



Mining Engineering Department Newsletter

Letter from the Mining Engineering Interim Department Head

It is my distinct pleasure to communicate the state of our Department and programs with our alumni, industry representatives and supporters. I am glad to report to all of you that our Mining Engineering program is strong and steadily growing. Let me start by acknowledging **Dr. Priscilla Nelson**, who has led the **Mining Engineering Department** for the past six years and helped the Department grow to the highest number and most diverse faculty we have ever had. For the past five years, the program has **ranked No. 1 in the world by QC World University Rankings** and has attained international recognition as the leading program in mining and minerals engineering worldwide. During Priscilla's tenure, we added two endowed chair professor positions in Mining Engineering: the **Timothy J. Haddon - Alacer Gold Endowed Chair** (Dr. Rostami) and the **Fred Banfield Distinguished Endowed Chair** (Dr. Duzgun). Dr. Nelson continues to be an invaluable resource to the Department. On behalf of our faculty, I would like to thank her for the dedication and leadership she offered to our program.



I am also pleased to report that **Dr. Patrick Taylor**, **Dr. Corby Anderson**, and **Erik Spiller** have joined our department from **Metallurgy and Materials Engineering (MME)**. They offer valuable expertise in research and teaching in the areas of **Mineral Processing and Extractive Metallurgy (MPEM)**. The MPEM faculty are developing a new minor to students across campus, which will add to the appeal of the topics we offer in our department. The change also means that **KIEM – Kroll Institute for Extractive Metallurgy, CR3 – Center for Resource Recovery and Recycling**, and **CMI - Critical Minerals Institute** are now part of our Mining Engineering Department.

We have continued to work with partners across the country and around the globe to enrich our program. This includes collaborations with universities in **Australia, Asia, Europe**, and especially **South America** in the form of joint research projects, student exchanges, research internships and visiting scholar lectures. A major engagement is with **Universidad Nacional de San Agustin (UNSA)** in Arequipa, Peru, where eight research projects are underway related to sustainable mining practices, improvements in ground control and ventilation, safety, and social and technical aspects of small and artisanal mining in Peru. Discussions are underway with **Arab Mining CO (ARMICO)** to collaborate on educational and research topics. We have had visiting groups from **Brazil** to join in research consortiums to study tailing dams and their design, management, and risk assessment. We host summer training programs for students and faculty from **China** and **Saudi Arabia**. We are holding the **Henderson Mine Challenge** for the second year in a row, where student teams develop visions for the future use of the surface facilities after decommissioning the **Henderson Mill**. The model has been highly successful and other mining companies have contacted us to have multi-disciplinary teams work on their current and future issues.

Mining Engineering faculty are highly successful in their research activities, winning several prestigious grants and awards worth millions of dollars. This includes funding by the **National Institute of Occupational Safety and Health (NIOSH)**, the **National Science Foundation (NSF)**, the **Department of Energy (DOE)**, the **Department of Defense (DOD)**, the **National Aeronautics and Space Administration (NASA)**, the **National Renewable Energy Laboratory (NREL)**, and the **Alpha Foundation for Improving Mine Safety and Health**. Research topics include safety related to automation, big data analytics in mining, virtual, augmented and mixed reality technologies for training the work force, ventilation and explosion prevention in coal mines, tracking underground equipment, development of smart picks for various excavation units, studying small and artisanal gold mines in **Peru**, beneficiation of rare earth mineral ores, tellurium recovery from smelter byproducts, and critical element recovery from zinc processing residues. Our researchers will highlight some of these exciting and cutting-edge research projects in this newsletter.

While the achievements of the faculty and students during 2019 have been amazing, the future is promising and reaching new heights is even more exciting. We plan to continue growing the number of undergraduate and graduate students along with our research volume. We are currently developing a new minor in **Space Resources** that will excite many incoming students. We will inaugurate a new **Timothy Haddon Lecture Series** on campus that is focused on "Visionaries in Mining and Minerals Industries" with the first lecture scheduled for April 2020. These lectures will allow us to host executives and leaders in our industry to offer their wisdom and experience to campus-wide audiences.

I look forward to hearing from you and welcome your input and feedback on our ongoing activities. If you happen to be on campus, please stop by to chat, present a seminar to our graduate students, or talk to our students in the biweekly **SME Student Chapter** meetings.

Best regards-

Jamal Rostami, PhD, PE,
Interim Department Head,
CSM Mining Dept. Alumnus 1992 & 97

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Quick Bits



Edgar Mine Has a New Manager

Lee Fronapfel was hired as the new Edgar Mine Manager earlier this year. Lee has had a successful career managing several mines including the Henderson Mine. Updating of the mine facility continues along with developing a master plan and acquiring equipment upgrades.



ABET Accreditation

ABET accreditation was renewed this past summer.



Department Head Search

The search for a new department head has resulted in three candidates visiting campus. The search committee made its recommendation to the Provost and President, and negotiations are underway.



Faculty Grab Sample: Hugh Miller

Hugh has taken a year-long sabbatical from Mines as he serves as the 2019 President of the Society for Mining, Metallurgy & Exploration (SME). With more than 14,000 members representing a wide breadth of industry sectors, SME is the largest global professional organization in the mining industry, consisting of more than 50 regional sections and 78 student chapters. The scope of the organization is one of its fundamental strengths and contributes to its success as a global leader in the dissemination of technology and technical know-how, professional development, and academic support of the industries it serves.



Curriculum Reform

To reduce the total credit hours and add sustainability and data science, the department is working hard on reforming curriculum.



New Faculty Hires

Hiring of new faculty in Explosive Engineering and the forming of an Inter-Departmental and Interdisciplinary Coalition for expansion of the Explosives Research Lab (ERL). Extractive Metallurgy faculty will be hired soon as well.



