

MINES MAGAZINE

COLORADO SCHOOL OF MINES ALUMNI MAGAZINE

Spring 2018 Volume 109 Number 2



ENGINEERING THE GAME
Chad Frieauf '05, with the support of former Broncos quarterback Jake Plummer, developed digital playbook software to help athletes learn new football plays. **14**

UNSCRIPTED INNOVATION
Mines' newest building acts as an epicenter for unlimited collaboration and groundbreaking research. **20**



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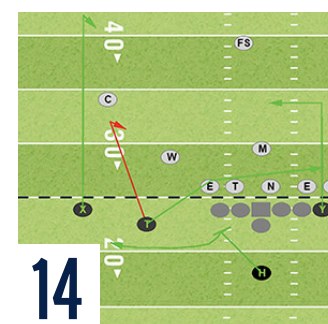
CONTENTS

Cover image: Chad Friehauf '05 and former Broncos quarterback Jake Plummer teamed up to create ReadyList Pro, a cloud-based, digital playbook program to help football players quickly learn new plays and strategies on the field. The software is now being implemented in football programs across the United States. (Photo by Joe DelNero)

DEPARTMENTS

- 5 **ALUMNI NOTE**
- 6 **INSIDE MINES**
 President's Corner | KEEN | Q&A with Stefanie Tompkins | Athletics | Putnam Math Competition | *High Grade* Meets George Saunders '81 | Grad Student Goes to UN
- 24 **LOOKING BACK**
 Hoffman Mining Murals
- 26 **ALUMNI NETWORK**
 Leadership in Social Responsibility Interest Group | On Our Wall | Orediggers Give Back | Alumni Interest Group Updates
- 28 **ALUMNA PROFILE**
 Penny Pettigrew '92
- 31 **ALUMNUS PROFILE**
 Eugene McMahan '49
- 34 **ALUMNI NEWS**
- 38 **IN MEMORIAM**
- 40 **AT YOUR SERVICE**
- 42 **MINER'S PIC**

FEATURES



ENGINEERING THE GAME

Mines alumnus' new software is changing how athletes tackle football.

14

UNSCRIPTED INNOVATION

The CoorsTek Center for Applied Science and Engineering enables groundbreaking research and unlimited collaboration at Mines.

20

WEB EXTRAS | MULTIMEDIA

TO VIEW WEB EXTRAS, VISIT MAGAZINE.MINES.EDU

LOST AT SEA-DAYS

Orediggers gather to celebrate being engineers and put their skills to the test in the yearly E-Days festivities. Watch a video about this year's celebration and reminisce on the annual tradition.

SME STUDENT CHAPTER RECOGNIZED

Mines' Society for Mining, Metallurgy and Exploration (SME) student chapter was recognized as the Mineral Education Coalition student chapter of the year at the annual SME national conference. Read more about the student group and the conference on our website.

RESTORING THE HOFFMAN MURALS

When the series of murals painted by Irwin D. Hoffman was damaged by a leaking roof in the Mines Geology Museum, Mines called on art conservator Cindy Lawrence to help restore the paintings. Check out our interview with Lawrence to learn about her process and how she was able to preserve Hoffman's work.

ALUMNI AWARDS

Each year, Mines' alumni office honors exemplary members of the Mines community with awards, including the Young Alumna/Alumnus Award, Outstanding Alumna/Alumnus Award, Melville F. Coolbaugh Award and Alumna/Alumnus of the Future Award. Read about the most recent recipients on our website.

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Editorial Board

Stuart Bennett '66, Damian Friend '75,
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Contributing Writers

Tim Flynn, Teresa Meek, Katharyn
Peterman, Kellie Spoerl, Emilie Rusch,
Christina Vessa, Anica Wong

Advertising Contact

Ashley Spurgeon
aspurgeon@mines.edu
303-273-3959

Graphic Design

Christina Vessa

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Comments and suggestions are welcome. Contact us via our contact form at minesmagazine.com/contact-us or via mail at Mines Magazine, 1500 Illinois St., Golden, CO 80401. To update your address, go to minesalumni.com/update or email minesalumni@mines.edu.

ALUMNI NOTE

Ray Priestley '79 is leading the Leadership in Social Responsibility Interest Group, encouraging Mines alumni and students to be conscious of how engineering projects impact people and communities and how to be leaders in their fields.

Photo by Deirdre O. Keating



EXERCISING YOUR LEADERSHIP

To complement the story about the Leadership in Social Responsibility Interest Group on page 26, I was asked to share my thoughts on how my Mines experience helped me become a successful leader. By no means am I a pundit on leadership, so after accepting the request, I found myself wondering how best to sound somewhat profound.

My solution was to change the topic to how each of us can be better leaders and help our alma mater achieve our common goals of continuing to train the world's best engineers, support alumni and secure the long-term vibrancy of Mines.

Engineers have the ability to dramatically impact projects, influence outcomes and provide inspiration. That is why it has been a long-held belief by many that we have a social responsibility in the work we do. Let's not forget either that these are often the reasons why we are passionate about our work.

Each of us realized early in our education that both self and group leadership skills are important to finding success in our careers. Leadership is a practical skill, and hard work and critical observation can nurture the development of this skill. They are traits Orediggers have always been known for.

The point here is that there is a great pool of Mines alumni to draw upon in helping develop these skills in our current students and throughout the alumni network. This was, in part, why the various interest groups were created. Alumni have the opportunity to support Mines through sharing our skills and knowledge, while further building on that foundation. Be it Social Responsibility, Entrepreneurship, Aerospace, Women in Engineering or STEAM, each of the new interest groups needs individuals interested in exercising and developing leadership and helping enable others to better lead or guide teams and organizations in the future.

Orediggers understand the importance of teamwork and the value of being conscientious about human impact. No matter how smart and knowledgeable we individually may be, the group makes us better.

As Dwight D. Eisenhower said, "The supreme quality of leadership is unquestionably integrity." I agree and am proud that our graduates stand out and that our shared integrity has led to our success.

So pick your opportunity, get involved and exercise your individual leadership. You will feel your passion grow.

Ray Priestley '79

Mines Alumni Association Board President

PRESIDENT'S CORNER

LOOKING TO THE FUTURE: MINES@150

What did you do for spring break this year?

Whether you're a student or the president of Mines, more sleep, less email and getting away for a few days are always ideal spring break ingredients. Elyse and I flew out to Sacramento to visit our daughter Kaitlin, who is finishing up her doctoral program in chemical engineering at UC Davis. We also drove up the northern California coastline to The Sea Ranch, where there are about 50 miles of running trails and an aquatic center for me, and whale watching, bird watching and hiking opportunities for Elyse. Then we headed back to Mines for what's shaping up to be an exciting and packed last month of the semester.

How do you see Mines evolving over the next 10 years to continue its legacy of leadership in industry and the world?

This is what our new MINES@150 strategic plan is all about. Above all, we have to stay focused on producing distinctive and highly desired graduates and provide the innovations and knowledge industry and society need for the future. To do that, we will continue to emphasize close partnerships with industry, national labs and mission-oriented government agencies, take a critical look at how we prepare our graduates and work to be attractive and accessible to top students and faculty from all backgrounds.

Future graduates will still be known for their grit, technical knowledge, ability to get things done and teamwork. But to be future leaders, they will also need greater digital and data literacy, increased business acumen and a broader contextual understanding of their responsibility to and impact on society. If we can accomplish this, we will move from being a hidden gem in higher education to being universally recognized as one of the best universities in the world.

How can alumni help achieve the goals you envision for the school's 150th anniversary?

Alumni support and engagement are critical to our future, and we have a range of opportunities through which alumni can meaningfully connect to Mines. I recently met with alumni leadership to map out the needs and opportunities



President Paul C. Johnson helped welcome Mines' new Blaster mascot at Rock the Lock in February with Elyse Johnson and men's basketball head coach Pryor Orser.

Photo by Joe DelNero

for graduates in the MINES@150 plan. These include involvement in the professional development of our students, special strategic initiative groups, promoting Mines and lecturing in our courses. We will be more deliberate about the professional preparation of our students and their entrepreneurial ventures, and alumni are some of the best to lead that effort.

Alumni-driven strategic initiative groups are already advancing aspects of the MINES@150 plan with our growing interest groups and other engagements. I'm excited alumni are taking ownership for preparing our students to be engaged with Mines in the future.

Of course, we will need to secure resources to support our MINES@150 plan, and I hope all alumni will step up to the challenge when we formally launch our campaign for MINES@150.

Go Orediggers!

Paul C. Johnson, PhD
President and Professor

ENGINEERING UNLEASHED

MINES PARTNERS WITH KEEN TO TEACH ENTREPRENEURSHIP



Mines is now an official partner of the Kern Entrepreneurial Engineering Network (KEEN), an organization focused on preparing engineering students with an entrepreneurial mindset who can create personal, economic and societal value through a lifetime of meaningful work.

Partnering with KEEN brings access to resources that will broaden and improve entrepreneurial education on the Mines campus. This includes equipping faculty with the tools to incorporate entrepreneurial concepts into the curriculum, as well as funding for other related initiatives.

According to KEEN's website, there are three core components of an entrepreneurial mindset, referred to as the "3C's:" curiosity, connections and creating value. Each core component strives to better prepare students for their future careers by teaching them to infuse their technical skills with curiosity about the world.

Mines is well suited to partner with the KEEN since both value the importance of hands-on experiences and creative thinking for undergraduates, which are already highlighted in two programs at Mines—Cornerstone (a freshman-year

design course) and Capstone (a senior-year design course).

Implementation of the KEEN framework allows Mines to develop new programs and equip faculty with the tools needed to incorporate the entrepreneurial mindset into initiatives and curriculum so students are best prepared to find success when beginning their careers.

"A partnership with KEEN is a tremendous addition to the ongoing academic programs involving entrepreneurship at Mines," said Werner Kuhr, director of the Center for Entrepreneurship & Innovation. "Mines has already integrated entrepreneurial training and teamwork into some of its undergraduate curriculum, and we look forward to working with KEEN to add even more content and capability to our programs."

By **Katharyn Peterman**

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

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WEAVING THE COMPLEX FABRIC OF RESEARCH

A Q&A WITH MINES' NEW VICE PRESIDENT OF RESEARCH AND TECHNOLOGY TRANSFER



Stefanie Tompkins joined Mines in February 2018 as the new vice president of research and technology transfer, serving as the public face of the university's diverse research portfolio.

