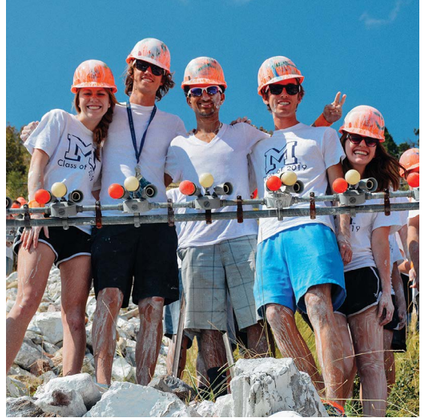
WHAT MAKES AN OREDIGGER?



Times change, but Mines graduates remain the same—hard workers who know their discipline cold.

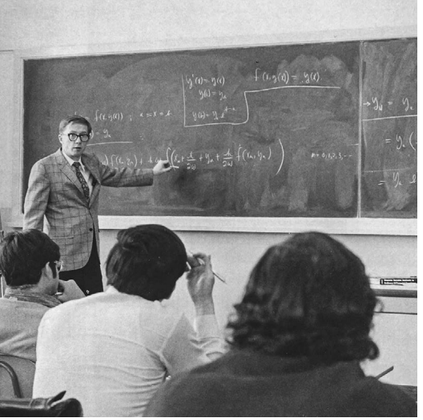
By **Lori Ferguson**

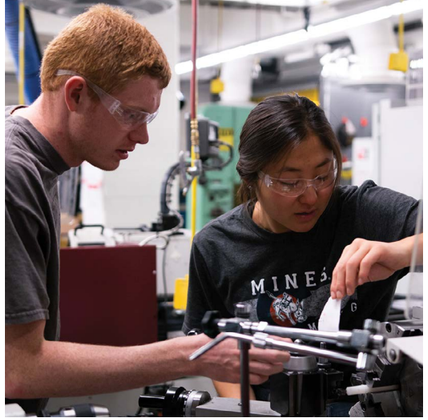
For more than 100 years, Mines has enjoyed a reputation as a tough, no-nonsense educator of engineers in the earth sciences. Although that ethos has not changed, aspects of the Mines educational experience have transformed over the past several decades to keep up with societal changes and evolving industry demands.

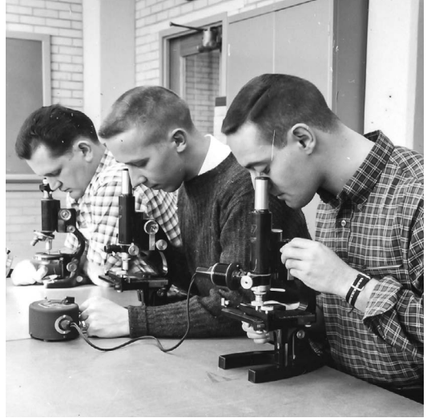
In years past, for example, students learned foundational skills by completing countless problem sets, a practice known variously as "drill and kill" or "plug and chug." Today, students leverage technological innovations such as high-powered calculators and computers to learn the basics and more quickly begin to focus on higher-order thinking skills like synthesis, analysis, evaluation and design.

The approach to learning has also evolved, expanding from a predominantly lecture-based format to a more collaborative approach. The student body has grown from two graduates in the inaugural class of 1883 to more than 6,200 undergraduates, graduates and non-degree students; the campus' square footage has grown exponentially; and diversity within the student body is much greater—there are more women, more underrepresented minorities and more students from outside the state of Colorado.

Despite these generational shifts, conversations with alumni, faculty and administrators reveal that there are three characteristics to a Mines education that remain steadfast: a strong work ethic, superb expertise and an outstanding ability to work collaboratively to get the job done well, whatever it takes.







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—Teaching Professor Tracy Gardner ’96, MS ’98

MINES IS (STILL) HARD

“When I came to Mines as a freshman in 1955, I remember being told on the first day, ‘Look to your right. Now look to your left. In a year, one of those people will be gone,’” recalled Jim Payne, a geophysical engineering major from the Class of 1959.