Minors and Minor Certificates

Support continues with Explosive Engineering and Underground Construction and Tunneling minors. Initiated the development of Minor Certificates for Mineral Processing, Extractive Metallurgy, and Space Mining.

Staff Grab Sample: Gretchen Wodniak

The Mining Engineering Department welcomes our new Program Administrator, Gretchen Wodniak. Gretchen comes to us from the Office of Research Administration (ORA). As an Administrative Assistant at ORA, she was heavily involved with the research administration process, specifically processing awards and managing the Time and Effort process. Before starting at Mines in 2016, she worked in commercial property management and has several years of experience in marketing, webpage management, email marketing campaigns, and event management. We welcome Gretchen to the Mining Engineering Department!

Earth Mechanics Institute



2019 Was a Busy Year for the Earth Mechanics Institute (EMI)

The Earth Mechanics Institute had another busy and successful year, completing a record number of rock mechanics tests, as well as continuing its multi-year equipment development project with **DeBeers**. A large linear cutting project for the **Mexican Fresnillo Mine** was also completed this year for this gold and silver mine that has been mined for over 450 years! EMI has recently been awarded a project with **NIOSH** on smart bit development, with the project kicking off in September. **Dr. Hugh Miller's** PhD student **Erik Charrier** has been very busy doing his research on water jet cutting, bringing one of the pumps back to life after an extensive overhaul. EMI is currently working on doing rock mechanics testing on a large trona project as well. Lastly, the new **Epiroc Jumbo Drill** is now fully operational and quite impressive!

On the **NASA** front, EMI is currently involved in 3 separate projects. The first, being led by PI **Dr. Jamal Rostami**, is related to material characterization while drilling in vacuum and cryogenic conditions. The second is a small lunar regolith test bed, being used by local startups and the **Mines Robotics Club**. The third **NASA** project being conducted at EMI is a 14 foot tall 3D printer, used to print livable structures on the **Moon** and **Mars**.

With the construction of the 4-story tall parking garage

outside of EMI, EMI has also started making some long overdue improvements inside the facility, including remodeling the office and conference room on the south end. Outside of EMI, old equipment is being disposed of to make room for new activities, and a new gravel driveway and back lot were finished over the summer. Inside EMI, equipment are being upgraded and in some cases, rebuilt while data acquisition systems and related software are being updated with new hardware and software. EMI has in the process of receiving some equipment from Kennametal, including a full scale rotary cutting machine (as seen in the picture above and to the left) that allows cutting of rock samples with drums (i.e. roadheader, CM, roadmilling, etc.) with diameter up to 1 m (~3ft). Another piece of donated equipment from Kennametal is a full scale Fletcher roof bolting unit. These units complement the current capabilities and offer testing abilities to EMI that did not exist beforehand.

EMI Manger: Brent Duncan

Diversity, Inclusion, and Access Initiative in Mining Engineering

In July, as part of the **Mines Diversity, Inclusion, and Access (DI&A)** initiative, the Mining Engineering Department drafted a strategic plan for DI&A, (see our DI&A Mission and Vision below). We now have a committee that is conducting a baseline study of the status of DI&A in the department, and we look forward to implementing some of the recommendations that emerge from this study. Please stay tuned for more updates on our DI&A efforts or reach out to Nicole Smith at nmsmith@mines.edu for more information.

DI&A Mission: To be a multidisciplinary community that values the intrinsic worth of all members, recognizes our shared values, and embraces our differences. We will include all persons in our community, promote wellness among all members, foster a spirit of openness and active engagement, and strive to be diverse and inclusive in every aspect of department operation. In doing so, we will ensure a full educational opportunity for all who teach in, learn in, and interact with our department.

DI&A Vision: The commitment to diversity, inclusion, and access is infused into every action taken by our Mining Engineering community, including our words, actions and decisions within department meetings, curriculum and courses (both face to face and online, and external interactions). Our department stakeholders are committed to raising our retention and graduation rates and promoting ally-ship among our faculty, staff, students, and external stakeholders so that we demonstrate equal opportunities of success for all.

DI&A Committee:

Nicole Smith, Priscilla Nelson, Jurgen Brune, Christine Monroe, Gretchen Wodniak, Jaime Martinez Calvo, Clair Kincaid

Safety & Health Training for Western Mine Workers

The Mining Department's Energy, Mining, and Construction Industry Safety Program (**EMCIS**) is currently entering into the final year of a **3-year, \$1.445 Million grant from CDC NIOSH Mining** in support of its continuing efforts to enhance the quality and availability of health and safety training for Western mine workers. The primary investigators of the grant are **Hugh Miller** and **Michelle Reiher**, and supported by an outstanding group of safety professionals that include **Kirk McDaniel**, **Korky Vault**, **Jerry Powers**, **Lori Guasta**, and **Joe Bourgeois**. The primary goals of the grant include providing workers with relevant knowledge regarding the hazards associated with working at mine sites and effective controls for reducing risk for injuries and illnesses. As part of this effort, a comprehensive approach to meeting the safety and health training needs of the Western mining industry has been facilitated by providing a high quality, interactive training experience that targets several audiences, including mine workers, trainers, safety and health professionals, mine management, and mining engineering and geology students. In addition, this training program is designed to service underrepresented industry sectors, such as contractors, consultants, suppliers and equipment manufacturers. This approach strongly encourages trainees to become active participants and take ownership in improving the health and safety conditions where they work. If you have any questions or would like to learn more about the program, please contact either **Hugh Miller** (hbmiller@mines.edu) or **Michelle Reiher** (mreider@mines.edu).

