction, it doesn't really matter in an area like Denver because there's not a lot of open land to go build a new road or a new recreation center or police station."

One of his key projects right now is at the Colorado Convention Center: an expansion that will add

80,000 square feet of meeting and ballroom space, 35,000 square feet of pre-function space and a 20,000-square-foot outdoor terrace. Instead of trying to expand outward into space Denver doesn't have to spare, it's going up: the addition is being built on top of the existing convention center.

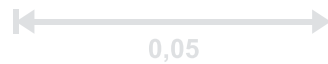
Planners and engineers are "repurposing existing infrastructure and either retrofitting it or doing larger demolition projects to make way for new construction projects," he said. Engineers are creative in that they figure out how to make older buildings more energy efficient while also handling unforeseen challenges like existing infrastructure that weren't on any blueprints.

Cities are going to be affected by what's beyond their limits, he added, as is the infrastructure that supports them. "As the climate changes, that means that infrastructure we relied on, like dams and hydropower, maybe we can't rely on them in the same way anymore,"



This image shows the construction site of the Beck Venture Center, one of the newest buildings on the Mines campus.

Photo by Nathan Bryce



to help the school figure out the best kind of degree to offer and the curriculum.

Not only will students working toward this degree get the foundation of how to be a construction engineer and practice tackling real problems, but they will also be challenged to push the industry to think more sustainably than it is right now.

“There are not enough analytical people who are out there asking how we can do this in a better way,” said Karen Gupta, professor of practice for the Construction Engineering program. “Everybody sees sustainability as being different and being expensive. It doesn’t have to be expensive, and it doesn’t have to be different. That’s part of the core that Mines teaches, and that’s what we’re going to teach, too.”

Both Moore and Konishi guest lecture at Mines and see the school as poised to train construction engineers to meet these infrastructure challenges.

“We focus most of our lectures and presentations on the broader picture of what does development work do and what does consulting work do and what does the word infrastructure mean?” said Moore.

“And students ask the best questions,” Konishi added. “We go into this class every semester and always have students asking tough questions, like ‘how do you tie green infrastructure into your projects,’ and ‘how do you deal with municipalities that aren’t willing to accept different things?’”

Munakata Marr sees the construction degree working for Mines students specifically because it will do what Konishi says: “build on the strength of our civil engineering program” she said, and take the same kind of real-world, problem-solving approach to teaching the specifics of working in the construction world. That way, another generation of Mines students will be leading the way into a newer, greener, infrastructure-resilient world, wherever that kind of expertise is needed.



➔ To learn more about the new Bachelor of Science in Construction Engineering, contact Junko Munakata Marr at jmmarr@mines.edu.

he said. As concerning as that is, he added that engineers are being prompted to “establish new means of infrastructure” to figure out how to manage those resources as they change and find new solutions.

PREPARING THE NEXT GENERATION OF ENGINEERS

To meet the needs of both public entities and private businesses to rebuild and improve the country’s existing infrastructure, Mines is launching a new Bachelor of Science in Construction Engineering in Fall 2023. It grew organically from both students showing an interest in the field and alumni working in the construction industry making a compelling case that such a degree is needed, said Junko Munakata Marr, professor and head of the Civil and Environmental Engineering Department at Mines.

“A lot of our alumni from civil engineering are working construction and suggested that Mines add this degree,” she said, adding that these alumni have also stepped up



AN EYE FOR THE ENVIRONMENT

Jeff Gillow PhD '06 uses his love for the natural world to find solutions to protect our environmental future

BY ERIC BUTTERMAN

Witnessing sea life in the Caribbean. Shipwrecks in the Eastern United States. A love of scuba diving as a teenager grew Jeff Gillow's PhD '06 interest in the environment. While he once thought that interest would take him into a career as a marine scientist, he saw greater opportunity and a chance to enhance the environment in a different way as a geochemist. It has taken him from being a part of nuclear clean-up to having a positive effect on water as it relates to mining.

Gillow is a technical expert and vice president at consultancy Arcadis, focusing on geochemistry for manufacturing companies, industrial companies and many mining companies.

"Metals and radionuclides are my specialty," he said. "One focus is on dealing with metals in groundwater systems. Instead of pumping water out of the ground and using a treatment system to remove chromium,

I've worked on immobilizing chromium in the ground. When you pump water out, you wind up wasting it and pulling much more water out of the system altogether. My overall job is to work on improving the mining process for the environment and work on cleaning environmental missteps of the past."

Mining, Gillow believes, has a vital role to play in the energy transition. "As we transition from oil, gas and coal to other technologies, like battery technology, electric vehicle technology, wind and solar, they all require metals," he said. "Mining materials will be critical, including copper, for expanding electricity networks and distribution networks. Other examples are nickel and cobalt, important for battery technology. Mining is going to be critical going forward but it must be done in a sustainable manner. To do this, you need attention to detail and an intelligent management of waste."

CONNECTIONS

- ▶ Mines alumni gathered on campus and in their local cities in April for E-Days 'Round the World, reminiscing on Oredigger stories and traditions and celebrating being a part of the Mines community. ▲

Before Arcadis, Gillow was an associate chemist at the U.S. Department of Energy at the Brookhaven National Laboratory from 1989 to 2006. He was a scientist on the Waste Isolation Pilot Plant project, the Natural and Accelerated Bioremediation Research initiative and the Department of Energy's Environmental Management Science program.