Photo by Ashley Spurgeon

Stefanie Tompkins, former acting deputy director of the U.S. Defense Advanced Research Projects Agency (DARPA), joined Mines in early February 2018 as the school's vice president of research and technology transfer. Tompkins will lead Mines' efforts to expand the reach and impact of the projects it conducts for industry and government. Shortly after she arrived on campus, Tompkins sat down with *Mines Magazine* to discuss what she believes the future looks like for research at Mines.

Why did you decide to join Mines?

It's complicated. I spent my career in a combination of national service and science and technology development. I was in the military. I have worked for the federal government. I have worked in industry doing science and technology. When you're in the intersection of these spaces, you start to develop an idea of what is important to you and what is needed to solve hard problems. Mines really epitomizes that nexus—there's a connection to government, industry and science that enables the school to tackle many of the really difficult challenges that the world faces today.

Had you heard about Mines before you applied for a job here?

Mines is legendary for its geology programs. When I applied to graduate school in geology, it never occurred to me to apply to Mines, because I didn't think my grades were good enough. I applied to Brown University instead.

What do you envision for research at Mines?

I envision Mines research as a fabric that interweaves different kinds of science and engineering—both curiosity-driven and use-inspired—and many different disciplines, with all of these elements thriving independently but also feeding back into each other.

We live in a complex world with complex problems. Mines' research should play a significant role in solving those problems—it already does, in some fields, but could do much more for bigger technological, social and policy challenges. For instance, Mines' research currently encompasses the entire lifecycle of the materials supply chain—from discovery and extraction of resources, to their transformation into new materials, to manufacturing and finally to recycling and re-use. Research results in any one of those areas—say, a new material that displaces the need for a mine—could significantly affect the others, as well as economics and policy. Thinking about the entire system would allow us to tackle much bigger, harder problems than we do today.

How do you think we can elevate Mines' research in the next few years?

There's not a single answer. One thing we can start off with is improving how we communicate our research to the outside world. This involves helping junior faculty connect to different funding opportunities. It also means defining which big problems we want to start tackling and starting there.

Interviewed by **Katharyn Peterman**



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Amy Hegarty
ME '13, MSc ME '15 | PhD Candidate 2018
Research: Biomechanics for children with cerebral palsy

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Hareem Subramaniam
Class of 2019, Petroleum Engineering
Technology: Ruska Gas Permeameter

ATHLETICS

REVIEWING THE WINTER SEASON AND WELCOMING A NEW OREDIGGER

A NEW MEMBER OF THE FAMILY

Mines introduced the newest member of the Oredigger family at the annual Rock the Lock basketball games on Feb. 16, 2018. Mines welcomed a new mascot, Blaster, to join Marvin the Miner as a new figure of Oredigger athletics.

Of course, the “real” Blaster the Burro has been a beloved part of the Mines family since the 1950s and will continue to be a mainstay at football games and many other campus events. But there are many indoor spaces on campus that aren’t as burro-friendly—like basketball courts—and the introduction of the new mascot will help bring Blaster’s spirit and determination to more fans than ever before.

Photo by Joe DelNero



GARNIER NAMED COLORADO SPORTSWOMAN OF THE YEAR

Mines women’s soccer senior Emily Garnier made history in February when she became the first Oredigger in any sport to be twice named a Colorado Sportswoman of the Year. Garnier earned the award for 2016 and 2017 as she finished a tremendous career for Mines as a three-time All-American and three-time Rocky Mountain Athletic Conference Defensive Player of the Year. In fall 2017, Garnier led the nation with 15 assists and helped lead Mines to the NCAA Tournament. She was honored by the Sportswomen of Colorado Foundation in March, along with winners from 56 other sports around the state.



Photo by Tim Flynn



Photos by Sam Boender

HISTORY MADE AT STEINHAUER FIELDHOUSE

For the first time since 2010, the best conference meet in NCAA Division II was hosted by Mines as the 2018 Rocky Mountain Athletic Conference Indoor Track & Field Championships descended on Steinhauer Fieldhouse on Feb. 23-24, 2018.

In a memorable weekend, the Mines men won the conference championship at home for the first time, capturing their second RMAC indoor title in three years in front of a raucous crowd.

“We’re proud of being able to pull it off as an institution,” said Matt Sparks, Mines’ head track & field coach, about the meet, which managed to pack more than 500 fans and 52 events inside one of the nation’s oldest fieldhouses. “We try to take a lot of pride in competing well here [at Steinhauer Fieldhouse].”

The result was a dominant performance by the Mines men, who won by a 61-point margin over the University of

Colorado Colorado Springs with 151.5 team points. It was highlighted by a podium sweep of the men’s heptathlon with Austin Smith, Chase McLean and Hayden Sather taking the top three spots, while Triston Sisneros added a gold medal in the 60-meter hurdles and broke the 19-year-old school record in 8.01 seconds.

The women’s team had plenty of success as well, finishing tied for fifth behind Courtney Clark’s championship in the shot put, Gina Coleman’s shot put bronze and three of the top six spots in the mile thanks to Molly Reicher, Brook Eberle and Chloe Cook.

The RMAC meet was also a tune-up for the NCAA Championships, where the men finished 11th in the nation and the two teams combined for 16 first- and second-team All-America honors. Connor McLean led the way with a national runner-up spot in the pole vault, and the Mines men had seven other individuals—Mason Brevig, Miller Kettle, Austin Smith and Patrick Weaver in the distance medley relay, Grant Colligan, Josh Hoskinson and Nick Sevcik in the 5,000-meter run, and Weaver in the 800-meter run—earn first-team All-American honors. For the women, Chloe Cook and Molly Reicher were All-Americans in the mile, finishing fourth and eighth, respectively.

By Tim Flynn



Molly Reicher

Chloe Cook

Connor McLean

► For more on Mines athletics, visit minesathletics.com



TOP MARKS

TWO MINES STUDENTS RANK IN THE TOP 500 ON PUTNAM MATH EXAM

Mines had its best team placement and individual placement in school history in the 2017 William Lowell Putnam Mathematical Competition, the preeminent undergraduate mathematics competition in the United States and Canada.

Sam Reinehr, a junior majoring in mathematics and computer science, placed 51st out of 4,638 total students who participated in the exam. Overall, the Mines team, comprising three pre-selected individuals, ranked 40th out of 575 participating institutions.

Both Reinehr and Mines freshman Matthew Iverson also had their names published in the official Putnam announcement, an honor reserved for top 500 scorers.

“The median on this year’s exam was 0, meaning that more than 50 percent of all participants earned no points whatsoever on the exam’s 12 questions, worth 10 points each,” said Steve Pankavich, associate professor and director of graduate studies for the Applied Mathematics and Statistics Department. “The high score this year was 89—Sam Reinehr earned a score of 58, which ranked him 51st among all competitors, including dozens of students at the nation’s most prestigious and high-scoring universities, such as MIT, Harvard, Princeton, Berkeley and Carnegie Mellon.”

Reinehr, a member of the Mines team that qualified for the world finals of the ACM International Collegiate Programming Competition in April, also earned the highest Putnam score in Colorado.

“This was my third time taking the Putnam,” Reinehr said. “I was able to focus fully and didn’t run too hard into any snags this time around.”



Mines’ Putnam club earned its best team placement in the school’s history, and two Mines students ranked in the top 500 of the Putnam Mathematical Competition.

Photo by Joe DelNero

Reinehr participated in Mines’ Putnam club to help prepare for the exam. He also credited his high score to doing “a lot of competitive math” in high school, attending summer camps and taking online classes on Art of Problem Solving (AoPS) about competitive proof-writing.

“I have not really thought much about what this means to me—it’s nice,” Reinehr said.

Iverson, a freshman planning to major in computational and applied mathematics, ranked 302nd with a score of 33 in his first time taking the Putnam exam.

“I’m really excited that I was able to score as highly as I did in my first year,” Iverson said. “I still hope to make significant improvements in future years with more practice and preparation time.”

Taking Foundations of Advanced Mathematics (MATH 300) with Debra Carney, teaching professor and assistant head of the Applied Mathematics and Statistics Department, this fall really helped him on the exam, he said.

“The Putnam competition focused heavily on proving results, rather than just getting correct answers,” Iverson said. “The proof techniques and logic I learned from Dr. Carney were integral to the test.”

By **Emilie Rusch**

LEADING THE FUTURE

GRADUATE STUDENT CONTRIBUTES TO UN ECOSOC YOUTH FORUM

Sajith Wijesuriya, a mechanical engineering PhD student, was among the young leaders from around the world who gathered at United Nations headquarters in New York in January to discuss the role of youth in building sustainable and resilient urban and rural communities.

He co-moderated one of the breakout sessions at the 2018 United Nations Economic and Social Council (ECOSOC) Youth Forum, reporting back the takeaways to the main conference following the breakout discussion.

Wijesuriya, whose work at Mines focuses on thermal energy storage and peak electricity demand management strategies, is the focal point for the Science Policy Interface Platform of the U.N. Major Group for Children and Youth. His co-moderator was Yera Ortiz de Urbina, permanent observer to the U.N. for the International Renewable Energy Agency (IRENA).

“It was really productive and exhilarating to sit at the same table with entities like IRENA, UN-Energy, UNIDO and UNESCO to discuss and put forward the recommendations from young practitioners around the world,” Wijesuriya said.

Wijesuriya has been working on climate change-related issues, support for resilient communities and technology facilitation for the urban/rural sector in Sri Lanka for the last decade through a couple of organizations, including SciencePolicy Circle.



Sajith Wijesuriya (second from left) co-moderated a breakout session on U.N. Sustainable Development Goal 7.

Photo by Nisreen Al Sayeem, YOUNGO

The breakout session he helped lead at the youth forum, Sustainable Energy for Climate Resilient Communities, focused on U.N. Sustainable Development Goal 7 to “ensure access to affordable, reliable, sustainable and modern energy for all.”

Since the forum, he has been working with entities such as Asian Institute of Technology and YOUNGO-UNFCCC to ensure youth participation at an upcoming global conference focused on SDG 7. He will also facilitate, support and present content at the U.N.’s 3rd Multi-Stakeholder Forum on Science Technology and Innovation later this year, along with University of Colorado graduate student Kimmy Pugel.