MN Updates

Summer 2019 Field Session

Four vans of students with faculty and staff drivers took off for the field on June 3rd for the start of a newly designed week of summer field session! Each day, we loaded up the vans with people, lunches, and water and took to the MINES! Throughout the trip, we were informed and regaled by the knowledge and stories of **Dr. Vince Matthews**, former State Geologist of Colorado, and we stayed overnight at the **Colorado Mountain College** campuses in Leadville and Glenwood Springs. We visited Cripple Creek and Victor, Climax, West Elk, Yule Marble, Trapper, Twentymile, Henderson Mill, and also visited the Climax treatment facilities, Vail Pass Geology, and the Hanging Lake Tunnels. All in 5 days! The students had a fantastic time, and we thank **Newmont Goldcorp, Freeport McMoRan/Climax Molybdenum, Colorado Stone Quarries, Arch Coal, Peabody Energy, Colorado DOT**, and the **Mining Hall of Fame** which provided us with an after-hours tour opportunity. We plan to continue this adventure with the students in 2020 as well – and any contributions or donations to support the field session trip will be gratefully accepted.



ARMICO Jordan Partnership



The Mining Engineering Department has established a partnership with the **Arab Mining Company (ARMICO)** in Jordan. ARMICO promotes investment and successful development of Arab mining industries, and Mines and ARMICO are discussing the establishment of the **Arab Mining Industrial Development Institute (AMIDI)**, an entity that will be devoted to developing the knowledge, professional development, and workforce of the future for industries in **North Africa and the Middle East (MENA)**. **Dean Graves** and **Dr. Nelson** travelled to Jordan in March for initial discussions, and several additional visits happened during the summer. Dr. Nelson and **Professor of Practice Rob Reeves** travelled to Jordan with our new **Dean John Bradford** in October, and began work with industry to establish research, consulting, and training program for AMIDI.

Mines has formed a team of faculty members and industry consultants to conduct an assessment of research and training needs in the MENA region. A report of the team's findings, conclusions and recommendations on next steps for moving the partnership will be prepared by the end of February 2021.

A Special Note from the Department

On behalf of the students, faculty and staff, the Mining Engineering Department would like to express its sincere and heartfelt thanks to **Dr. John Grubb** for his many years of dedicated service to Mines as a course instructor, student mentor, donor, and researcher. While he will continue to engage and provide assistance in support of the Department's educational mission, John is retiring from teaching in January 2020. His extensive industry background and student-oriented approach towards teaching has made him a favorite among undergraduate and graduate students alike. He has been extremely generous with his time, commuting weekly from New Mexico to teach 2-3 courses per semester in Golden. In addition, John has graciously contributed financially to a wide range of student activities critical to learning and professional development, including field trips, TAs, and laboratory equipment at the Edgar Mine.



John's impact on student education and the academic success of Mines for more than 15 years can't be overstated and the Department is truly grateful for all his contributions. Thank you, John! We all wish you the very best in your future personal and professional activities, and you know that you always have a second home to visit when you pass through Golden.

Mining Department Head Search

In its international search for our new **Department Head**, the Search Committee reviewed the applications of 18 candidates that met minimum requirements for the position. 11 of the applicants were from academic, research and industry positions in the United States, while 7 were at universities in Australia, Europe and Asia. Two of the applicants were female.

The Committee was unanimous in its selection of the top three candidates, who traveled to Golden for on-campus interviews in September-October. Search Committee members also conducted extensive background interviews with references for the candidates. Following the on-campus interviews, the Committee unanimously selected the preferred candidate and made a formal recommendation to Vice Provost Bradford. We understand that, at the time of this printing, the candidate is in final negotiations with President Johnson and Provost Holz, and we hope to have an announcement to the public in early Spring.

The Henderson Sustainability Challenge

The Henderson Mine Sustainability Challenge returned and the charge was to develop a concept for sustainable repurposing of the Henderson Mine's mill facilities and land holdings that is economically sustainable, socially acceptable, and provides a positive and lasting legacy to the community. This year's winners are:

- 1st - T2G (Tailings-to-Glass) - \$25,000
- 2nd - Rocky Mountain Shrimp - \$15,000
- 3rd - Growth and Production - \$10,000

Freeport McMoRan/Climax Molybdenum/Henderson Mine and Mill also indicated that we will have a third competition next Fall 2020 - this time on repurposing the underground space in the mine. Information will be distributed next fall.

Congratulations to these teams, and to all who participated in the competition!



Mining Engineering Curriculum Update

The current Mining Engineering curriculum requires **139.5** credit hours for the Bachelor's degree. This is the highest credit requirement on campus and makes the Mining Engineering degree non-competitive with other majors, whose credit requirements range from **126** to **137.5** with an average of **133** credit hours.

In discussions among the Faculty and with members of the Industry Advisory Committee (IAC) and in consideration of ABET and university requirements, the Faculty proposed the following curriculum changes to reduce required credits to **132.5**:

1. Integrate elements of Coal Mine Design into the Underground and Surface Mine Design courses. Coal Mine Design will continue to be offered as a Track Elective.
2. Combine Thermodynamics with Mine Ventilation. To a large part, the current mine ventilation course repeats many elements of Thermodynamics, so this combination makes good sense.
3. Remove Underground Construction from the Mining engineering core and continue to offer it as a track elective.

In addition, the new curriculum will incorporate Corporate Social Responsibility, Data-Driven Sciences and strengthen Mine Closure and Reclamation. Students continue to have three technical electives and may choose to select courses that emphasize one of five Track specialization offerings:

1. Mining Operations and Management (MOM)
2. Mineral Resources and Mine Valuation (MRME)
3. Excavation Engineering (EE)
4. Earth Materials and Processes (EMP)
5. Mineral Processing and Extractive Metallurgy (MPME)

The revised curriculum is in the approval process through Undergraduate Council, Faculty Senate and the Provost's office and is scheduled to become effective in Fall of 2020. The university is also making an effort to revise the "common core" courses (math, sciences, humanities) with the aim of further streamlining to improve the 4-year graduation rate for all Mines majors.