"Leading some of the effort even on some of the studies, that was an important time in my career, learning about applied research and solving problems of nuclear waste, nuclear waste management and interaction of nuclear waste with the environment," Gillow said.

Gillow is proud that his work meshes his passions for the environment and problem-solving. "There is so much challenge, and that was part of the attraction

to keep going down this career path," he said. "You have to be patient when coming up with solutions

in this work, but you also know it's more than just finishing a goal but making the environment better. I've had the chance to work with so many smart people, and we all feel like we're working towards something important."

Being based in Colorado has had Gillow trade in scuba diving for hiking, but that's fine with him, just enjoying reminders of the beauty of our natural environment. "I love that I have a job where I can help protect our environmental future," he said.

"The questions it brings up are a lifetime pursuit. And then those that come after us will ask questions and pursue answers. You're really a part of something in that way."

"YOU HAVE TO BE PATIENT WHEN COMING UP WITH SOLUTIONS IN THIS WORK, BUT YOU ALSO KNOW IT'S MORE THAN JUST FINISHING A GOAL BUT MAKING THE ENVIRONMENT BETTER. I'VE HAD THE CHANCE TO WORK WITH SO MANY SMART PEOPLE, AND WE ALL FEEL LIKE WE'RE WORKING TOWARDS SOMETHING IMPORTANT."

SHERIDAN ROSS PC

ATTORNEYS AT DIFFERENT PERSPECTIVES



Patent



Trademark



Commercial
Litigation



IP Litigation



Dan Krygowski MS '75, PhD '78 volunteered as a judge at a recent Capstone Design Showcase, pictured here listening to a student group describe their project.

RETURN TO CAMPUS

Alumni involvement at Mines has benefits for the entire Oredigger community

For many college graduates, their alma mater is a point of pride. It's where they earned a degree or two (or three). It's where they started their professional lives. It's where they made some of their best friends and started their network.

However, after completing their degree, many graduates may only return to their alma mater for events such as Homecoming and their class reunions. But at Mines, there are so many other opportunities for alumni to return to campus and engage with the Oredigger community long after graduation—with benefits for both the university and alumni.

“Having alumni on campus is really the ultimate win-win proposition,” said Andrew Flynn '86, ME '98, director of alumni engagement at Mines. “For students, alumni coming back to campus demonstrates a desire to be part of the school and share their professional experience. For alumni, there is a great sense of pride being asked to come back

to campus. Being around Mines students reminds you the quality of education is still at the highest level and to contribute to our students' success is personally rewarding.”

“Mines alumni provide a connection to industry and innovation that helps our students see beyond their degree to opportunities that at one time may have seemed unrealistic,” Flynn said. “Alumni participation in special interest groups has connected Mines to the aerospace industry, helped promote and support women in STEM and developed a new set of entrepreneurs. Alumni investing their time and sharing their passion for problem solving instills an atmosphere of excellence across campus in all departments and programs.”

WE ASKED SOME ALUMNI WHO REGULARLY VOLUNTEER ON CAMPUS FOR THEIR PERSPECTIVES. HERE'S WHAT THEY HAD TO SAY ABOUT THEIR EXPERIENCES AND MOTIVATIONS FOR GIVING BACK TO MINES.



CONNECTIONS

- ▶ The second annual Forces of Mines: Elevating Women summit was held on campus in March 2023, featuring speakers, networking opportunities, breakout sessions and more. ▲

“My father, Jim Molden '60, motivated me to stay in touch with Mines and give back. We started one of the first M Clubs as a way of keeping alumni engaged and connected in Bellingham, Washington. Currently, I am interested in volunteering my time because our son is attending Mines, and I want to help make his experience as good as it was when my father and I attended, to continue the reputation of Mines. I value the capabilities of Mines graduates, and I am interested in hiring more Mines graduates for the clean energy consulting work I do.”

–Sabine (Molden) Brueske '94

“During my industry career, I participated in campus recruiting at Mines and other schools. This was always a very positive experience, discussing courses and outlook with the students. Direct student interaction reviewing Capstone Design projects is a similar opportunity to understand current student goals and objectives, new technology applications and to provide some feedback regarding my experiences.”

–Dennis Fagerstone '71

“Judging the Capstone projects is a great way to learn about cutting-edge technology the students are learning—their projects are amazing, and the students' enthusiasm is infectious. And mentoring in the Innov8x class is an exciting way to share my experience and at the same time be with students as they come together as teams and solve complex problems in new and innovative ways. I'm really impressed by the excitement and energy that there is on campus and how many student activities there are. When I attended, it felt like it was pretty much just classes, studying and exams with a little bit of sports—you had to go somewhere else for any special interest and social activities. Now, there are so many activities, organizations and support groups available on campus. I'm really energized to volunteer and be part of the present and future of Mines and these amazing students.”

–Gary Hoffman '70

➔ Interested in getting involved on campus? Learn more about all the ways you can engage with students, share your expertise and volunteer your time at volunteer.mines.edu.



FIVE ALUMNI JOIN THE MINES ALUMNI BOARD

The Mines Alumni Board supports activities that connect Mines alumni to the school, students and the broader Oredigger community through service, support and participation. Board members help create and nurture a culture that promotes the university's rich tradition of excellence by fostering and strengthening connections and service among Mines alumni within the Mines community.