“My contribution to these processes is driven by the need to implement the targets included in the Sustainable Development Goals and 2030 Agenda in all communities across the world,” he said. “There are many communities in need of technology facilitation and other resources to increase their resilience against the issues related to climate shifts, conflicts, inequalities of resources distribution, etc.”

By **Emilie Rusch**

LITERATURE FROM AN ENGINEER’S PERSPECTIVE



From left to right: Kyle Markowski, Wenli Dickinson, George Saunders '81, Connor Weddle

Photo by Toni Lefton

In March 2018, editors of *High Grade*, Mines’ literary arts journal, attended the Association for Writers and Writing Programs conference in Tampa, Fla. Mines alumnus George Saunders '81 gave the keynote address at the conference, his talk centering around the theme of compassion.

Before his talk, Saunders met up with *High Grade*’s editors and swapped stories about Mines. “The students connected with him on how meaningful the arts are to their technical worlds, failing their first test and how writing, creativity and tough engineering classes are synonymous,” Toni Lefton, *High Grade*’s advisor, said. “It was a moment of a lifetime for our young engineers.”

By **Ashley Spurgeon**

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ENGINEERING THE GAME

ReadyList Pro software is changing how athletes tackle football **By Kellie Spoerl**

Learning a football team's plays and strategies may not seem very difficult. But for many athletes, memorizing a playbook is often like learning a new language, as was the case for Chad Frieauf '05.

Frieauf enrolled at Mines knowing he would not only have the opportunity to earn a great education but also to pursue his dreams of playing quarterback for a college football team. And in his four years with the Orediggers, he became legendary in Mines athletics.

Frieauf completed his career at Mines as the all-time leader in passing yards (9,873) and touchdown passes (84). His records for total offense (5,363 yards) and completions (384) during Mines' undefeated 2004 season still stand. Frieauf received the first Harlon Hill Trophy in Mines history that year, recognizing him as the most valuable player in NCAA Division II. Mines hadn't seen a quarterback of this caliber since Vince Tesone '61 led the team to its first conference championship in 1958.

When he graduated from Mines with a bachelor's degree in civil engineering, Frieauf knew he wasn't ready to retire his helmet and pads. "I wanted to continue my athletic career as long as I could," he said. "I signed with the Denver Broncos immediately after college."

Frieauf immediately started mini-camps and organized team activities in the 2005 preseason. He built strong relationships with his teammates, most notably with then first-string quarterback Jake Plummer.

"Jake took me under his wing, treating me as a part of the team, although I was not a highly touted rookie," Frieauf said.

Despite the bond he had with his teammates, Frieauf found it hard to quickly learn the Broncos' plays. He only had seven days to memorize the playbook, all while competing and learning with the other four quarterbacks on the team.

"When I was with the Broncos, sitting in the meeting room with four other quarterbacks who had been on the team the year before, I was the only one in the room who didn't know the language or the terminology," Frieauf said. The question for him then became, how does a rookie compete with seasoned athletes and further his career?



Chad Frieauf '05 (left) developed ReadyList Pro with former Broncos quarterback Jake Plummer to help football players learn playbooks more efficiently.

Photo by Joe DelNero

THE START OF AN IDEA

Unfortunately, Friehauf was released by the Broncos before the season began, but he wasn't ready to give up.

"I just wanted one more shot at an NFL training camp," Friehauf said. He spent the next seven years playing for nine different professional football teams across North America. He played for the Canadian Football League, Arena Football League and United Football League, and even trained for NFL Europe.

As he traveled and played with these teams, Friehauf still experienced the same struggles he had when training with the Broncos—his approach to learning the playbooks wasn't efficient, and many of his teammates seemed to have the same problems. He continued to think about how to approach learning a new team's strategies on the field. Fortunately, Friehauf was able to play with many different athletes in different parts of the country and observe how each player approached learning new plays.

"I watched my teammates and asked them how they studied," Friehauf said. "If I was struggling, there must be a lot more people on the team who may be worse off in terms of structure and how to study. I thought, 'There must be a better way to do it.'"

By the time he reached the end of his career in professional football, Friehauf had an idea of what would come next. "My body had enough," Friehauf said. "So I came back and coached for Mines for two years." It was then that he was able to focus on the idea that would become his entrepreneurial brainchild, ReadyList Pro.



"I have yet to see anything like this software that helps kids play faster and gain knowledge about the game."

Jake Plummer
Co-founder, ReadyList Pro

to upload their playbooks, videos and notes into their team's profile. Players are then able to engage with these plays, with tests for each position on the football field. Coaches not only see their players' progress but are able to see exactly where their team needs improvement. The program gives coaches at the collegiate and professional levels more information on their athletes through their performance and progress within the program. Athletes are able to learn better and faster, but the software also helps them learn how to play smarter and limit injuries.

The fully interactive learning and testing technology works by allowing teams to create digital playbooks within the ReadyList Pro program, and players then study each play and are randomly tested on the correct routes for each player. Athletes are evaluated based on their choices and response times, as well as how well they know formation alignments. The software immediately scores each assessment and gives the players results based on a comparison with their teammates' average scores, while coaches receive detailed analytics on each individual player.

Friehauf's main goal was to create something that would work with all types of players, whether they were audio, visual or tactile learners. He needed something that would be manageable for all athletes.

But in order to get this idea off the ground, Friehauf knew he was going to need some help. He turned to his former teammate-turned-friend, Jake Plummer. Friehauf presented him with a 350-slide PowerPoint presentation about what he envisioned for ReadyList Pro and, luckily, Plummer was hooked.

"ReadyList Pro is a game-changer with a fully interactive, web-based playbook that leverages multiple learning styles," Plummer said. "I have yet to see anything like this software that helps kids play faster and gain knowledge about the game."

Plummer has been more than just one of the investors in Friehauf's program—he has been instrumental to its success. With his connections to NFL and college coaches, Plummer has set up many meetings to demonstrate ReadyList Pro's potential for individual teams. He and Friehauf then work together to make updates and discuss further enhancements to keep the software running efficiently in the future.



"My hope for the future is that kids use it because they enjoy learning from the software and not because their coaches make them. It makes me feel like we are doing something pretty cool."

Chad Friehauf '05
Co-founder, ReadyList Pro

THE ROSETTA STONE FOR PLAYBOOKS

Friehauf threw all his football knowledge and experience into the software he calls the "Rosetta Stone for playbooks."

ReadyList Pro is a cloud-based software application aimed at helping athletes take thousands of plays and put them into a more manageable, easy-to-understand format. The online, customized playbook allows coaches



Chad Friehauf '05 came up with the idea for ReadyList Pro after struggling to learn playbooks as a student and professional athlete and wanted to help other players who were also struggling learn better and faster.

Photo by Joe DelNero



With the program still in its early stages, ReadyList Pro could not only be an asset for college and professional football teams but also have applications in youth sports, to help young athletes learn the foundations of football.

Photo by Joe DelNero

AN ENGINEER'S MIND

With initial interest in ReadyList Pro from football programs across the country, Friehauf and Plummer began working with CD2 Learning, a programming company that specializes in learning, in 2015. However, Friehauf quickly realized there was a bit of a language barrier between football jargon and software terminology. Friehauf and the programmers he was working with seemed to constantly talk over each other's heads, both parties trying to communicate their vision for ReadyList Pro in very different ways.

Friehauf's engineering background came in handy when tackling this issue. "Just being an engineer enabled me to relate and think like they do," Friehauf said when explaining how he adjusted to the programmers' work style. "I was able to lay out the specifics of my idea and present it to them in a black-and-white way that they could understand."

The integration of Friehauf's engineering knowledge and football expertise into one cohesive language not only allowed for a smoother process in creating ReadyList Pro, but also allowed Friehauf to make sure the program is understandable from all perspectives. The software is user-friendly and compatible with tablets, desktops and smartphones—a limitless array of devices, so any team can be ready to use ReadyList Pro.

Friehauf believes Mines prepared him for the entrepreneurial journey he has taken over the past few years. "At Mines, I got good at time management, especially in the two years I played two sports, as well as developing problem-solving skills and learning skills," he said. Friehauf knew there would be a lot more valleys than peaks when he first started developing this software, but he knew how to handle them and take the whole journey in stride.

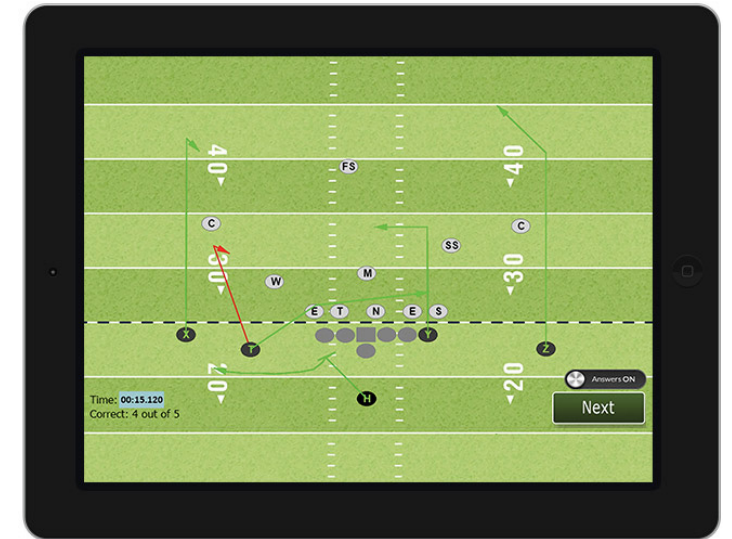
A GAME-CHANGER FOR FUTURE ATHLETES

During the 2016 football season, several college programs were asked to test ReadyList Pro and give Friehauf feedback. Mines was one of them.

"ReadyList Pro is an outstanding resource that has allowed us to speed up the learning process for our players," said Nicholas Fulton, Mines' offensive coordinator. "It is easy to use and has given our guys an interactive way to compete and learn our offense in a way that encourages them to study outside of our meeting time."

Officially rolling out the product three months before the 2017 football season began, ReadyList Pro signed up teams in eight states, including Division I university teams, smaller colleges, high schools and even a middle school.

Friehauf even convinced former Broncos head coach Mike Shanahan to interact with the software. "ReadyList



ReadyList Pro allows football teams to upload their playbooks and test players on the best plays, allowing athletes to learn faster and more efficiently.