MN Updates

Faculty Perspectives



Corby Anderson
Professor

Dr. Corby G. Anderson is a registered engineer with over 40 years of global experience in industrial operations, corporate level management, engineering, design, consulting, teaching, research and professional service. He is a native of Butte, America. Since 2009 he has served as the Harrison Western Professor in the Kroll Institute for Extractive Metallurgy as part of the Mining Engineering Department and the George S. Ansell Department of Metallurgical and Materials Engineering at the Colorado School of Mines. In 2019, he has managed 13 research projects sponsoring 3 PhD students, 5 MSc students, 3 Research Faculty 1 Fullbright Scholar, 2 Post Graduate Researchers and 5 undergraduate students. This has resulted in 1 recent patent application and 2 new invention disclosures. In 2019, he also reviewed and he was appointed as a Visiting Faculty within the Minerals Engineering Department of Central South University in China, the largest program of Mineral Processing and Extractive Metallurgy in the world. Finally, SME recently honored him as one of their Henry Krumb Distinguished Lecturers for his presentation entitled "Star Regulus and the Triumphal Chariot of Antimony".

2019 has been a very busy year for Priscilla Nelson. She traveled to Brazil, China, Jordan, Kazakhstan, Peru, South Africa, and Sweden. She served as the Krumb Lecturer (SME), and was appointed to the Global Safe Production Advisory Panel (Sibanye Stillwater), and the WIPP Technical Advisory Panel. She served as Chair for the federal Mine Safety and Health Research Advisory Committee (MSHRAC/NIOSH/CDC), the SME DH meeting, and conducted an external program review for University of British Columbia. She is also leading the 2019 Freeport McMoRan/ Climax Molybdenum Henderson Challenge, and is chairing the organizing committee for the ARMA 2020 Symposium on campus. Priscilla also gave lectures at the ISRM Rock Mechanics Symposium in Stockholm, at the Women in Mining (WIM) National meeting on campus, and at Hexagon Live in Tucson. She attended the Nazarbayev University commencement of the first Mining Engineering graduates from the Mining Engineering program, and met the President Emeritus of Kazakhstan. Priscilla also has several R&D projects which are listed which are all listed on page 9 of this newsletter. If you want to know more – just call or email her.



Priscilla Nelson
Professor



Nicole Smith
Assistant Professor

Our research group has had a productive and exciting year! We are proud to report that we were awarded a National Science Foundation (NSF) grant that will fund a three-year research project beginning in January 2020 (see research page). Drs. Sebnem Duzgun (Mining) and Tulay Flamand (Economics and Business) are both working on this project with us, and we will also collaborate with the Payne Institute at Mines. We are looking forward to embarking on this exciting, interdisciplinary research. Our research group continues to grow, and we welcomed Cansu Perdeli Dameriken and Claire Kincaid. We also welcomed postdoctoral fellow, Dr. Aaron Malone, who is conducting research on the human dimensions of geohazards and water quality among small-scale mining communities in Peru with our Center for Mining Sustainability, a collaboration between Mines and the Universidad Nacional de San Agustin de Arequipa in Peru. We look forward to having a large presence at the SME meetings in Phoenix this coming February and hope to see many of you there. Please feel free to reach out anytime and check out our website to learn more and stay updated on our activities: <https://resourcesandcommunities.mines.edu>

Mining Faculty



Patrick Taylor
Professor

- Selected for an AIME Oral History Interview, now available online at https://ethw.org/Oral-History:Patrick_R._Taylor
- CMI – Fundamental electrochemical Study of Neodymium Molten Salt Electrolysis in Fluoride Bath - PhD Thesis 2019
- CMI – Mitigating material supply risks: Evaluation of abrasion specific comminution for commercial recovery of indium from liquid crystal displays – PhD 2019
- CR3 – Vacuum Distillation of Complex Lead Bullion – PhD 2019
- Co-advisor - Predicting the product particle size distribution from a vertical stirred mill - PhD thesis 2019
- REMADE - Sorting and Impurity Removal to Improve the Recycling of Steel Scrap from Auto Shredders – PhD Thesis in Progress
- CMI – Critical element recovery from Zinc plant residues – PhD Thesis in Progress
- CMI – Critical element recovery from zinc ferrites – PhD Thesis in Progress
- CR3 – Alternative fluxes in lead softening – PhD thesis in progress
- NREL - Electrochemical Control for Corrosion in Molten Chlorides during CSP Plant Operation - starts January 2020

In 2019, I led two major initiatives for our Department: the search for a new Department Head and an effort to revise the Mining Engineering curriculum and reduce total credit hours (see previous page updates on both of these committees).

I was the first academic PoP at mines when I received my appointment in January 2017. My appointment is similar to that of Teaching Faculty – an academic appointment without tenure. Unlike Teaching Faculty who typically do not conduct research, my responsibilities include teaching, research and academic service, very similar to the responsibilities of tenured Faculty. According to the Mines Faculty Handbook, Typically, a PoP appointment is suitable “for exceptional practitioners in fields aligned with Mines to whom Mines wishes to extend a title that conveys a closer tie and long-term commitment to the School.” Many universities appoint PoPs to bring skill sets of deep industry practice to campus. In my case, I had worked in the surface and underground mining industries for 20 years and served in the federal government as a research manager for 8 years before joining Mines in 2012. Mines affords me the opportunity to give back and mentor undergraduate and graduate students and this is a job I thoroughly enjoy!