Mining engineer Bruce Grewcock ’76—now chairman and CEO of construction engineering company Peter Kiewit Sons’ Inc.—has a similar recollection. “We were told at freshman orientation that a number of us were going to flunk out,” he said. “There was a sense that this place was different, and we all knew it was going to be tough. My freshman year, I remember walking up to a booth in the fieldhouse to sign up for a course, and the professor gave me my first homework assignment at the booth—I hadn’t even attended class yet.”

While today’s students are no longer looking over their shoulders in the same ways as their predecessors, Jim Payne’s granddaughter, Julia Payne ’19, maintains that Mines still has a very challenging undergraduate program. “My grandfather always says, ‘Y’all have it so easy,’ but I can’t really believe it was that much harder in his day,” she said.

In fact, it was her grandfather’s good-natured ribbing that motivated Julia Payne to attend Mines in the first place. “He said I couldn’t do it, so I said, ‘I’m gonna do it,’” she noted with a chuckle.

And she did. Julia completed her degree in geological engineering and is now an engineer-in-training with Austin-based Corsair Consulting. Attending Mines taught her what it means to work as hard as it takes for as long as it takes, she said. “For example, my senior year, I only had one class at 8 a.m. on Mondays, Wednesdays and Fridays, but I still did homework until 4 p.m. every day.”

While Julia argues that the difficulty of securing a degree from Mines has not changed, she does believe the approach to teaching is different. Teachers’ expectations remain high, she asserts, but their approach is softer. “I think teachers are nicer and more willing to help than they were in my grandfather’s day,” she observed. “My professors were willing to meet me outside of regular office hours and answered my emails at off hours. Their attitude was, ‘I’m a teacher, and I’m here to help.’”

Longtime faculty member Tom Boyd, an associate professor of geophysics and associate provost, agrees. “The learning experience has changed radically,” he said. “Thirty years ago, we lectured at students—and I say ‘at’ very intentionally. We lectured, then gave them six to ten hours of homework to do every week and called it good.”

But today, Boyd said, faculty approach teaching quite differently. “Thanks in part to guidance from staff at the Trefny Innovative Instruction Center, we’ve rethought our approach to residential instruction, and we’re much less reliant on lectures,” he explained.

Instead, teachers are asking students to be more engaged in the learning process. “Alumni from the ’50s, ’60s and ’70s wouldn’t recognize our classrooms today,” Boyd asserted. “Nowadays, instructors are expected to help facilitate student learning—students take the lead in their educational experience.”

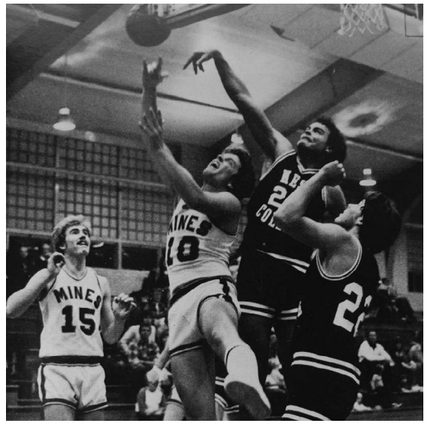
Teaching Professor of Chemical and Biological Engineering Tracy Gardner ’96, MS ’98 applauds the change. “Research on the ways that people obtain—and retain—information has shown that students who are involved in their own learning process are more successful, so I think it’s much more helpful to think of ourselves as learning facilitators than as teachers or professors,” she said.

Gardner is quick to acknowledge that the landscape has changed for students as well. “The standards for admission to Mines have gone up over the years, not down,” she asserted. “Now, in addition to good grades and a strong work ethic within the classroom, students are expected to be involved in a host of other interests outside those four walls.” And when they graduate, they will find that employers are also looking for well-rounded individuals, Gardner continued. “These days, companies are also not just looking at GPAs, they’re looking at the whole person.”