Image courtesy of ReadyList Pro

Pro is going to do something for these players that many have not seen," Shanahan said. "We will see different perspectives and exactly how to attack an offense and defense, making athletes ready for the NFL as well as the collegiate game."

But Friehauf's main focus right now is on younger athletes. After receiving considerable interest from youth coaches, Friehauf has been working on simpler versions of ReadyList Pro aimed at kids—ReadyList Youth and ReadyList Flag. These programs are expected to launch in spring or summer 2018. Friehauf hopes the use of this software at a young age, when kids are still learning the foundations of football, will have continuous benefits as they progress through the sport.

As he looks to the future, Friehauf wants ReadyList Pro to continue to fill the need for coaches, players and recruiters to have the right tools to learn, perform and teach football, from adolescent to professional.

"It's a way to learn that's better than the archaic way of staring at static playbook images," Friehauf said. "My hope for the future is that kids use it because they enjoy learning from the software and not because their coaches make them. I've already seen the reactions from players who get on the system for the first time and see their plays in there. It makes me feel like we are doing something pretty cool."

UNSCRIPTED INNOVATION

The new CoorsTek Center for Applied Science and Engineering acts as an epicenter for collaboration at Mines

By **Ashley Spurgeon**

Mines' newest building houses several new research centers and enhances industry partnerships to keep Mines at the forefront of materials research.

Photo by Mark Ramirez

Mines is known for being at the forefront of innovation and progress, and its campus is no exception. Campus architecture reflects the institution's 144-year legacy, with a balance of longstanding landmarks and sleek new structures, all of which continue to elevate Mines' reputation as a center for collaboration and advancement. When coupled with another well-known name in materials science—CoorsTek—the possibilities seem endless.

In 2014, CoorsTek and the Coors family made a historic \$27 million donation to Mines, funding the design and construction of the newest addition to campus, as well as providing the opportunity for new high-tech equipment and sponsoring a graduate research fellowship program. The state of Colorado also provided \$14.6 million in funding for the building's construction.

Now the largest building at Mines, the CoorsTek Center for Applied Science and Engineering enables the expansion of a longstanding academic, research and career partnership between CoorsTek and Mines.

A leader in the manufacturing of technical ceramics for semiconductor, medical, automotive, oil and gas and other industries, CoorsTek is a natural fit at Mines. The new space allows the company and Mines to further their research goals and continue to be leaders in materials science and engineering.

"For CoorsTek, our investment in Mines is not only an investment in the future of our company and a great university—it's an investment in solving global challenges in energy, transportation, information technology, the environment and the quality of human life itself," said

John Coors '77, chairman, president and CEO of CoorsTek, when the initial investment was announced. "This partnership between CoorsTek and the Coors family, the state of Colorado and Colorado School of Mines is not about a building. It's about something much more. It's about connecting students, researchers, faculty and industry to impact the world in ways that we can't even predict today."

The state-of-the-art facility acts as an epicenter of collaboration, housing innovative university, government and industry activities, such as the planned Mines Materials Institute (MMI), the planned International Center for Multiscale Characterization (ICMC) and the Alliance for Development of Additive Processing Technologies (ADAPT).

The laboratories and customizable classrooms further foster partnerships among four departments and two interdisciplinary programs: the Department of Physics, the Department of Chemistry, the Department of Chemical and Biological Engineering, the Department of Metallurgical and Materials Engineering, the Materials Science Program and the Nuclear Science and Engineering Program.

"There is no end to the possibilities that research into advanced materials holds in making the world measurably better," Coors said. "Our decades-long partnership with Mines has already yielded not only many such developments that have accomplished this, but also some of the best materials scientists and engineers at CoorsTek and the industry generally. We expect many more of both in the future."



September 25, 2014

CoorsTek and the Coors family announced an unprecedented \$27 million investment in Colorado School of Mines, funding not only the CoorsTek Center for Applied Science and Engineering, but also high-tech equipment and a graduate research fellowship program.



June 4, 2015

Mines selected internationally renowned architecture firm Bohlin Cywinski Jackson, in partnership with Denver-based Anderson Mason Dale Architects, to design the new building.



May 2, 2016

Officials from CoorsTek, the Coors family and Colorado School of Mines broke ground on the new building.



September 28, 2017

Mines hosted a CoorsTek Grand Opening Preview during Homecoming weekend. The event included a sneak peak of the new building and a ribbon cutting ceremony.



January 9, 2018

The CoorsTek Center for Applied Science and Engineering officially opened, welcoming students and faculty at the start of the semester.

EXPANDING RESEARCH POSSIBILITIES

The opening of the CoorsTek Center enables Mines to remain at the forefront of groundbreaking research. With several new research centers and industry partnerships, researchers and scientists can explore new possibilities and pursue breakthroughs in materials science.

MINES MATERIALS INSTITUTE

The planned MMI will bring together researchers from ADAPT, ICMC, the quantum theory lab and other materials centers across the Mines campus and partner organizations. The institute is intended to be a flexible space where researchers, faculty and students from several departments will co-locate with researchers from CoorsTek, the National Renewable Energy Laboratory (NREL) and the National Institute of Standards and Technology (NIST) to work on materials projects that require cross-cutting expertise.

“If we can provide a space where researchers with different backgrounds and expertise are interacting, collaborating and exchanging ideas, unforeseen and great advances at the interfaces of traditional fields will emerge.”



Ryan Richards, PhD
Professor, Chemistry
Associate Vice President for Research

INTERNATIONAL CENTER FOR MULTISCALE CHARACTERIZATION

The planned ICMC combines cutting-edge instrumentation and cross-disciplinary expertise to address multimode, multiscale materials issues in industry-relevant applications. These include photovoltaics, battery materials, fuel cell materials, lightweight alloys, composites, membranes and more.

The ICMC labs within the CoorsTek Center were purpose-built for state-of-the-art materials characterization. The suite of instrumentation in the labs allows researchers to characterize materials on the atomic scale all the way up to the macro scale.

“The ICMC labs in the CoorsTek building will enable research in many different areas of materials research, including metallic alloys for the automotive and aerospace industries, ceramics for structural and high-temperature applications, next-generation fuel cell and solar cell materials, next-generation battery materials and our understanding of geologic processes and our earth history.”



Brian Gorman, PhD
Associate Professor, Metallurgical and Materials Engineering
ICMC Director

UNIQUE PARTNERSHIPS

Mines has an extensive relationship with NREL and NIST. The CoorsTek Center brings researchers together into a shared space to continue to strengthen those connections and leverage the assets of all collaborators. Mines faculty, staff and students work alongside CoorsTek, NREL and NIST researchers to catalyze innovation at all levels, from fundamental materials discovery to manufacturing and processing and, ultimately, demonstration and deployment

The new facility also expands the capabilities of the ADAPT consortium. Dedicated to solving challenges in additive manufacturing using data-driven approaches, the ADAPT research facilities are moving from Brown Hall into the CoorsTek Center within the next year to better fulfill its mission in the collaborative space. The new facility allows ADAPT to continue to grow its technical capabilities and enhance the scope of their work.

NEW SPACE, NEW TECHNOLOGY

CoorsTek’s commitment to collaboration with Mines allowed the purchase of new technology to advance the capacity of the research at Mines.

One of these purchases was the FEI Talos microscope, a world-class analytical transmission electron microscope that is the first of its kind in the United States.

The technology delivers fast, precise, quantitative materials characterization in multiple dimensions, with new software features that are designed to improve imaging and usability. The microscope is used to view thin specimens through which electrons can pass and is capable of capturing fine details—as small as a single column of atoms—and produces high-resolution images to characterize a wide range of material specimens.

“In order to measure a material down to a single atom requires highly specialized instrumentation that also requires a very stable laboratory environment,” said Brian Gorman, associate professor of metallurgical and materials engineering. “The CoorsTek donation of a new analytical transmission electron microscope is one such piece of instrumentation, and the building allows us to maximize its capabilities, as well as plan for future acquisitions.”

With this versatile system, scientists and engineers have unlimited possibilities for discovery and advancing the potential for materials research at Mines.

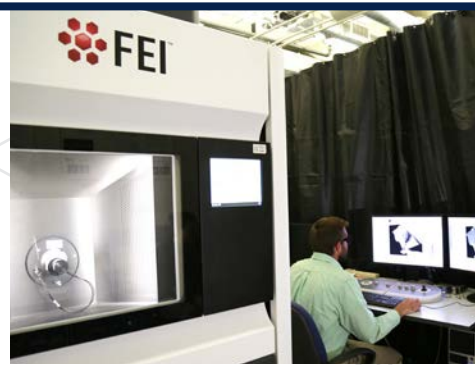


Photo by Mark Ramirez



Members of CoorsTek, John Coors '77, Mines President Paul C. Johnson and Mines Foundation President and CEO Brian Winkelbauer unveiled the new CoorsTek Center on Sept. 28, 2017.

Photo by Joe DelNero

COLLABORATIVE AESTHETICS

When initial plans were created for a new building on campus, Mines knew it would be a state-of-the-art, interdisciplinary facility that would elevate the research pursuits of its faculty and students. Yet the building itself also needed to fit in with the look and feel of the Mines campus, while serving the needs of the researchers and scientists who would call the new building home.

Mines hired the same architectural firm that designed the adjacent, steel-framed Marquez Hall: Bohlin Cywinski Jackson. They designed a modern, 94,000-square-foot, four-story structure, with similar steel framing to Marquez Hall.

“Peter Bohlin has a signature design style that is reflected in both CoorsTek and Marquez Hall,” said Chris Cocallas, Mines’ executive director of capital planning and design. “The aesthetics that tie the design to Mines is the blond brick seen throughout campus and the gray metal panels that were introduced in our newer buildings about 10 years ago.”

A curtain of glass panels forms the northern façade, overlooking Kafadar Commons and providing stunning views of the Mines campus and Mt. Zion from the building’s upper floors. A floorplate extends out over empty space at the northeast corner, with the upper three floors cantilevering out from a concrete wall and braced frames between each level.

The building also has six exterior vertical glass fins that project from the south façade, which required support between the first and second levels. W8 posts were installed to account for the weight of the fins and wind load. The steel support is hidden behind the brick veneer to create a floating effect.