Dr.-Ing. Jürgen F. Brune
Professor of Practice
Associate Department Head



Elizabeth Holley
Assistant Professor

This has been an exciting year for my Mining Geology Research Group. We're bigger than ever with 8 PhD students, 1 post-doctoral fellow, and a co-advised master's student. Our work continues to examine the intersections of mining and geology from exploration to mine development, production, and closure. Please visit our website at <https://mininggeologyresearch.mines.edu/> to look at our individual projects and read the profiles of all our team members. Major accomplishments this year include the graduation of PhD student Marion Nicco, the initiation of a new project on sustainability of small-scale mining in Peru (<https://miningsustainability.mines.edu/>), and the receipt of National Science Foundation funding in the new INTERN program. This program supplements existing NSF funding (my CAREER award) to support the cost of student internships with federal agencies. Through this program, PhD student John Meyer is interning with the USGS Spectroscopy Group to conduct hyperspectral mapping of mineral deposits. I took the fall semester off from teaching to welcome the birth of Charlotte Grace; James is a proud and happy big brother. Wishing you all a peaceful and rewarding 2020!

Dr. G. Walton is the newest member of the department on a joint appointment from Geological Engineering. His Computational Geomechanics group focuses on numerical modeling for ground control and remote sensing techniques for monitoring of rock slopes. The group graduated its first two Ph.D. students this year: Lane Boyd, whose thesis was on applications of geostatistics to tunneling problems and who will start with Gall Zeidler consultants in Washington D.C. in the new year; and Deepanshu Shirole, whose thesis was on the use of geophysical tools to track the damage process in intact rocks at the laboratory scale (Dr. Shirole will be staying at Mines for a postdoc). We also have three new students: Isabella West, whose research is on the interaction between intact rock damage and pre-existing joints in controlling rockmass deformation; Rahel Dean-Pelikan, whose research is on stress transfer in underground mines during de-pillaring operations; and Brian Gray, whose research is on the characterization of slopes using photogrammetric techniques. Collectively, the group is looking forward to the American Rock Mechanics Association symposium in 2020 (which will be held at Mines), and has submitted over a dozen abstracts.



Gabe Walton
Assistant Professor

Faculty Perspectives Continued



Kadri Dagdelen
Professor

Dr. Kadri Dagdelen has been a faculty member at CSM since 1992 and was Department Head between 2008 and 2012. Dr. Dagdelen's teaching and research interests include Geostatistical Resource and Reserve Estimation, Surface Mine Design, Mine Production Schedule Optimization and Operations Research Applications in Mining. He is the author of more than 50 research and technical publications in the mining industry. He is a QP in the area of Resource Estimation and Mining Engineering under Mining and Metallurgical Society of America (MMSA).

Dr. Dagdelen served as a board member of Randgold Resources between January 2010 and May 2017. He also served as a board member for SME between 2000 and 2006 including a seat as an Executive Committee Member for its M&E Division. He has received the Distinguished Service Award from SME's Minerals and Exploration Division in 2006 and the Distinguished Member award in 2013.

Prior to his academic career at Colorado School of Mines, Dr. Dagdelen worked for Homestake Mining Company. Dr. Dagdelen received his Ph.D. (1985), M.Sc. (1979), and BSc. (1976) in Mining Engineering, from Colorado School of Mines and a Master of Engineering (Equivalent) (1981), Geostatistics, from L'ecole des Mines de Paris.

Greetings-What a busy year! This year I taught Introduction to Mining, Rock Slope Engineering, Mine Water and Environment, and also covered Dynamics for Mining Engineers for Masami who is on Sabbatical. My PhD student Fei, is also graduating this December, after finishing up his work on numerical modeling of rockburst. My research group keeps expanding as we welcomed three more new members this year – Carolina who is working on small-scale rock mechanics, Sewit is working on life cycle analysis, and Kizito working on rock burst mitigation. In February I gave a talk at the annual SME conference in Denver on Feasibility of using microwaves to break hard rock for underground tunneling and excavation. In addition I chaired two sessions at the same SME conference in Denver. In July, I gave an invited talk at a sustainable workshop in Zambia on energy and the environment. I also gave a talk at GSA in Phoenix Arizona in October on mine reclamation and remediation. In addition to my research and teaching duties, I also continue to remain active in various professional service activities such as helping organizing the TBM-DiGs conference, reviewing journals, SME committees, and so much more. I delivered a workshop on active learning and published a couple more papers with my students and collaborators. Until next time, please keep in touch!



Rennie Kaunda
Assistant Professor

This year was a great year expanding my research portfolio and serving Mines and professional organizations. Our interdisciplinary team received two Alpha foundation awards. Dr. Jurgen Brune, PI of the first project entitled Integrating Real-time Personal Dust Exposure Monitoring with Location Tracking. My role as Co-PI is to develop AI models for dust exposure prediction. Dr. Andrew Petruska from Mechanical Engineering is the PI of the second Alpha Foundation project. The project is entitled Lifting the Veil: Fusing RaDAR and Sound to Provide Enhanced Perception in Obscured Environments. This project will deliver machine learning-enabled acoustic imaging for first responders who will be visualized by Augmented reality (AR). Problems of navigation under low visibility will be overcome, and this project will represent a major advancement in mine rescue.

This year was great in terms of international collaboration. My team at Mines with researchers from my alma mater, Middle East Technical University in Ankara, took part in the Data for Refugees Challenge. Our work, "Data Analytics without Borders: Multi-Layered Insights for Syrian Refugee Crisis," was awarded an honorable mention in this international data challenge.