**ADAM BRADY MS '12,
PHD '21**



JEFFREY EPSTEIN '87



AMRO FARRAG '12



**ANDREA WESCOTT
PASSMAN '98**



DAN PORPORA '06

▶ Mines alumni attended the March Lunch Bunch event, which featured discussion about the Capstone Design Showcase. ◀



A PIPELINE FROM CHEMICAL ENGINEERING TO BANKING

Working at the forefront of introducing new engineering processes to mobile deposits, Melanie Gipe '81 has had to think outside the box

BY ASHLEY PICCONE

When Melanie Gipe '81 graduated from Mines, she had no idea that her career would mimic the twists and turns of the pipelines she studied as a chemical engineer, especially as it eventually, and unexpectedly, flowed into banking.

Gipe started out in a traditional engineering role at Gulf Oil, after which she transitioned into more strategic and analytical product management positions at Chevron Chemical. She was involved in introducing company-wide tools that were used for decades and led projects that impacted the entire organization. But when she wanted a job closer to her home and young son, she began consulting as a product manager for all kinds of companies, even those beyond oil and gas. One of those was Wells Fargo, where interesting projects and processes incentivized her to stay.

"I fell into banking," she said. "I really didn't plan it. I didn't wake up one morning and say, 'I should get into banking.'"

Despite the unanticipated change in career paths, Gipe found that her skills translated well as she became a product manager and helped create now everyday conveniences, such as mobile check deposits, card-free ATM access, new banking accounts and instant cash transfer. Like oil and gas, she found banking to simply be another process flow: as a card is inserted in an ATM, it triggers a stream of data instead of fluid.

CONNECTIONS

- ▶ Mines leadership hosted a webinar in early April 2023 to give updates about Mines' successes in the 2022-23 school year and what's ahead for the university's 150th anniversary in 2024. ▲

“I was learning a bunch of things that I didn’t know and using all of the information and all of the logic and processing skills that I learned from engineering,” she said.

But when she first started in banking, mobile deposit was just a pipedream. Gipe helped bring it to reality by carefully balancing the risk to the bank and the customer experience with a safe but easy-to-use platform.

“Mobile deposit was one of those tricky projects,” she said. “It was all about being able to understand multiple systems, how to work with a large cross functional team and how to think about the problems that we had in a really logical fashion.”

Gipe was also involved in the early design and discussions of Zelle, an app that allows easy money transfer. Originally a service limited to a handful of banks, Gipe helped extend the capabilities of the app to make it ubiquitous.

“I WAS LEARNING A BUNCH OF THINGS THAT I DIDN’T KNOW AND USING ALL OF THE INFORMATION AND ALL OF THE LOGIC AND PROCESSING SKILLS THAT I LEARNED FROM ENGINEERING.”

“A lot of the projects that I did at Wells Fargo were leading-edge capabilities for banking. It’s cool to have been at the forefront of all of that,” she said. “It doesn’t sound earth-shattering now, but we didn’t always think we could just take pictures of checks.”

These challenges drove Gipe to stay in banking, where she enjoyed tackling hard problems by asking questions and listening to every voice at the table. She recently retired from Wells Fargo after 15 years with

the company, and she encourages others to explore similar, untraditional paths.

“Your education doesn’t define your career for a lifetime. Engineering taught me to think, and that was fundamental to every role I took on,” said Gipe. “But I love to learn and try new things, and I think that was because of engineering. So, don’t be afraid to explore.”

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PUTTING OTHERS FIRST

Josh Dickerson '12 shares what it takes to build welcoming, impactful workplaces and support future engineers

BY ASHLEY SPURGEON

Becoming a successful engineer often doesn't come without a lot of encouragement and support, whether that's from family and friends, colleagues, professional groups and societies, or a combination of sources. For Josh Dickerson '12, a senior project engineer at civil and structural consulting engineering firm Martin/Martin, that external support was instrumental in helping him find a path into engineering and ultimately thrive in his career.


Dickerson was first introduced to engineering through outreach programs and summer camps a teacher enrolled him in as a child—including one at Mines. He not only learned basic engineering concepts but was introduced to real-life engineers who volunteered their time to teach kids about the profession. He got to see the impact of engineers' work and the stability of their careers, and he was inspired and encouraged to pursue that for himself.

Since earning his environmental engineering degree from Mines, Dickerson has been involved in several high-profile projects in Denver, including being a project engineer on the City Park Golf Course's redesign and working on the hydrologic modeling for the 16th Street Mall redesign in downtown Denver. In recognition for his technical work and community leadership, he was named the 2022 Young Professional of the Year by the American Council of Engineering Companies of Colorado.



CONNECTIONS

- ▶ Arjumand Alvi '16 was the 2023 Women's History Month speaker, where she spoke about her passion for space exploration, STEAM education and outreach and her experience as a finalist in the 2022 Miss International pageant. ▲



We recently sat down with Dickerson to gain some of his insights into how to be an effective leader, building inclusive communities in the workplace and the importance of supporting the next generation of engineers. Here are some of our takeaways.

COMMUNICATION IS KEY TO LEADING PROJECTS—ESPECIALLY THOSE THAT INVOLVE MANY DIFFERENT STAKEHOLDERS.

For Dickerson, being a good leader means being able to clearly communicate ideas and needs, something he’s experienced when working on complex projects with many different moving parts.