With high-tech research equipment going into the new building, vibration performance was also a main design consideration. Though most vibrations from day-to-day activities are often below human perception, they can affect the performance of the highly sensitive microscopes and lasers in the labs. To account for this, lab equipment was placed on thick, vibration-isolated slabs on grade where space allowed.

The natural cohesion of the Mines and CoorsTek aesthetics and missions allowed for a fresh and modern addition to the Mines campus that enhances the collaborative partnerships and research crucial to the school’s vision for the future.



\$27 million
DONATION FROM COORSTK



\$14.6 million
GRANT FROM THE
STATE OF COLORADO

NEARLY
100,000
SQUARE FEET

WITH PARTNERSHIPS ACROSS
4 academic departments

- Chemical & Biological Engineering
- Chemistry
- Metallurgical & Materials Engineering
- Physics



Flexible lab space,
customized classrooms,
centralized teaching
& research space

WITH ALMOST A DOZEN
research centers



7 CoorsTek
Fellows



3 NREL Energy
Fellows

AN ARTIST'S TAKE ON MINING HISTORY

A SERIES OF MURALS SPANS TIME TO CONNECT THE PAST WITH THE PRESENT

The Mines Geology Museum is known for its extensive collection of minerals and mining artifacts, serving as the state repository for Colorado's geologic heritage. However, upon entering the museum, attention is drawn away from the brightly lit cases of sparkling gemstones and minerals to a man-made display with just as much significance and value.

Hanging on the west perimeter of the museum's main floor, a series of murals reflects the story of how many of the museum's artifacts were found. The massive oil-on-stretched-canvas paintings depict the history of mining—from the discovery that metal can be mined from meteors to the applications of ore in contemporary society.

Appropriately titled *The History of Mining*, the series, painted by Irwin D. Hoffman (1901–1989), was commissioned for the 1939 Golden Gate International Exposition in San Francisco. Ranging in size from 7 by 5 feet to 7 by 11 feet, with some of the larger pieces weighing nearly 150 pounds, the murals have become a focal point of the museum that is hard to miss.

AN ARTIST'S LIFE

Hoffman developed a passion for art from an early age. He was first given a sketch pad and sticks of charcoal when he was six years old. By the time he reached high school, Hoffman's talents were apparent, and he attended the School of the Museum of Fine Arts in Boston. Hoffman's training earned him the prestigious Paige Traveling Scholarship in 1924, allowing him to study art in Paris for two years. Over the next several years, Hoffman traveled Europe and northern Africa, immersing himself in the art and culture of the region.

When he returned to the U.S. in the 1930s, Hoffman settled in New York, concentrating on portraits and etchings. Yet, what made his work unique was that he tended to live and work with the people who appeared in his works, bringing a familiarity into his art that a casual observer may not have been able to capture.

Hoffman's brothers, Arnold and Robert, were both successful mining engineers, and Hoffman often accompanied them on their claim-staking expeditions. While on the road, Hoffman documented the people he encountered—miners and the people who resided in mining towns. According to an account in the book *An Artist's Life*, “the rapport he developed with his subjects allowed him to depict startlingly intimate details in the lives of these remote people.”

Hoffman's works were widely exhibited and received numerous awards, so it was no surprise when Hoffman was commissioned to paint a series of murals for the Golden Gate International Exposition in San Francisco in 1939. When writing about the event in her article, “Artist Irwin David Hoffman (1901–1989),” Susan Robinson said, “At the

time, the paintings were labeled a ‘tour de force’ by both the scientific and art communities, a profound compliment to the thirty-eight-year-old artist that solidified both his name and career.”

FINDING A HOME

After the exposition, Hoffman's murals were bought by Barney and Gertrude Whatley, Denver residents with connections to the mining industry, who donated the series to Mines in 1940. A year later, Hoffman visited campus to view his paintings, then on display in Berthoud Hall.

In 1988, the murals were loaned to the National Mining Hall of Fame until they were transferred to the Mines Geology Museum in 2003. However, when the museum suffered ceiling damage from heavy rains in 2013, the murals underwent a yearlong restoration to bring them back to their original state. The restoration brought out the paintings' colors and new LED lights were installed above each piece to better highlight Hoffman's work.

RECOVERING A FORGOTTEN PIECE

One day in June 2016, Mines Plumbing and Utilities Supervisor Craig Crow was in the Engineering Hall Annex, searching for shut-off valves in preparation for a new makerspace in the building. While there, Crow came across what looked like a rolled-up poster pushed to the back of a shelf and forgotten. When he unrolled it, he discovered it was actually a painting.

Crow snapped a picture of the signature in the corner and took the painting back to the plumbing shop on campus. After a bit of research, Crow realized the painting likely

had some value and took it to Mines project planner Mike Ray, who had been involved in hanging the other six murals in the Mines Geology Museum. “I immediately recognized it as belonging to the group hanging in the museum,” Ray said.

After a considerable amount of time spent rolled up and slightly crumpled and creased, the paint on the canvas was starting to crack and flake off, leaving the painting in a state of disrepair. Over the next two years, the painting underwent an extensive restoration, which involved cleaning, patching holes, touching up the dry and flaking paint, restretching the canvas and documentation. A frame was also created to match the other murals in the collection. The painting was finally hung in the museum on March 2, 2018.

This final painting depicts the parallels between early and contemporary miners, a summative piece to the other murals in Hoffman's series and a lasting tribute to the extensive history of mining.

By Ashley Spurgeon

► Visit the Mines Geology Museum to view the Hoffman mining murals and learn more about Colorado's mining and mineral history. Go to mines.edu/geology-museum for visiting hours.

Some of Hoffman's smaller paintings and sculptures can be viewed in the Arthur Lakes Library.

Photos by Joe DelNero



1 This panel shows the three early developmental stages of mining. The upper left depicts a group of miners working stopes for flint. The upper right details the beginning of the Iron Age, when early humans discovered iron can be made into tools.

2 This panel moves into the mining and metallurgical practices of the Egyptians. Slaves were driven without mercy in gold mines, digging, crushing, smelting and refining the precious metal.

3 This painting depicts ancient Greek and Roman miners who worked their mines by kindling fire against the ore-bearing rock face. The heated rock was then doused with water until it cracked and could be pried loose. On the left, Greek artisans are shown casting bronze statues.

4 This section details the various phases of surface mining. Two gold rush pioneers pan nuggets from a stream, while others participate in hydraulic mining, dredging and open-cut mining.

5 This panel shows modern mining and reducing operations. The miners on the left drill into the rock face, while the workers in the middle demonstrate the method by which broken ore is drawn from the stopes and loaded into ore carts. The upper left shows the plant or mill where the ore is crushed and the metal extracted for the final stage of smelting and refining.

6 The final panel in the series serves as a summary of the story of humans and metals. The miner holds a piece of the ore which made possible all that surrounds him: the modern city, the ocean liner, the train, car, radio and the movies.

MINDFUL ENGINEERING

LEADERSHIP IN SOCIAL RESPONSIBILITY INTEREST GROUP STRIKES A CHORD WITH ALUMNI AND STUDENTS

Like many engineers in the oil and gas industry, Ray Priestley '79, was trained to focus on specific tasks—design this pump, drill this well. Dealing with community concerns about a project wasn't part of his training and was usually handled by advocacy groups that didn't always communicate with engineers. As a result, objections often surfaced after plans were underway, causing delays and cost overruns.

"Often there's a disconnect," said Priestley, Mines Alumni Association Board president. "Most engineers are not trained in community relations, and people in community relations are not trained in engineering. So sometimes projects don't get explained correctly or something that needs to be incorporated into the design gets left out."

Mines' new Leadership in Social Responsibility Interest Group aims to minimize that disconnect, bringing together alumni experienced in dealing with communities affected by engineering projects and students eager to learn how to incorporate social responsibility into their practice.

BEYOND THE CODE OF ETHICS

"We're trying to redefine social responsibility, which is usually defined as understanding the engineering code of ethics," said Juan Lucena, a faculty advisor to the group and co-director of Mines' humanitarian engineering program. Lucena suggests the definition of social responsibility should include incorporating community ideas into plans from the get-go. "We want to show that social responsibility can live in engineering practice, design and modeling," he said.

The formation of the interest group comes at a time of increasing campus interest in social justice, reflected in the development of the humanitarian engineering program, which now offers two minors. "Students today want passion in their careers. They don't want to be half-engaged; they want what they do to make a difference," Priestley said.

Many alumni feel the same way. The group got started after Jessica Smith, the other co-director of the humanitarian engineering program, spent three years interviewing mining engineers, including many Mines alumni, about the role of social responsibility in their jobs. Many of those alumni wanted to connect their experience with the school.

After holding an initial networking event in Golden, group organizers invited researcher Rachel Dzombak to speak on campus in November 2017 about the role of engineers as social innovators and problem-solvers. "We were thinking we'd get 15 to 20 people," Priestley said. Instead, 75 people showed up. Today, the interest group has 187 members.

Members visit classrooms, talking to students about how social responsibility can be integrated into engineering projects. A petroleum engineering class recently staged a mock community meeting in which students addressed the potential concerns of people living near an oil field. Interest group members served as judges, explaining which parts of their presentations were effective or ineffective and why.

"It gave students the opportunity to learn from people who have been through this," Smith said. "It's first-hand feedback they wouldn't get otherwise, even though it will be a big part of their careers." Alumni who are unable to participate in person can use Skype to join the classroom discussions. The interest group also hopes to host live broadcasts of some of its events.

This spring, the group plans to show a film about the effects of small-scale, or "artisanal," gold mining, which can cause mercury contamination and other environmental and public health problems. Mines recently received a \$4 million National Science Foundation grant to tackle these challenges. Lucena is leading a team of researchers from Mines, the University of Colorado Boulder, U.S. Air Force Academy and universities in Colombia and Peru to better understand the interrelated social, environmental and technical dimensions of artisanal mining and work with miners to find more sustainable solutions. The project builds on research done by Nicole Smith, a Mines professor on the NSF grant as well as a faculty advisor to the alumni group, using human-centered design to reduce mercury use in artisanal gold mining in Peru and Bolivia.

TRIP ABROAD

In addition to hosting quarterly events, the group is planning a summer trip to Guatemala, where members will learn about a program created by Mines alumnus Ethan Faber MS '16 to help communities deal with landslides—and meet face-to-face with locals.