With all these projects, my research team grew significantly to two Dost-Doc Fellows (Dr. Hilal Soydan and Dr. Mahmut Cavour) seven PhD students (Natalia Soares Rodrigues, Cansu Perdeli Demirkan, Doga Cagdas Demirkan, Ergin Isleyen, Jaime Moraga, Simone Gaab, Mehmet Ali Akyol), one MSc student (Gurbet Gurkan) and three Mines MURF (Mines Undergraduate Research Fellowship) program fellows (Nicholas Bellusci, Ryan James and Daghan Yigitbas).

This year, I was elected to the faculty senate. I served the department graduate seminar coordination, VPRIT's Research Advisory Board, HPC Steering Committee, Curriculum Revision Committee, Sort Course Coordination, Faulty Advisor of Women in Mining Student Chapter, Mines Community Alliances, Co-chair the Women in MCA, and Library Committee Chair. I also took part in several committees in SME, USSD, and IEEE.



Sebnem Duzgun
Professor
Fred Banfield Distinguished
Endowed Chair

Mining Faculty

Other Faculty Updates

- **Dr. Jurgen Brune** received the 2019 Society for Mining, Metallurgy and Exploration (SME) Health and Safety Research Excellence award presented by the SME Health and Safety Division. This award is presented to an individual or a research or education institution exemplifying exceptional innovation and dedication toward advancement in technology or education for the protection and well-being of miners.
- **Dr. Nelson** has at least five major R&D projects under way: Active R&D activities: 1) developing recommendations on Equipment and Facilities for the Nexus Institute for Sustainable Mining (NISM) to be established at UNSA (Peru); 2) research on melting earth materials to produce fibers and composites, 3) developing departmental and campus participation in a new initiative on ACCUSS – Avoidance, Carbon Capture, Utilization, Storage and Sequestration of Green House Gases, 4) establishing a new international Center for Mine Tailings and Water Management, and 5) pursuing partnerships and funding for a new campus initiative on “Smart Cities and Underground Urbanism.”
- With interdisciplinary collaboration, **Dr. Duzgun's** research teams were awarded three NSF grants. The first NSF-funded project is entitled C-Accel Pilot - Track B1: AI and Future Jobs: AI-Enabled Personalized Training for Displaced Workers in Materials Supply Chain, which has an award of 1 Million \$ from the NSF's new Convergence Accelerator Pilot program. They are compiling and analyzing data for predicting the future work environment and understanding knowledge and training gaps in metals mining, processing, and manufacturing. Then they will develop an AI system to assess a worker's existing skills quickly and identify gaps to create a personalized retraining plan. The second NSF project is entitled Engineering Online Learning Pathways in Advanced Manufacturing and Data Science. The research team was awarded \$2 million to develop online learning opportunities that empower the workforce of today and tomorrow to exploit data science in advanced manufacturing better. This project is one of the five nationwide projects to receive a Production Engineering Education and Research (PEER) award, which was developed by a \$10 million gift The Boeing Company made in 2018. As one of the Co-PI's of this project, **Dr. Duzgun** is responsible for developing an online course on data visualization, including use of VR and AR. The third NSF project is also quite exciting and is entitled ISN2: Mapping, Modeling, and Optimizing the Disruption of Illicit Gold Supply Chains in Peru. The research team is led by **Dr. Nicole Smith** as the PI and includes **Dr. Tulay Flamand** from the Department of Economics and Business and **Dr. Duzgun**. They were awarded \$700 000 and this all-women PI's team compiles a broad range of expertise to approach a compelling problem in mining.
- In addition, **Dr. Duzgun's** research team were awarded three NIOSH projects. The first project is entitled Improving Health and Safety of Mining Operations Through Development of the Smart Bit Concept for Automation of Mechanical Rock Excavation Units and Dust Mitigation. **Dr. Jamal Rostami** is the lead PI of this project, and **Dr. Duzgun's** role involves the development of machine learning models for smart bit data for characterizing dust. The second project is entitled Digital Technologies Improve Mine Safety and Health. **Dr. Brune** is the lead PI of this project, and **Dr. Duzgun** lead the tasks related to the development of system safety concepts and Virtual and Augmented Reality models for collaborative mine design. The third project is entitled Capacity Building in Artificially Intelligent Mining Systems (AIMS) for Safer and Healthier Automated Operations. **Dr. Javad Sattarvand** from the University of Nevada is the lead PI, and **Dr. Duzgun** will collaborate with the University of Nevada team in developing VR models.
- **Dr. Hugh Miller** was awarded the Medal of Honor from the American Mining Hall of Fame this year.
- Edgar Mine Day 2019 was held this fall and it was a great success! Several first-year students attended this event which featured not only the Mining Engineering Department, but Colorado Geological Society, Petroleum Engineering, and GeoPhysics as well.



Student Updates

SME Student Chapter

The Mines Student Chapter of the **Society for Mining, Metallurgy and Exploration (SME)** had a banner year. In February, **SME** presented the Mines chapter officers with the prestigious Outstanding Student Chapter Award. The Chapter organized and supported the following major events and achievements during the past year:

- At the SME 2019 Annual Meeting in Denver, the chapter staffed an exhibit booth and students assisted during the various luncheons held over the course of the weekend. Several Mines students also presented research papers during the conference.
- The **CMI Gala**, where our students put on a fundraising gala to raise money for the student chapter. This year's gala was held in the **Geology Museum at Colorado School of Mines** and had a silent auction as well as refreshments. Invitations were sent out to alumni, professors, industry professionals, and various others. Ticket sales and the silent auction helped raise \$800.00 for the chapter.
- The student chapter focused on reaching out to the student body and expanding membership in number and across various degree programs. The Chapter was represented at many school events including the M-Climb, Celebration of Mines, Homecoming, and E-Days. These outreach initiatives proved effective as the chapter saw attendance at the bi-weekly general meetings increase significantly, having a consistent turnout of 30 or more people.