“Engineering projects are completed by people from many different backgrounds with different goals and ways of thinking. Between clients, contractors, engineers and architects, it’s easy to miscommunicate, which often leads to mistakes and broken trust,” he said. “I’ve found the best approach is to try and be patient, overcommunicate and believe the best in others. This means if there is something wrong, try and talk to the people who are responsible and figure out why it happened and how to solve the problem rather than jumping to conclusions or blaming.”

LEADERSHIP EXTENDS BEYOND TECHNICAL EXPERIENCE AND MANAGING PEOPLE. GOOD LEADERS ALSO BUILD INCLUSIVE AND DIVERSE COMMUNITIES IN THE WORKPLACE AND MAKE PEOPLE FEEL VALUED.

While effective communication is important when collaborating on projects and working with different groups, it’s also important to carry that through to employees and create a sense of community within a company—and that includes recruiting new employees from diverse backgrounds to retaining them after being hired.

“When I was a student at Mines, there were not many consulting companies marketing directly to students from underrepresented backgrounds,” Dickerson said. “Over the last few years, we have made significant progress at our company. There are a lot of really great, talented students who haven’t thought about working in consulting engineering.

Our industry is missing out unless we are able to welcome these students into our profession.”

But other than hiring top talent, investing in talent from a broader applicant pool also signals to your existing employees that their experiences and backgrounds are valued.

“If you’re the only one of something—if you’re the only woman or you’re the only African American—you feel a lot more pressure, and it’s harder to feel comfortable enough to be yourself and give your best,” Dickerson said.

Dickerson is one of the founding members and former chair of the Justice, Equity, Diversity and Inclusion (JEDI) Committee at Martin/Martin. The committee hosts numerous diversity recruiting events, mentors high school interns from underrepresented backgrounds and has even sponsored a refugee family from Afghanistan.

In this way, companies like Martin/Martin are building a sense of connection. “We’re a part of the community, and if we make it better, it will be better for us,” Dickerson said.

DICKERSON REMEMBERS HOW ESSENTIAL MENTORSHIP WAS FOR HIM, AND HE’S DETERMINED TO PAY THAT FORWARD AND ENCOURAGE OTHERS TO PURSUE ENGINEERING OR BECOME THE BEST VERSIONS OF THEMSELVES.

Since he first started out in his career, Dickerson has made a point to give back and volunteer with organizations that help young people gain the skills and opportunities to succeed later in life—similar to how he was supported through mentorship growing up when engineering didn’t seem like an attainable path. He has been involved in mentoring programs, tutored students and volunteered on councils to make spaces like churches be more welcoming and inclusive for people from all backgrounds.

“So many people invested in me, and I know that I couldn’t have gotten here without them,” Dickerson said. “That’s kind of my mission outside of just doing good work—to invest in the next generation.”

A BRIDGE BETWEEN MINES AND THE FEDERAL GOVERNMENT

Mines' new director of federal relations is working to maximize the university's impact and influence

BY EMILIE RUSCH

Ensuring Mines is a top-of-mind and first-choice partner for federal labs, funding agencies and policymakers is a big job.

In fiscal year 2022, federal funding, including funding from national labs, accounted for more than \$85 million—more than 80 percent of total funding—to support the Mines research enterprise.

But securing research funding is just one piece of the pie when it comes to Mines' relationship with the federal government.

As Mines' first director of federal relations, Andrew Lattanner is responsible for advancing awareness of the university's world-leading research and supporting productive relationships with the U.S. government and federal agencies.

"I see my role as a bridge," Lattanner said, "connecting the Mines community and the federal government to inform policies and strategies that solve problems and to maximize the impact of our research, education and leadership."

Lattanner, who joined Mines in January 2023, brings to his new role more than a decade of experience working in the U.S. Congress. His time in Washington, D.C. included six years as legislative director and deputy chief of staff for then-U.S. Sen. Joe Donnelly of Indiana, as well as two years as chief of staff to then-Congresswoman Kathy Hochul of New York. Most recently, he served as director of the Oregon Manufacturing Innovation Center Training Center, a public-private advanced manufacturing training initiative designed to bring together post-secondary education, workforce systems and industry partnerships to deliver quality, industry-aligned manufacturing training.



Here, he answers a few questions about the new role and why Mines is primed to remain a strong partner to the federal government.

WHY DOES MINES NEED A DIRECTOR OF FEDERAL RELATIONS?

Andrew Lattanner: Mines' reputation is built on its students, alumni, faculty and research, but it's strengthened by its partnerships with industry, academia and government—and the collective impact the university has on communities across the world.

Good federal relations is about translating science and research into impact by helping policymakers solve complex problems and advocating for continued investment in Mines innovation, exploration and science.

Our federal partners increasingly view Mines as a go-to community of problem solvers. My job is to continue to support our federal relationships and to maximize the university's impact.

CONNECTIONS

- ▶ The Grand Junction M Club gathered for a reception in March 2023 to learn about Mines' space resources program from program director Angel Abbud-Madrid. ▲

WHAT DO YOU SEE AS MINES' ROLE IN LEADING THE FUTURE OF STEM RESEARCH?

Lattanner: Mines' leadership in the future of STEM research is rooted in its nearly 150-year tradition of training the world's best engineers and scientists. Today that means preparing students to respond to a rapidly changing innovation economy and the complex social, economic and environmental challenges that shape the day.

From a federal perspective, it's important that Mines research continues to align with national priorities—to lead the energy transition and address climate change, promote national security and technological competitiveness, and innovate for equity. It's also critical that Mines research continue to lead the way in emerging areas, such as new manufacturing processes, space exploration and quantum computing.