Faber wrote his master's thesis on the impact of landslides on the impoverished hillside neighborhoods of Guatemala City. He also lived in the area for a year, working with residents.

In the past, the way of addressing such disasters in landslide-prone areas was to warn the community of dangers and get them out—by eviction, if necessary. Faber tried a different approach. "I went house by house, listening to what people's problems were besides landslides," he said. Residents were not ignorant of the danger landslides posed, but weighed that threat against other concerns. If forced to move, many would have lost jobs they feared they

couldn't replace. Others would have faced transportation costs that put a serious dent in their finances. "They made the tough choice to stay here, but they also asked, 'What can I do?'" Faber said.

He worked with a local nonprofit, the Fundación EcuMétrica Guatemalteca Esperanza y Fraternidad (ESFRA), to develop training to help people recognize when a landslide is likely and how to reduce risk. "It was so different from a traditional engineering course, where you build a model, assume variables and use a calculator," Faber said. While he did all of those things, he also worked with the community to develop solutions that were practical for them.

Faber is now training as a geological engineer in Denver, but ESFRA continues to run his program in Guatemala. Current Mines student David LaPorte is documenting the results. But the best way to understand how this community-based program works is to go on the trip, which Ethan is planning for August 2018. Though the trip is educational, "we'll also have a good time," Faber said, with visits planned to nearby Mayan ruins and sandy beaches.

The interest group may also arrange a trip to South America to see the work Lucena and Mines students are doing with artisanal mines.

JOINING THE GROUP

The interest group would love to hear from more alumni with community experience, Priestley said. "By telling their stories and sharing their successes and failures, they show how to do engineering in a socially responsible way," he explained.

The curious are welcome, too. "It's a lot of fun going on trips, and engaging with people keeps you young," Priestley said. "You build your network not just in your career, but in your personal life. You never know where you're going to meet your next best friend."

By **Teresa Meek**

- ▶ To get involved with the Leadership in Social Responsibility Interest Group or to learn more about the other interest groups Mines has to offer, visit minesalumni.com/interestgroups.



ALUMNA PROFILE

SHOOTING FOR THE SPACE STATION

When Penny Pettigrew '92 was a young girl in California, she dreamed of being an astronaut. Growing up in the era of space exploration, it wasn't an uncommon aspiration for her and others her age. Further inspired by the 1986 movie *SpaceCamp*, Pettigrew hoped she'd be able to visit space one day.

Determined to achieve this goal, Pettigrew applied to Mines. She visited the school for a quick tour to make sure it was the right fit for her, then started on the path to earn a chemistry degree that eventually led to a job as the space station payload communications manager (PAYCOM) at NASA's Marshall Space Flight Center in Alabama.

Although her career path was set, Pettigrew found another opportunity for self-discovery. She had only recently learned of her family's Native American heritage before enrolling at Mines but received a large Native American student scholarship and became part of the American Indian Science and Engineering Society (AISES), where she was able to connect with students who all had different Native American backgrounds.

"I was still learning [about my background]," Pettigrew said. "Some folks had lived on reservations and understood their heritage their entire lives. Even though we were all Native American, we all came from very different backgrounds. We could learn from each other."

Coupled with the AISES support system and a small chemistry cohort, Pettigrew excelled at Mines and found herself looking into graduate programs. When nothing grabbed her interest after touring prestigious schools in California, she talked to her counselor at Mines.

"I remember explaining my experience and the counselor asked, 'Well, what do you want to do in your life?'" Pettigrew said. "I've always been interested in space, so she said, 'Then go find a grad school that does space stuff.' Which, to me, was like a 'duh' moment."

Pettigrew thought back to her experience attending the Adult Space Academy—the adult version of space camp—as a Mines student, when they toured the university across the street: the University of Alabama in Huntsville. When she went back for a second visit, she had the same good feeling she had when first visiting Mines. She enrolled at UAH and participated in graduate research for NASA, which eventually led her to the position she holds today.



Penny Pettigrew '92 dreamed about outer space as a young girl. Now, she works for NASA as the space station payload communication manager.

Photo by Emmett Given/MSFC NASA

"I'm one of the few people on this earth who get to talk to the astronauts who are living and working at the space station," she said. "We focus on the science that the astronauts do up there."

At any given time, there could be 150 science payloads at the International Space Station, and Pettigrew and her team monitor the steps the astronauts are taking and the tools they are using in their research. When she looks at her daily tasks, she sees similarities to her EPICS project at Mines.

"What I learned to do at Mines that I still use today is critical thinking," she said. "In an environment like the space station, you don't always know what's going to happen."

Pettigrew started on the path to her dream job while at Mines, and she continues to encourage today's youth to follow their passions, particularly those with diverse backgrounds like hers.

"When I talk to Native American kids, I see the same excitement in their eyes all kids have about space," she said. "Then when I start talking about opportunities, I can see that switch flip, and they think, 'Oh, I can't afford to do that,' or 'I don't have a way to do that' or 'those opportunities aren't available to me.' The excitement and chatter quiets. I try to encourage them not to give up and keep working toward their dreams no matter what."

By Anica Wong

SPRING 2018 ON OUR WALL

Whether it's a quiet nook in the library or a sunny patch of grass on Kafadar Commons, Mines has some great places to study or take a quick break from a busy schedule. Where was your favorite study or hangout spot on campus when you were a student?

Steps of Engineering Hall.

Greg Brown '76

The Ace-Hi Tavern.

Andrew Aichlmayr '96

There was a yarn shop across the street from the metallurgy building where I loved to hang out while in grad school.

Wendy Hahn MS '92

I would hang out in the Digger Den. A group of 14 or so friends would rotate through three tables we pulled together. We always could find a spot to sit and a friend to chat with while doing homework.

Cassie Harmon '12

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OREDIGGERS GIVE BACK

ALUMNI GOLF TOURNAMENTS SUPPORT STUDENT SUCCESS

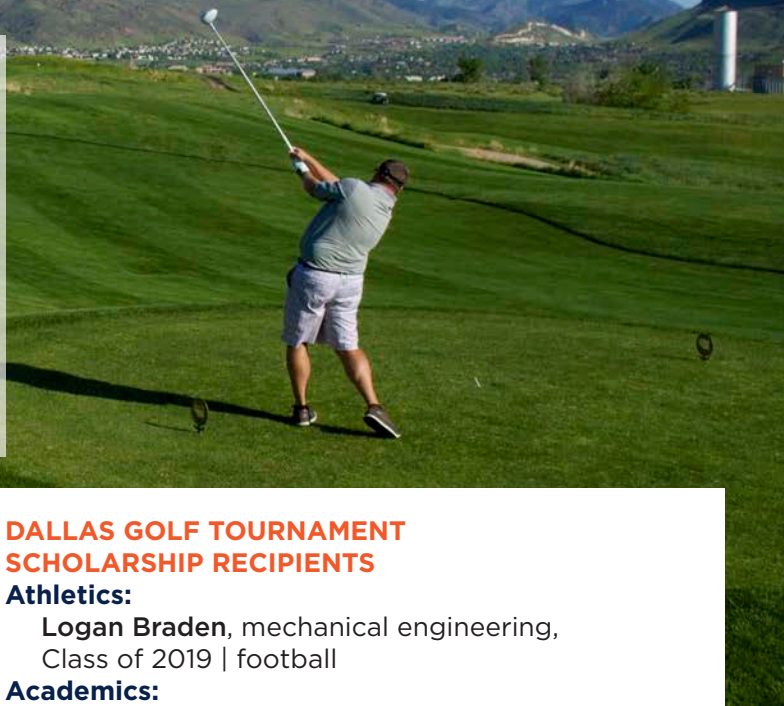
TOURNAMENTS AND DATES:

18th Annual Houston Endowed Scholarship Golf Tournament
April 27, 2018 | Gleannloch Pines Golf Club

9th Annual Oklahoma City Endowed Scholarship Golf Tournament
May 4, 2018 | Rose Creek Golf Club

4th Annual Dallas Scholarship Golf Tournament
May 18, 2018 | Bear Creek Golf Club

34th Annual Golden Scholarship Golf Tournament
June 8, 2018 | West Woods Golf Club



HOUSTON GOLF TOURNAMENT SCHOLARSHIP RECIPIENTS

Athletics:
Ryan Buck, computer science, Class of 2019 | football
Scott Marshall, economics and business, Class of 2020 | football
Madeline Behr, biochemical engineering, Class of 2018 | volleyball

Academics:
Mackenzie Malkowski, geology, Class of 2021

OKLAHOMA CITY GOLF TOURNAMENT SCHOLARSHIP RECIPIENT

Academics:
Joseph Kusbel, mechanical engineering, Class of 2020

DALLAS GOLF TOURNAMENT SCHOLARSHIP RECIPIENTS

Athletics:
Logan Braden, mechanical engineering, Class of 2019 | football

Academics:
Daniel Stehling, mechanical engineering, Class of 2019

GOLDEN GOLF TOURNAMENT SCHOLARSHIP RECIPIENTS

Academics:
John Strang, mechanical engineering, Class of 2018
Badreddine Belfageoua, mechanical engineering, Class of 2018



Dean Stoughton '75, MS '78

“I was one of the original organizers for the Houston alumni scholarship golf tournament. Two other Houston colleagues and I spent more than ten years organizing and marketing a successful tournament that would help financially challenged students attend Mines. It requires a lot of dedicated work by individuals with unique skill sets that complement each other.