The SME student chapter at Mines is a strong chapter with exemplary leadership and professionalism. We commend the outgoing officers for their outstanding leadership – they have developed critical managerial and organizational skills and have built professional relationships for life through their membership in SME and involvement in leadership roles in the student chapter. We congratulate and commend 2018-19 officers, President **Marie Hetherington** and with officers **Carson Eltz**, **Alex Murray**, **Ashlyn Hohenshelt**, **Indira Gregorio**, **Dakota Locklear**, **Stela Cayatte**, **Leila Mateus**, **Chamir Bello**, and **Isabel Casasbuenas Cabezas** and 2019-20 officers, President **Indira Gregorio** and Officers **Dakota Locklear**, **Orlando Vidaurre Torres**, **Marie Sullivan**, **Jacob Mellema**, **Lukas Fahle**, **Seth Edelen**, **Chloe Poindexter**, **Natalia Soares Rodrigues**, and **Isabel Casasbuenas Cabezas**.

Mining Competition Student Chapter

The Colorado School of Mines Mining Competition Team will host the **42nd International Intercollegiate Mining Games** on the Mines Campus in March 2020.



We expect thirty to forty teams of five representing national and international mining universities to gather for a competition in seven historic mining disciplines that include hand steeling (drilling),

jackleg drilling, mucking, track spiking, swede saw, gold panning and surveying. Usually, we also get a few professional mining teams to compete and show off their skills.

The Colorado School of Mines female, male and co-ed competition teams have a long record of excellence with many top three finishes and a **World Champion** title won in **Cornwall, England**, in 2012. Mines last hosted the **35th International Intercollegiate Mining Games** in 2013. Past competitions have featured international teams representing universities in **Canada**, **Australia**, **England**, **Germany** and **The Netherlands**. These teams will compete with students from the 12

mining engineering programs in the **United States**.

The **International Intercollegiate Mining Games** began in 1978 as a way to honor 91 miners who died in a fire at the **Sunshine Mine** in northern **Idaho**. Mining schools throughout the world have alternated hosting the event each year.

Hosting the games requires significant funding, as the host university pays for all guest team accommodations, food and an Awards Banquet. To support the Mines Team and the competition, please contact the organizers and club officers, **Ryan Coffin** and **Aaron Rickey** or their Faculty Sponsor, **Brent Duncan** via email at **Mining@Mines.edu**.

Women in Mining Student Chapter



This year, the **Women in Mining** (WIM) student chapter hosted the national conference for **WIM USA**. This week long conference brought together women from across the **United States** to plan future projects, engage industry, and build new student chapters. At this meeting, students from five universities were invited to network with over 100 industry professionals, vote on national decisions, attend workshops, and join committees with other student chapters and professionals.

The **CSM WIM Student Chapter** also invited the **Denver WIM Chapter** to campus for a night of networking and mentoring for students, male and female, with industry professionals. The event connected approximately 40 students with 25 members of industry for several hours of mentoring. Professionals spoke personally with students about internship offers, career fairs, networking, resumes, and taking meaningful strides towards a productive and safe career in the mining industry.

The **CSM WIM Student Chapter** is growing steadily. Last year, there were eight members involved in the club, and we have expanded to over 20 members, two faculty mentors, and numerous industry mentors. We look forward to adding many more students, faculty, and industry members in the future!

Mine Rescue Team Student Chapter

Over the summer, members of the mine rescue team were off on internships from **California**, to **West Virginia**, and even **Germany**. **Jaume Martinez Calvo**, the president, was in **Germany** conducting some research on mine rescue systems and comparing them to those in the United States. In addition, he assisted a college mine rescue workshop as an instructor. In August, the team got together before school started and went to **Loveland, Colorado** competing against professional teams in the **Biennial Regional Competition**. The team placed 11th out of 20 professional teams overall and learned a lot from all the teams there.

Since the school year started, the team has doubled its numbers with a wave of incoming freshmen whose enthusiasm has led the team into the new school year. In mid-October the team had the pleasure to participate in a rope rescue training organized by the **Rocky Mountain Mine Rescue Council**, where the team learned to operate rope pulley systems and work together to lift patients through vertical shafts. In mid-November the team visited the **Smuggler Mine** in **Aspen, Colorado** for another training session with professional mine rescue teams from around the state. In the spring, our team will partake in the first international mine rescue competition hosted by **UBC** in **Vancouver, Canada** and a regional competition in **Winnemucca, Nevada**.

Finally, our team has received multiple donations since the beginning of the school year. We are very grateful to **Carroll Technologies** and **Bulwark** for their help furnishing our extra team for competitions. For any more information on donations or the team please contact: **Jaume Martinez Calvo** at Mining@mines.edu.



Mining Research Grants

Our faculty have been very busy with various research projects and grants.
Below is a list of the new research projects awarded in 2019:

Project Title	Amount*	PI or Co-PI from Mining	Sponsor	Project Dates
Improving Health and Safety of Mining Operations Through Development of the Smart Bit Concept for Automation of Mechanical Rock Excavation Units and Dust Mitigation	\$249,599 (\$1.25M over 5 years)	Drs. Rostami, Brune, Duzgun, Miller, Rostami	National Institute for Occupational Safety & Health - NIOSH	9/13/2019 - 9/12/2023
The Great Convergence	\$905,904	Drs. Duzgun, Brune	NSF	9/1/2019 - 5/1/2020
Integrating Real-time Personal Dust Exposure Monitoring with Location Tracking	\$308,417	Drs. Brune, Duzgun	Alpha Foundation	9/1/2019 - 8/31/2021
Lifting the Veil: Fusing RaDAR and Sound to Provide Enhanced Perception in Obscured Environments	\$618,957	Drs. Duzgun	Alpha Foundation	9/1/2019 - 11/30/2022
The Size Effect of Coal/Mine Particles to Lung Cells and Exposure Assessment	\$43,200	Dr. Brune	Alpha Foundation, Colorado State University - CSU	9/1/2019 - 8/31/2022
Mine Ventilation-Studies and Environmental Interventions for Artisanal and Small-Scale Mining (ASM) in Arequipa, Peru Region	\$438,061	Dr. Brune, K. McDaniel	Universidad Nacional de San Agustin de Arequipa - UNSA	3/1/2019 - 12/31/2020
Development of New Operational Production Scheduling Optimization Algorithms	\$96,000	Dr. Dagdelen	Newmont USA Limited	1/1/2019 - 12/31/2019
ISN2: Mapping, Modeling, and Optimizing the Disruption of Illicit Gold Supply Chains in Peru	\$673,754	Drs. Duzgun, Smith	NSF	1/1/2020 - 12/31/2022
Geothermal Anomaly Detection from Hyperspectral Images via Deep Learning	\$481,854	Dr. Duzgun	Department of Energy - DoE	9/1/2019 - 8/31/2021
Digital Technologies Improve Mine Safety and Health	\$247,441 (\$1.25M over 5 years)	Drs. Brune, Duzgun, Bogin, Walton	National Institute for Occupational Safety & Health - NIOSH	9/13/2019 - 9/12/2024
Predictive Geology and Geometallurgy at Small-Scale Mine Sites in the Department of Arequipa, Peru	\$628,749	Drs. Holley, Smith	Universidad Nacional de San Agustin de Arequipa - UNSA	3/1/2019 - 12/31/2020
Geomechanical Evaluation of Groundfall Hazards for Small-Scale Underground Mines in the Arequipa Region of Peru	\$456,344	Drs. Kaunda, Rostami	Universidad Nacional de San Agustin de Arequipa - UNSA	3/1/2019 - 12/31/2020
A Study of Sustainable Mining Practices in Zambia and USA for Capacity Building	\$22,980	Dr. Kaunda	University of Zambia	9/19/2019 - 8/20/2020
Terramechanics Modeling of Soil-Wheel Interactions at the Lunar Poles	\$37,500	Dr. Nakagawa	Blueshift, LLC	8/19/2019 - 2/19/2020
Expert Advice and Consulting on the Design of UNSA's Proposed new Research Center for Sustainable Mining	\$57,263	Dr. Nelson	Universidad Nacional de San Agustin de Arequipa - UNSA	3/1/2019 - 2/28/2020
Risk Assessment and Management for Geohazards Near Formal and Informal Mining Operations in the Arequipa Region, Peru	\$398,479	Dr. Smith	Universidad Nacional de San Agustin de Arequipa - UNSA	3/1/2019 - 12/31/2020

*Calendar Year 2019 award amounts are through the current budget period as of this printing

Mining Research

UTC-UTI Research Project Update

Funded by the **U.S. Department of Transportation** through the **University Transportation Center for Underground Transportation Infrastructure (UTC-UTI)**, in collaboration with **RAMAX** and **Scientific Associates**, this research sought to develop a unique system that utilizes waterjet technology as the primary excavation tool to circumvent the technical and operating challenges associated with conventional shotcrete removal and repair. The project was successful in demonstrating empiric evidence that indicated waterjets were capable of selectively removing damaged areas of support liners without structurally compromising or damaging intact material around the area being repaired. The primary research objective was to compare and contrast the unintended damage caused to the surrounding structural liner and rock substrate by both mechanical impact hammers and waterjet excavation methods during empiric testing. This analysis involved physical testing on instrumented shotcrete panels designed to better understand the dynamic excavation processes associated with liner repair. Led by an interdisciplinary project team comprised of **Hugh Miller, John Steele, Brian Asbury, Erik Charrier, and Joe Bourgeois** working in collaboration with industry partners, this project provided students with a valuable hands-on learning experience that seeks to address relevant industry challenges. Given the positive results of this project, several follow-up research activities are planned.

Summer Research Internships in Germany

Mines undergraduates **Kendall Callahan** (Mechanical Engineering), **Jaume Martinez** (Mining Engineering) and **James Frazar** (Mechanical Engineering) completed research internships in Germany last summer.

Kendall and Jaume went to the **Institute for Deep Mining at the Technical University Bergakademie Freiberg in Saxony**, about 100 miles south of Berlin. Kendall designed a mechanical control intervention for a shaft hoist. Due to a non-work related illness, the hoist operator lost use of his hand and would have been unable to continue in his job. Kendall designed and constructed a system of complex levers to allow the operator to control the brake with his foot to save his job. Kendall wrote a paper and will present her findings at the Society for Mining, Metallurgy and Exploration (SME) Annual Conference in Phoenix next February.

Jaume is an officer in the Mines Student Mine Rescue Team. He worked with professional and student mine rescuers in Freiberg to compare mine rescue systems and organization between Germany and the U.S. to identify best practices and highlight areas where U.S. teams can learn from Germans and vice versa. Jaume also wrote a paper and will present at SME.

James Frazar completed a research internship at **Deutsche Versuchsanstalt für Luft- und Raumfahrt (DLR, German Research Agency for Air and Space)**, the **German counterpart to NASA**. Jaume conducted aerodynamic computer modeling to test the behavior of a new aircraft design in difficult flight situations. James is working on a publication as well. If you are interested in a summer internship in Germany, **please contact Dr. Jürgen Brune**.

Thank You for Your Support

We would like to take a moment to thank our donors for their continued support of the Mining Engineering Department. **iDig Mines Giving Day** is coming up on **2.26.2020**. Stay tuned for more information!

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