HOW DO YOU PLAN TO ADVANCE MINES' RELATIONSHIPS WITH GOVERNMENT AGENCIES AND POLICYMAKERS?

Lattanner: Relationships with the federal government can take many forms. It can be collaboration, like the soon-to-be-built U.S. Geological Survey/Mines energy and minerals research facility or joint research and educational programming with the U.S. Department of Energy's National Renewable Energy Laboratory. It can be congressional testimony on clean water or responding to a lawmaker looking for advice on how to craft a policy to maximize effective community engagement for energy projects.

Whatever form that relationship takes, it's important that our federal partners know that Mines is a community of problem solvers with a record of providing unbiased, solution-oriented expertise.

HOW CAN MINES CONTINUE TO BE A GO-TO INSTITUTION FOR SOLVING TODAY'S BIGGEST TECHNICAL AND SOCIAL CHALLENGES?

Lattanner: Ultimately, Mines will continue to be a go-to institution because of its multi-disciplinary expertise and the impact its students and faculty have on the complex science and technology challenges of the day. That impact can be strengthened by strong federal relations, and I'm excited to be a member of the Mines team to support Mines research and grow its impact.

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GOING FOR THE GOALS

For two Orediggers, teamwork has been the key to success—on the field and in the office

BY EMILY HALNON

When Nicholas Clausnitzer '07 and Michael Dixon '06 met at Mines as students in 2003, they immediately spent nearly every waking hour of the day together. It was preseason for varsity men's soccer, and they were running drills on the soccer field multiple times a day and sharing meals with their teammates between practices. All that time together meant they became fast friends.

"You bond very quickly during preseason," Dixon said. Twenty years later, they're still spending many waking hours of the day together as colleagues at Aera Energy where their desks sit side-by-side. They jointly manage the reservoir portfolio for the company, which is one of the largest oil and gas producers in California. Clausnitzer leads the efforts for light oil assets, and Dixon is responsible for the heavy oil side of the

CONNECTIONS

- ▶ Mines alumni learned about the new business, engineering and management science degrees and the expansion of Mines' online graduate programs at the Economics and Business' networking event in March 2023. ▲

business. They work to maximize efficiencies so Aera can increase oil output and meet strategic goals for production.

They've both been at Aera since they graduated from Mines, ascending through different positions within the company until they took on their current roles about three years ago. While they may be many years removed from their collegiate soccer days, they're still using the skills they honed as student-athletes to thrive in their professional careers.

"Both of us are very goal-driven," Dixon said. "And Aera allows us to keep tackling new challenges and keep growing and to do it in an environment that truly feels like a team."

But it was their first soccer season together that shaped their approach to teamwork and collaboration in their professional lives. The Orediggers won the Rocky Mountain Athletic Conference Men's Soccer Championship in 2003, which was especially impressive because that year's team was smaller than the average soccer team. Instead of the standard 25-28 players, they had 17 on the Orediggers team, which meant everyone had to contribute a bit extra and work together to succeed on the field.

"We quickly developed bonds and started acting like a team," Dixon said. "We didn't really have any players that were standout all-stars, so we had to work together to perform and overcome challenges."

"We struggled a lot with such a small team," Clausnitzer remembers. "But we still found a way to win the conference together."

Both Dixon and Clausnitzer draw from their experience as Orediggers when it comes to leading their respective teams at Aera. They prioritize collaboration, mentorship, a strong work ethic and shared goals to help their teams succeed.

"The shared vision of a soccer team translates so well to work," Dixon said. "I try to foster an environment where everyone is committed to the same goal and helping each other get there."

He points to a recent stretch at Aera where his heavy oil team was constrained by resource limitations. He was able to borrow employees from Clausnitzer's group to help his side of the portfolio stay on track.

"We understand that it's about getting the job done and doing whatever holistically benefits our company," he said. "We know that helping each other out helps Aera win."

It's not unlike when they had to play a game in freezing conditions, with shards of ice covering the grass and temperatures so cold that Clausnitzer couldn't talk because his mouth went numb.

"We called it the Ice Bowl," Dixon remembers. "But it didn't matter how cold or miserable the weather was. Everyone was fully committing themselves to the game, sliding through the ice and mud and coming off the field bruised and bloodied."

Clausnitzer scored the game-winning goal, but win or loss, that game was the kind of experience that brought their team together and highlights what they loved about being part of something bigger than themselves.

They both say that the people at Aera are what have kept them with the company for over 15 years now. And that mirrors what they loved about playing competitive soccer and being able to develop such close and reliable relationships with their teammates.

"I've always thought about our soccer team as the ideal state," Clausnitzer said. "And you may not totally be able to recreate that exact kind of a team at work, but that's the goal that I want to push towards."

Clausnitzer and Dixon have continued to function as teammates for more than two decades. They know they can count on each other, and that's been as valuable for their performance and experience at Aera as it was on the soccer field.

Dixon said, "It makes a huge difference to be able to work with someone that you can rely on and maintain such a close and lasting relationship with."



The Mines

Entrepreneurship Showcase returned this year, with Mines alumni, students, faculty and regional friends gathering for an evening of entrepreneurial presentations and networking opportunities. Attendees were able to learn more about the unique Entrepreneurship and Innovation Ecosystem at Mines and how to get involved, connect with others on ideas and boosting ventures, hear success stories from Mines alumni-founded and operated businesses and more.