The number of hours required to complete an undergraduate degree has also changed, decreasing from 160 hours to around 130. Boyd said that some alumni have expressed alarm at the new standard, and while he understands their concerns, he believes they are misplaced.

The reduction in hours doesn’t reflect a dilution of curriculum, he argued. Instead, it’s a reflection of changing times. “Although today’s students aren’t completing as many hours, they’re gaining other extracurricular experience that’s equally important to their education,” he pointed out. “They’re involved in internships and more extracurricular activities off-campus. Today’s students are more problem-based in focus rather than disciplinary-based, and they’re constantly looking for ways to connect their passions with their expertise.”

Electrical Engineering Professor Kevin Moore, who also serves as Mines’ vice provost for strategic initiatives and dean of integrative programs, seconds that opinion. “It’s true that students are taking fewer credits these days, but nearly all students are doing an internship at some



point during their four years, and many are doing multiple internships," he said. Moore also posited that virtually every student on campus is involved in at least two extracurricular activities. "They're learning valuable lessons outside the classroom as well."

Standards remain high, and faculty retain their dedication to equipping students with a strong professional foundation, Boyd said, but they also recognize that students are less tolerant of homework that seems redundant or repetitive. "Our students want to understand connections between their studies and the real world and exploit the computational and visualization resources available to them—it's the way they're accustomed to learning."

"Today's pedagogy lends itself to learning better and faster," explained Moore. "These days, we don't need to assign 50 homework problems when we can use a team-based approach and three problem sets to convey the same lesson."

Gardner agrees, but admitted she's seen a change in the way students respond to the expectations placed upon them. "Being a student here is tough, and expectations are high," she said. "At Mines, getting a B in a course is perceived by some students as failing, because they are used to earning A's only—or primarily—and students sometimes struggle with that. As a teacher, I'm interested in what students do when they hit a wall and how they handle that perceived failure. I believe a student's ability to persist and continue to learn when faced with something more challenging will correlate positively with their happiness as a working professional. It's important to me that students graduate knowing how to think, solve problems and handle a situation well when it's harder than they anticipated."

Faculty are committed to helping students manage expectations and become more resilient and resourceful using the many campus resources at their disposal, Gardner continued, but she also encourages understanding. "Students sometimes forget that faculty are scientists and engineers, too, and students may misinterpret a faculty member's seeming lack of enthusiasm or approachability as an indication that they're disinterested or uncaring, which isn't the case. We want to see these kids succeed," she said.

This new approach delights Jim Payne. "Nowadays, the message that incoming students receive is, 'Look to your left, and now to your right and know that we're going to do our best to get you all through.' And I think that's a much better approach," he said.

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TRADITIONALLY GROUNDED, FORWARD THINKING

For Julia Payne, this collaborative approach proved fruitful. She landed a job immediately after graduation and is already applying her education in the field.

"Professor [Paul] Santi always told us that getting an education at Mines isn't about memorizing stuff—it's about learning to work hard and learn on the spot," she observed. "Working toward my degree at Mines, I learned to pick things up quickly and take criticism well, skills that have helped me to hit the ground running in my new job."

While he graduated 60 years earlier, her grandfather said he realized the same benefits from his education. "My Mines experience gave me the background to compete with anyone in the oil and gas industry on a technical basis," Jim explained.

Today's students receive the same strong foundation, said Boyd, but they must be prepared to apply it within a different occupational landscape. "In the '50s and '60s, people were typically looking at a career path in one industry," he observed. "Today, however, students expect to change careers and directions multiple times. They know they need to be able to embrace change and retool themselves mid-career, and they're actually leading faculty in determining what skills they'll need to thrive and survive in careers 10, 15 and 20 years out."

And faculty are responding, employing new teaching strategies such as the studio model, which relies heavily on teamwork, and flipped classrooms, where teachers present the lecture materials online and lead students in more engaging, higher-level thinking in the classroom.