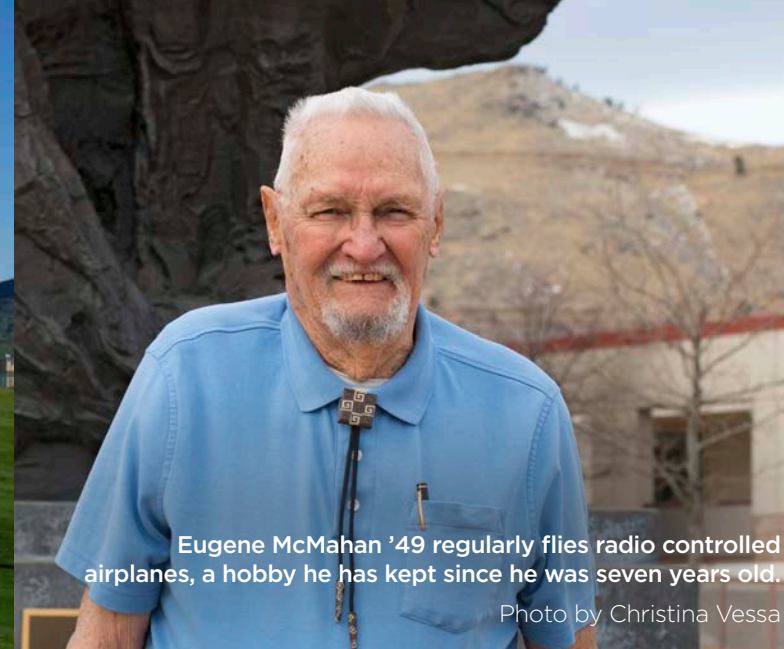
“Many of us who graduated from Mines have attributed a good portion of any success in our careers to our experience and colleagues while attending Mines. Like many, I couldn't wait to graduate and move on, but as the decades went by, I really saw the benefits of the Mines experience. Now, with a bit more personal time available, I enjoy being amongst alumni who love to give back in so many ways.”



Justin Dvorak '16

“It means a great deal to be participating in the tournament, one reason being that I'm a former scholarship recipient, but another being that the tournament is at the same golf course I worked at when I signed my letter of intent to play football at Mines. To be back as a participant is nostalgic.

“The scholarship was very impactful. Not only did it provide assistance financially, but it also motivated me to continue to handle my business. The scholarship was confirmation that my hard work and dedication wasn't going unnoticed.”



Eugene McMahan '49 regularly flies radio controlled airplanes, a hobby he has kept since he was seven years old.

Photo by Christina Vessa

When Eugene McMahan '49 was seven years old, he spent his time building 10-cent model airplanes from tissue paper. It took him about a month to build each plane, and then he would throw them out his second-story bedroom window. Only a few would actually fly, but that never discouraged him.

McMahan bought his first model airplane engine as a teenager. His father was a pharmacist who owned a drug store, and McMahan was tasked with cleaning the shelves after class at Wheat Ridge High School.

“I spent a week cleaning shelves, and when I was finished, [my father] took me to the cash register and handed me a \$10 bill,” McMahan said. “I took that \$10 down to the hobby shop on Welton Street in Denver, and I saw this model airplane engine for \$10. I bought it, eventually putting it in an airplane I built, and didn't fly it until years later.”

After graduating from Mines with a professional degree in geology, McMahan spent his entire career with Shell Oil Company's seismic crew. Even while working in Oklahoma, Louisiana, North Dakota and Texas, McMahan carried his love for model airplanes from state to state.

One of McMahan's favorite moments took place in the 1960s as he flew his first radio-controlled airplane near a forest in the New Orleans swampland. The engine stopped midflight and the plane disappeared into the woods.

McMahan goes to a jeweler in downtown Golden once a year—not to purchase anything for himself, but to order a silver coin for the most recent recipient of the Eugene C. McMahan Endowed Scholarship.

McMahan had the first silver coin made in memory of his oldest daughter, Teresa, who died of lupus-related complications in 1994. He gave the coin to his first scholarship recipient at CU's School of Pharmacy. Since then, his scholarship fund at Mines has provided a four-year award for an entering freshman who was a top high school graduate. First preference is given to graduates of Wheat Ridge High School.

ALUMNUS PROFILE

TAKING FLIGHT WITH MODEL AIRPLANES

“I went out to look for it, but the forest was so thick that you couldn't see five or 10 feet this way or that way” McMahan said.

He went to a local airport and asked a pilot to fly him above the forest. “I told him we might be able to see from up above,” McMahan explained. “We looked and looked and looked. We didn't find it.”

McMahan considered the plane a loss until a month later when he received a telephone call. A man hunting squirrels had spotted McMahan's airplane in the treetops of the same forest where it had gone missing weeks earlier. The airplane had landed without crashing, and the man climbed up the tree to retrieve it. Because McMahan's contact information was written inside the plane, the man was able to track him down. McMahan was reunited with the plane and continued to fly it for years. He still has the radio today.

McMahan also has a few free-flight model airplanes. He sparks the engine and throws them into the air with some fuel, and they fly all by themselves without any external control after launch.

A couple of years ago, he built an ambitious four-engine airplane with a 14-foot wingspan, which he says is very easy to fly despite the fact it is so complicated.

Today, McMahan is an active member of the Arvada Modelers Association, an organization of over 300 members that owns a field off Highway 93, between Boulder and Golden. They fly their model airplanes from a concrete runway on Monday, Wednesday and Friday mornings in the summer.

“The concrete runway is just a beautiful place to fly,” McMahan said. “Much better than the forest back in New Orleans.”

By **Christina Vessa**

Currently, four students benefit from McMahan's scholarship, and a total of 21 students have benefited from the fund over the years. The first Mines scholarship was awarded in 1999, and \$354,037 has been given since the fund was created.

McMahan supports his alma mater regularly, and after 39 years of giving, he is now Mines' longest-living continuous donor.



TAKING AN INTEREST

AN UPDATE ON
WHAT THE ALUMNI
INTEREST GROUPS
HAVE BEEN UP TO



Join a Mines alumni interest group to learn about industry-focused opportunities and stay connected with others from the alumni, faculty and student communities. Whether you're interested in the latest news at Mines, connecting with faculty, networking and attending events or sharing your expertise, there are many ways to get involved.



AEROSPACE

The Aerospace Interest Group has been participating in, co-sponsoring and planning many events. Recently, members were panelists and presenters at an Engineers Week event held at Mines and sponsored by Lockheed Martin on Feb. 16, 2018. In May, the interest group is co-sponsoring a Young Professionals Networking Event with the Rocky Mountain Section of AIAA. Additionally, the group is working with DiggerLoop, the Mines Hyperloop team, as they head to the finals of the 2018 SpaceX Hyperloop competition in July. The group is also planning Trajectories 2018, after last year's successful inaugural networking event.



ENTREPRENEURSHIP AND INNOVATION

The Entrepreneurship and Innovation Interest Group has been working on enhancing its presence at Mines. The group has held regular meetings with discussions about how to facilitate connections between Mines alumni seeking assistance in their business ventures and those with the services and expertise to achieve those goals. In January 2018, the group attended the Kern Entrepreneurial Engineering Network (KEEN) Foundation's annual convention with Mines' Center for Entrepreneurship and Innovation and faculty, learning about how other institutions have promoted entrepreneurship and innovation on their campuses. Mines was admitted to KEEN on Jan. 15, 2018.



WOMEN OF MINES

The Women of Mines Interest Group committee meets monthly to connect and bridge alumnae across demographics, disciplines and stages of career development. The group is kicking off quarterly opportunities for alumnae to connect and develop both personally and professionally. Already, members have been involved in Making the Connection events this spring, where alumnae shared stories of their Mines experiences with admitted students and their families. In addition, the group has held networking events like happy hours and forums with discussions centered around work-life balance, career changes and dealing with harassment.



STEAM

A group of alumni traveled with students and faculty from Mines' music program to Vietnam, where they were able to learn about Vietnamese culture, cuisine, language and music. In addition, they visited several universities, volunteered at an orphanage, participated in cooking classes and had a Vietnamese-language karaoke contest. Join the STEAM: Arts & Humanities Interest Group on Apr. 20, 2018, for the *High Grade* release party at Foothills Art Center in Golden.

► To learn more about any of these opportunities or to volunteer, visit minesalumni.com/interestgroups or contact Damian Friend at dfriend@mines.edu or 303-273-3154.



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WEDDINGS



ROCK-SOLID LOVE

Katie (Sarah) Logan MS '15 and Nicholas Kernan MS '15 were married on Aug. 12, 2017, in Breckenridge, Colo. The couple met in Dr. Piret Plink-Bjorklund's sedimentology course, and Nicholas was insistent Sarah join his field group. They began dating a few months later and have been together for five years. Sarah and Nicolas both took jobs in Oklahoma City after graduation but moved back to Golden in June 2016 when Nicholas began working as a geologist for the U.S. Department of the Interior. Sarah currently works as an operations geologist for Alta Mesa Holdings. Mines alumni who attended their wedding included Carl Symcox MS '15 and Mike Genecov PhD '18.



CELEBRATING TEAMMATES

Cole Spurgeon '16 and Taylor Helbig '15 were married on Aug. 5, 2017, in Thornton, Colo. Cole and Taylor started dating in their freshman year at Mines. Both athletes, Cole played college football for five years and Taylor played basketball for four years. Mines alumni in the wedding party included Cassie Vick '15, Sam Rusk '15, Danielle Skinner '15, Avery Llewellyn '15, Brandon Hostetler '15, Jared Spicer '15, Matt Schmid '15, Zach Richter '16, MS '17 and Devin Reaves '17. Many of the couple's teammates and coaches also joined the celebrations.



TIME TO CELEBRATE

Megan Peterson '16 married Trey Sloan '16 on June 10, 2017. Alese Madenwald '13 was Megan's maid of honor, with Betsy Hansing '13, Melanie Wannamaker '14 and Madeline Behr '18 serving as bridesmaids. Jordan Tucker '16, Daniel Zarrini '16 and Wyatt Lang '16 served as Trey's groomsmen, and Brianna Robinson '16 was the reader.



A SCAVENGER HUNT INTO THE FUTURE

Lauren Aberle '13, MS '14 and Thomas Brown '13, MS '14 were married on Sept. 16, 2017, in Loveland, Colo. Morgan Seifert '13 and Stephanie (Runia) Martin '13 served as bridesmaids and Charley Kruse '13, Derek Witte '13 and Brian Zook '14 served as groomsmen. More than 20 additional alumni attended the wedding. Lauren and Thomas met at Mines while studying computer science, and Thomas proposed during a scavenger hunt that ended on the Mines campus.

SURROUNDED BY OREDIGGERS

Scott Roman '14, MS '15 married Eliza Porterfield '14 on Nov. 11, 2017, in Irwin, Pa. Scott and Eliza met as students at Mines through a mutual interest in rock climbing. Several Mines alumni attended their wedding, including Shannon McAvoy '14, Shannon Blodgett '14, Ethan Blodgett '14, Conor Lenon '14, MS '15, Aaron Gunzner '14, MS '16, Alexandra Leroux '14, MS '15, Jonathon McBride '14, MS '15, Sam Cooper '14, Max Mazzocchi '14 and Nathan Neibauer '14.