1960s

Roy Glenn Vawter '60 published his book *Oil Shale: Past, Present, Future* in early 2023 detailing the history, stories, opinions and more about bringing oil shale onto the market in the western United States.

1980s

George Saunders '81 was named a finalist for the 43rd Los Angeles Times Book Prize for his short story collection *Liberation Day*.

Recently a group of friends, including three Mines graduates, went on a trek in Nepal. **Kathy Roldan '88, Vivek Chandra '88, Karen Schoonover '88** (pictured on page 40) visited Poon Hill soon

after sunrise, the highlight of the five-day trek in the Annapurna Range of Nepal. The friends have traveled together frequently since graduating from Mines and credit their adventures for making their relationship even stronger.

1990s

Don Reimer '99 was named as the sole finalist in the search for Colorado's new Chaffee County Administrator in March 2023.

2010s

Peter Charles Wolfram was born to **Edward Wolfram '15** and Cassandra Wolfram on November 28, 2022. Siblings Esther (4) and Paul (2) are overjoyed with the new arrival.

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.



Reese Hutton



Steven Rennolet '16, MS '18
and Caroline Ike '16, MS '17



Daniel Scarbrough '18 and Hannah Garland



Leah Froehle '16 and Yoel Benarroch were married on November 20, 2022 in Boston. They met in 2016 as Peace Corps volunteers in Mozambique and are now both medical students at Boston University School of Medicine. Sarah Pekarek '15, Abby Reuland '18, Frances (Cormier) Novak '16 and Corrine Din '16 were in attendance as bridesmaids along with the bride's brother-in-law Joshua Geist '13, who led the reception in the Mines fight song.

Eight years after meeting during their sophomore year at Mines, **Jake Ost '16** and **Leah Pinkus '16** were married on October 27, 2022. After overcoming several obstacles due to the COVID-19 pandemic, their intimate wedding took place at a winery in Dallas, where they currently live. Fellow Mines alumni Amanda Kirar '17 and Jordan Kirar '16 were in attendance to help celebrate the couple.

Steven Rennolet '16, MS '18 and **Caroline Ike '16, MS '17** were married on June 3, 2022 in Lyons, Colorado.

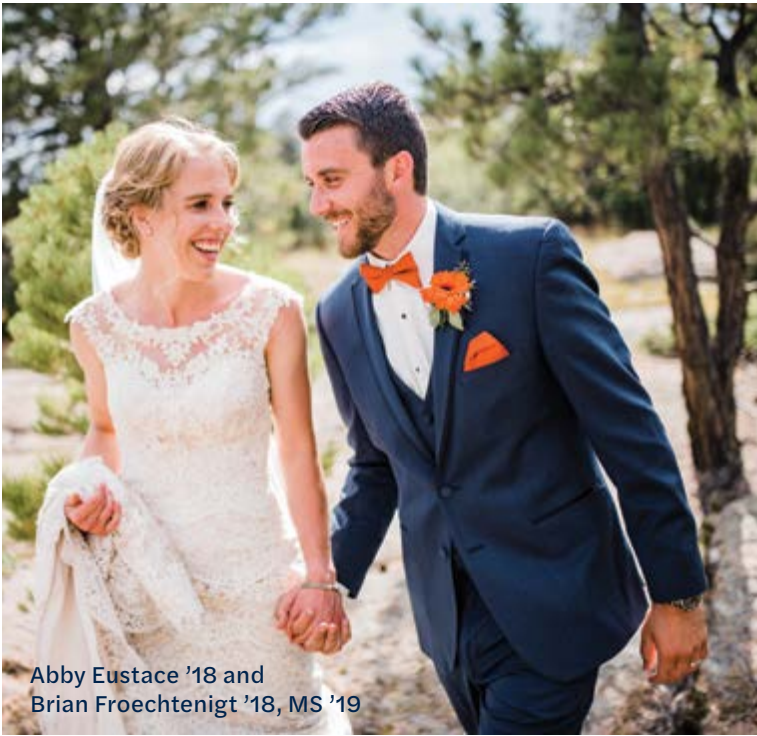
Following an adventurous proposal in Castlewood Canyon, **Abby Eustace '18** and **Brian Froechtenigt '18, MS '19** were married on a beautiful, sunny summer day on July 17, 2020, in Castle Rock, Colorado. Although the wedding ceremony took place during the height of the COVID-19 pandemic, the couple enjoyed a grand party with lots of family and friends—Mines alumni included—at Sanctuary Golf Course in Castle Rock, Colorado on July 24, 2021. The couple met in chemistry class during their first year at Mines and got to know each other while volunteering on the E-Days committee.

Gary Hutton '18, MS '19 and Morgan Hutton welcomed a baby girl to their family. Reese arrived on February 18, 2022.