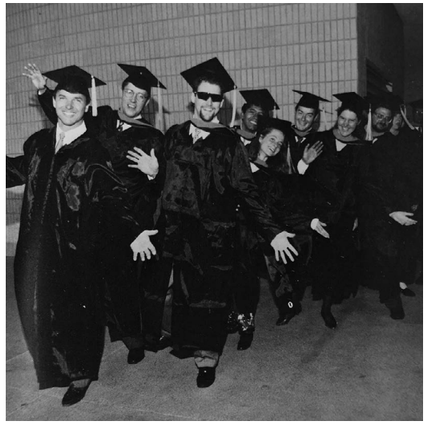
Online learning is also becoming increasingly commonplace, a trend that Gardner welcomes. "Students will inevitably have to do online training in the workplace, so gaining familiarity with this style of learning now can only benefit them," she observed.

Gardner recently offered her Material and Energy Balances course to students online with what she feels to be great success. "This course is one of the toughest chemical engineering courses that students have to take, and every single kid in my online course had been unsuccessful in the traditional, residential class at least once. Overall, they all did great with the online offering," she said. "It's also the most interactive course I've ever had—the students asked lots of questions and helped each other tremendously in the online forum, and I was able to provide more individualized feedback than I have before in face-to-face courses. I feel it was rewarding for all of us."

TACKLING TOMORROW'S PROBLEMS...TODAY

An ability to communicate well with others and work effectively in teams using the technology at hand is critical in today's workplace, noted Kiewit CEO Grewcock. "Engineers and scientists today need to deal with multiple constituencies—politicians, regulators, members of the public—so they need to be well-read, well-rounded, and they need to know how to interface with society at large."

"I'm pleased that the school maintains its sharp focus on a math and science expertise, but importantly has expanded its reach into the other engineering and science disciplines," Grewcock continued. "Mines, in my humble opinion, is the go-to place in the world for tackling issues of earth, energy and the environment. No place else that I am aware of is preparing undergraduate or graduate students



> **Earning a degree here is still challenging—that's an inherent part of Mines—and that's what produces such outstanding graduates.**
>
> —President Paul C. Johnson

or doing the research necessary to ensure we continue to raise the standard of living of the world and solve some of our most pressing challenges."

"Earning a degree here is still challenging—that's an inherent part of Mines—and that's what produces such outstanding graduates," observed President Paul C. Johnson in a July 2019 episode of the *Getting Smart Podcast.* "The value of an engineer going into the future is not only how well they do the calculations—that will always be an element—but also how they view the connections between the problems that they're working on and the impact on society and industry."

Mines students have always been recognized for their superb disciplinary expertise, strong work ethic and ability to work collaboratively to solve a problem, noted Boyd, and that will never change.

"Students from other institutions compete with each other, but that doesn't happen at Mines. Our curriculum has always been so difficult that students had to work together in order to survive—we've come to realize that's what makes us unique."

Nowadays, however, faculty are trying to be more thoughtful in incorporating this trait into the Mines experience. "Older alums never say they graduated Mines, they say they survived and got out," Boyd said with a rueful laugh. "Our aim is to maintain those high standards while also enabling students to recognize and value the learning experience as soon as they graduate, rather than 10 or 15 years later."

"We're on a very positive trajectory here at Mines," said Gardner. "The current administration, faculty and staff are keenly focused on the fact that the higher education landscape is changing. Mines was already doing a great job of providing an excellent education when I was a student—that's why I wanted to become a professor—but I believe the current learning experience is even richer now than it was for previous generations. Mines offers students an outstanding learning experience, and we're poised to become even better. I feel really lucky to be a part of it."

"Faculty expect students to be serious, grown-up and committed to their studies— that hasn't changed," Moore observed. "Mines graduates have always seen themselves as people who can have an impact and make the world a better place. Today's students are working hard to continue that legacy."