► To submit a wedding, birth or award announcement for publication in the magazine, visit minesmagazine.com/submit-an-announcement.

IN OTHER NEWS



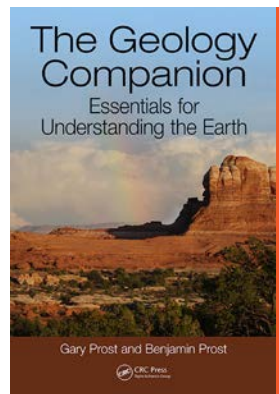
OUTSTANDING PROJECTS AND LEADERS AWARD

Dave Zanetell '87 recently received the American Society of Civil Engineers' Outstanding Projects and Leaders (OPAL) award. The OPAL awards honor outstanding civil engineering leaders whose lifetime accomplishments contributed to construction, design, education, government or management. With past involvement in projects across 22 states and as project manager for the Hoover Dam Bypass, Zanetell was honored for his achievements in construction.



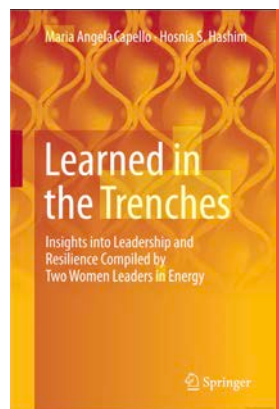
AVIATION WEEK LAUREATE AWARD

As part of a joint team with Boeing and Norsk Titanium, Matthew Crill '00 was selected as a winner of the 61st Annual Laureate Awards, in the category of Commercial, Supplier Innovation. The award granted on March 1, 2018, recognized the team for qualifying the first additively manufactured structural titanium parts for commercial aircraft. Crill served as project leader, and the additive parts are currently in production on the 787 Dreamliner.



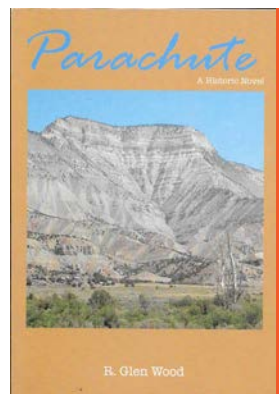
THE GEOLOGY COMPANION

Gary Prost MS '75, PhD '86 published the book *The Geology Companion: Essentials for Understanding the Earth* in December 2017. The guidebook provides a basic grounding in the principles of geology and explains how to apply them, in addition to how geologic processes affect people and their daily lives. (CRC Press, 2017)



LEARNED IN THE TRENCHES

Maria Capello MS '95 co-authored the book *Learned in the Trenches*, with Hosnia Hashim, vice president of operations at Kuwait Foreign Petroleum Exploration Company. The book details the perspectives of two women who waded through the challenges of multiculturalism and gender in corporate environments of the energy sector in the Middle East. The book contains interviews with influential leaders in the energy sector and offers a compilation of personal approaches to professionalism, resilience, work and success. (Springer International, 2018)



PARACHUTE

R. Glenn Vawter '60 published the novel *Parachute*, about a man and his grandson working in the oil industry in Western Colorado. The grandson develops a new oil shale technology and the two characters set out to test it. The grandfather is influenced by the events of the end of the last energy boom, while the grandson thinks he can improve his predecessors' practices. Over the course of the book, the characters realize their energy vision for the United States, though the success of their vision is uncertain.

BABIES



ANOTHER LITTLE SISTER

Dustin Bennetts '03 and Stephanie Bennetts '03 are excited to announce the birth of their fourth child, Shelby Jo Bennetts. Her siblings, Beau (9), Kiera (6) and Brock (3), cannot get enough of her.



NEW ADDITION

Bryan White '07 and Brittney White '10 welcomed their daughter, Brooke Marie White, on May 23, 2017.

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Visit plannedgiving.mines.edu/beneficiary-designations or call 303.273.3275



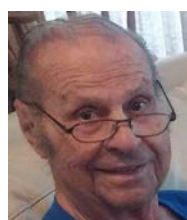
IN MEMORIAM

“When you are sorrowful look again in your heart, and you shall see that in truth you are weeping for that which has been your delight.”

-Kahlil Gibran



JEFFREY J. “JEFF” BELL '64 died Dec. 28, 2017. He was born in Ogden, Utah, in 1941. Jeff and his family moved to Colorado when he was a senior in high school, and he graduated from Mines in 1964 with a professional degree in metallurgical engineering. Jeff served in the U.S. Army from 1965 to 1968, with a stint in France as a member of the Army Corps of Engineers. He was an aide-de-camp to a brigadier general in Paris for one year. Upon his return, Jeff began a marketing career in the U.S. petrochemical industry, working for Shell Chemicals and Conoco Chemicals. In 2010, he retired as an executive vice president for marketing at Texas Aromatics, LP after a 30-year career.



KELSEY L. BOLTZ '64 died Oct. 9, 2017. Kelsey was born in 1930 in Springfield, Ohio, and excelled in academics and played minor league baseball for the Pittsburgh Pirates and Philadelphia Phillies, using his earnings to pay his Mines tuition. Kelsey graduated from Mines in 1964 with a professional degree in geology and began a 65-year career as a geological engineer and entrepreneur. He founded numerous companies around the world and was a lifetime member of the U.S. Geological Society and the American Institute of Professional Geologists.



BRIAN L. HILDENBRANDT '88 died Jan. 28, 2018. Brian was born in 1966 and graduated from Mines in 1988 with a bachelor's degree in civil engineering. As a student, Brian was known to hang glide off Lookout Mountain and land on the fields on campus. After graduation,

Brian worked for his father, Doug Hildenbrandt '58, for several years at Hildenbrandt Geotechnical in southern California. However, he eventually moved back to Colorado and worked for Entech Engineering. Brian then started his own consulting engineering company, Hildenbrandt and Associates, which he maintained for over two decades. He specialized in custom residential construction and forensic engineering investigation. Three of his six children also attended Mines: Ava '14, Everett '15 and Eric '18.



GENE J. KRAEFER '53 died Nov. 28, 2017. Gene was born in 1928 and enlisted in the U.S. Army Air Corps after high school. He then graduated from Mines in 1953 with a professional degree in petroleum engineering. Gene began his career as an exploitation engineer for Shell Oil

Company in Texas and Louisiana. In 1955, Gene joined Trunkline Gas Company and served as a lieutenant in the U.S. Army Reserve. Gene then worked for Parkersburg Rig and Reel Company and later became product manager and general manager of Parmac. Gene then joined FWI in 1967, becoming president of the company in 1972. He also served as vice chairman on the 1971 United Fund Campaign and was active in Boy Scouts and the local Mines alumni chapter. In 1974, Gene joined John Zink Co. as the director of manufacturing and later was active in the company's overseas operations. Gene rejoined FWI, which had become Wheatley Pump and Valve Co., as vice president and general manager in 1978. He later became a director, president and CEO of Wheatley TXT. He retired in 1994.



WALTER H. MARTZ, JR. '51 died Jan. 12, 2018. Born in 1927, Walter joined the U.S. Navy and played the baritone in the Navy band. He returned home to Hutchinson, Kan., where he attended junior college. After marrying his wife, Walter moved to Golden, where he graduated from Mines in 1951 with a professional degree in geology.



WILLIAM A. “BILL” MCELDUFF, JR. '82 died Mar. 10, 2018. Bill was born in 1958 in Seguin, Tex., and received an appointment to the U.S. Military Academy at West Point. He then attended Mines, graduating in 1982 with a bachelor's degree in petroleum

engineering. He worked for 36 years in the international oil and gas industry, starting in production and drilling engineering before moving into directional drilling. In the second half of his career, Bill focused on designing and implementing relief wells, and was a key part of the control team for the Deepwater Horizon oil spill.



CHARLES A. “CHUCK” RANLETT III '55 died Jan. 11, 2018, in Danville, Calif. Born in 1931, Chuck spent the year before college serving in the Merchant Marines and climbed Mt. Fuji. He then attended Mines and graduated with a professional degree in mining engineering in 1955. Chuck

settled in California, where he worked on the San Diego aqueduct. He then spent the next 37 years of his career with the East Bay Municipal Utility District.



JAMES F. “JIM” RUCKER '52 died Jan. 7, 2018. Jim was born in 1926 and received a professional degree in geological engineering in 1952. In his career, Jim worked as an exploration geologist for Union Oil, British American, Texas Gulf Sulphur and Monsanto. After 20 years

in the corporate world, he left to explore on his own and served as a long-term consultant to the Rowan Companies.



BRIAN J. SMITH '85 died Dec. 27, 2017. Born in 1962, Brian graduated from Mines in 1985 with a bachelor's degree in petroleum engineering. He spent his career working in the oil and gas industry for more than 30 years, which included working for Anadarko Petroleum. He was also a musician, avid traveler and craftsman.

► To submit an obituary for publication in the magazine, visit minesmagazine.com/submit-an-obituary.

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MINER'S PIC



STEPPING IN FRONT OF THE CAMERA

Vy Duong, a civil engineering major with a double minor in humanitarian engineering and public affairs, has done her fair share of traveling. Last fall, she studied abroad in Vietnam and visited Trang An Scenic Landscape Complex during one of her breaks. "Trang An is a really gorgeous place, physically and historically" Duong said. She was inspired to pick up her camera.

The photo above shows a local who provides boat tours. Duong explained that often, much of the standard fee tourists pay for boat rides goes to the company running the tours rather than the guides themselves. Instead, the guides rely on tips, but, ironically, tipping is not a large part of Vietnamese culture. "It's so important for these local people to make a connection with tourists in order to get the money they need," Duong said. "Yet there are many barriers

to that, including culture and language, which are rarely circumvented, unless the tourists are wealthy Vietnamese people or Vietnamese-Americans like myself."

Wanting to capture this relationship, Duong stepped out from behind the lens to become the subject of her photo. She had fellow Mines student David LaPorte take the photo, but she still staged the scene, adjusted the settings on the camera and edited the photo after it was taken. Duong is pictured in the foreground of the photo, turned away from the camera. "I really wanted to have this photo, because I am usually the one behind the camera," Duong said. "I don't always get the chance to record my interactions with locals in a visual manner."

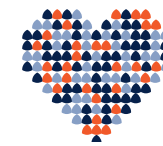
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