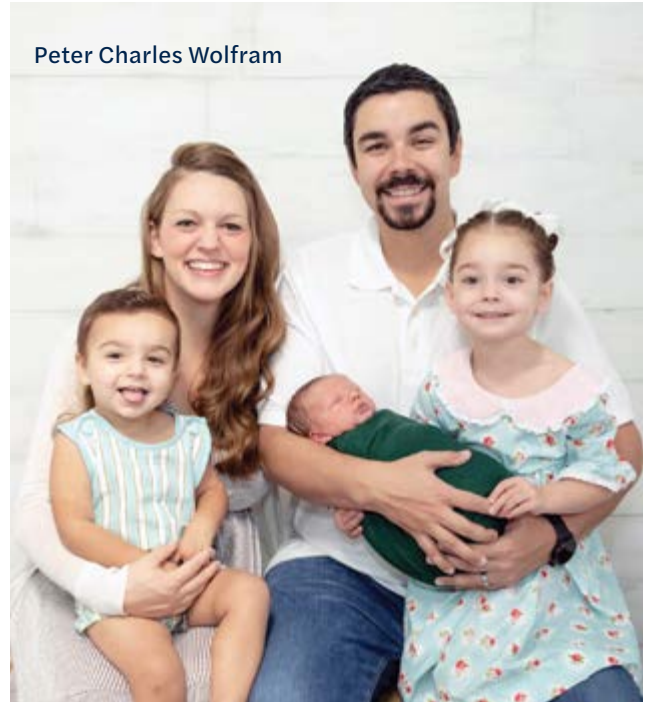
After a laser-engraved proposal visible only through a microscope, **Daniel Scarbrough '18** and Hannah Garland were married on September 2, 2022, in the mountains near Golden, Colorado. Thirty-five Mines-affiliated people attended the wedding, including alumni, current colleagues and a professor. Of these, 10 served as groomsmen and three as bridesmaids.

2020s

Following their engagement in Golden, Colorado, in May 2021, a day after graduating from Mines with their master's degrees, **Amanda Field '20, MS '21** and **Noah Ottum '20, MS '21** were married in Larkspur, Colorado, on June 12, 2022. Many Mines alumni made the trip to celebrate the couple including many of Amanda's sorority sisters and Noah's wrestling teammates. Claire Knight '20, MS '21, Emma May '20, Megan Van de Graaf '22, Ryan Fidel '21, MS '22, and Michael Field '22 were all part of the wedding party.



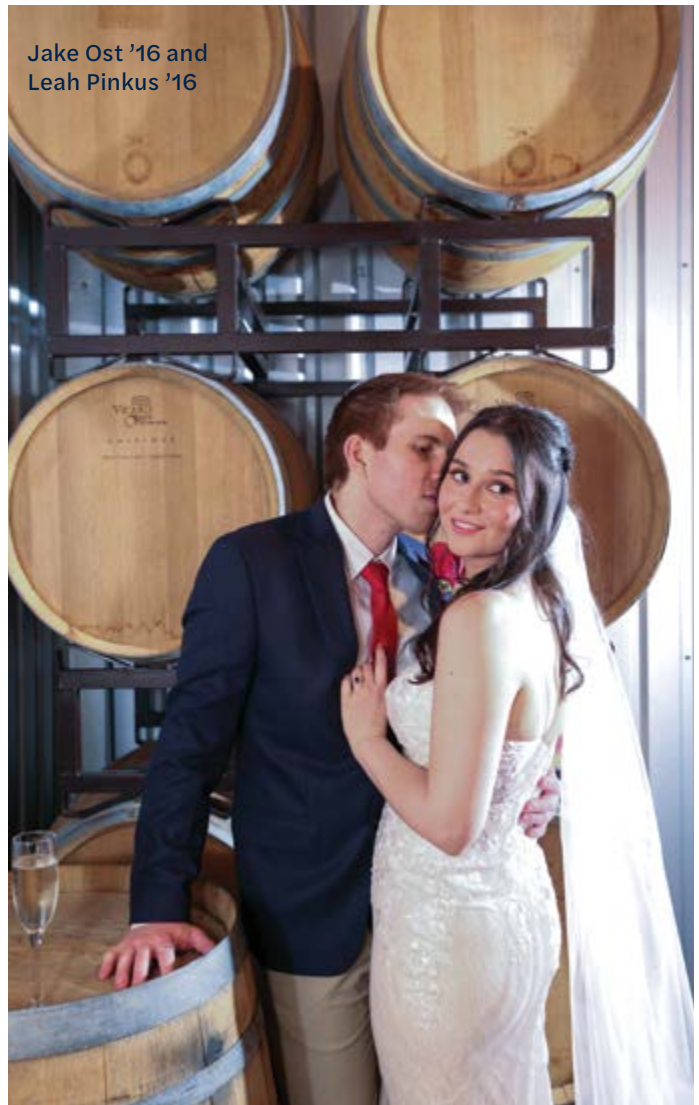
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IN MEMORIAM

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

Donald D. Bendell '54 died November 8, 2022. He was born in 1929 and started his professional career with the U.S. Air Force, serving in the Vietnam War. He spent 22 years in the Air Force before retiring as a major. He then spent another 20 years as vice president of Clementson Engineers and then worked as a consultant.

Jon M. Collis MS '03 died April 21, 2022. Born in 1976, Jon joined the Woods Hole Oceanographic Institution in Falmouth, Massachusetts, where he used his mathematics expertise to research underwater acoustics as part of his post-doctorate training. In 2008, Jon returned to Mines as a professor before becoming a researcher at MIT's Lincoln Laboratory. Over the next seven years, Jon worked on cutting-edge research collaborations related to how sound travels underwater.

Robert L. Graham '55 died October 28, 2022. He worked as a petroleum engineer for Carter Oil in St. Elmo, Illinois, and Creole Petroleum Corporation in Venezuela until 1963. He later worked as a patent attorney for International Harvester in Chicago before returning to the oil industry as a patent attorney for Phillips Petroleum Corporation, Exxon Production Research Company, Exxon Chemical Corporation and in private practice until his retirement in 2001.

Irving W. Glater '51 died August 26, 2022. Born in 1925, he joined the U.S. Army Air Corps in 1944, serving in Europe. He spent his career at various divisions of United Technologies where he was a respected authority on materials used in turbine engines. He continued his consulting career after early retirement, providing expert work in metallurgical failure analysis.

Richard E. "Rich" Jarboe '67 died January 21, 2023. Rich served as a Second Lieutenant in the U.S. Army Corps of Engineers and worked for more than 30 years in the mining and metals industry and computer

programming before retiring in 2012. In 2018, Rich and his wife, Joan, established the Jarboe Family Scholarship Fund at Mines to focus primarily on supporting women scientists and engineers at Mines.

Joseph M. Keating '61 died December 2, 2022. Joe was born in 1937 in Guangzhou, China. Joe worked as an engineer and consulted throughout his life. He was a member of the U.S. Marine Corps Reserves for many years and a member of the Knights of Columbus.

Ronald C. Lease '63 died October 9, 2022. After six years as a metallurgical engineer for Alcoa Corporation, Ron became a finance professor at the University of Utah. He also taught at the University of Chicago, University of Michigan, Tulane University, University of Arizona and Purdue University. After he retired in 2000, Ron taught part-time in a German international MBA program for seven years.

Jack Vincent Stant, III '87 died May 13, 2022. Jack began his career at the Cholla Power Plant, where he specialized in scrubber technology. In 2002, Jack moved to Laughlin, Nevada to work at Mojave Power Station, and later worked in Las Vegas, where he continued to lead projects throughout the state. He also worked at the Valmy Power Plant in Nevada.

Edwin E. "Ed" Wing '60 died January 8, 2023. Born in 1937, Ed was a member of Alpha Tau Omega fraternity and the Tau Beta Pi Honor Society at Mines. Ed worked in the petroleum and chemical industry early in his career, later leading cleanups of Superfund sites. He retired in 2002.

- ➔ 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.



ENGINEERING THE AVANT-GARDE

Mines group honored for advancing the field of music engineering and showcasing the intersection of art and science

An artistic—and metallurgical—collaboration between Mines and Denver music performance group itchy-O was recognized by the Colorado Business Council for the Arts. The Humanities, Arts and Social Sciences Department's Hennebach Program in the Humanities and the George S. Ansell Metallurgical and Materials Engineering Department were one of 12 honorees for CBCA's 2023 Business for the Arts Awards, the only statewide event honoring companies and individuals for their outstanding partnerships and engagement with the arts.

The Mines group received the Arts & Business Partnership Award in recognition of their work to design

and fabricate a custom set of instruments for itchy-O, a 50 plus-member avant-garde music performance group.

Inspired by a Balinese gamelan, the instruments featured a custom bell metal alloy created with recycled cymbals donated by the Denver music community and more than 50 individual pieces—gongs, metallophones and more. All of the pieces were cast in the Metallurgical and Materials Engineering Department's Hot Shop by Hennebach Artist in Residence and hot shop manager Sarah Harling.

"We are extremely honored to have been recognized for our collaboration with itchy-O," Harling said. "This



Members of itchy-O performed with the custom instrument created in the Mines Hot Shop for the first time on campus.



Hot Shop manager Sarah Harling works on one of more than 50 individual pieces that formed a custom instrument for Denver music performance group itchy-O.

Photo by Seth McConnell



Volunteers help tune one of the cymbals cast from a custom bell metal alloy created with recycled cymbals donated by the Denver music community.

project would not have been possible without the effort and expertise of talented artists and engineers from Mines and throughout the musical and visual arts community in Colorado and beyond. We are so grateful to have been part of the collaboration that brought this instrument into reality.”

As part of the itchy-O collaboration, Mines visual artists and writers—both students, faculty and the public—were invited to gather in the balcony overlooking the Hot Shop to craft poems inspired by the gongs being poured. The “ekphrastic” art inspired by the pours was displayed during an event on the Mines

campus, where members of itchy-O performed with the one-of-a-kind instrument for the first time.

The full 50 plus-piece band performed with the Mines-made instrument, called *SÖM SÄPTÄLAHN*, at Denver’s Fillmore Auditorium in July 2022. CBCA recognized the unique collaboration for “advancing the field of musical engineering and showcasing the intersection of the arts and science.”

“This type of cross-discipline and cross-campus and cross-genre experience for students and faculty is what makes the humanities at Mines unique,” said Seth Tucker, director of the Hennebach Program

and teaching associate professor in humanities, arts and social sciences. “Our faculty and the experts and scholars and artists we bring to campus through the Hennebach Program continually push the limits of what is possible when we collaborate without regard to the synthetic distances that have been created between scientific enterprise and artistic expression. This event pushed the boundaries of metallurgy into completely new realms in research and design and the musical and literary efforts of Sarah Harling and the band and our students and faculty were impressive and unique.”



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Mines' new construction engineering degree program launching in Fall 2023, will prepare students to enter high-demand jobs in a rapidly growing industry. Students will gain the skills and expertise needed to help solve infrastructure challenges, today and in the near future. Pictured here is the Beck Venture Center construction site, one of the newest buildings on the Mines campus. Learn more about the program and how Mines alumni are working to solve today's infrastructure challenges on page 18.

Photo by Nathan Bryce