CHEMICAL AND BIOLOGICAL ENGINEERING AT THE COLORADO SCHOOL OF MINES

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INTRODUCTION

As the Colorado School of Mines (Mines) approaches its sesquicentennial anniversary in 2024, the Chemical and Biological Engineering Department (CBE) is approaching its 80th anniversary. Formed in 1944 as the Petroleum Refining Engineering Department, CBE is noted for its teaching, research, diversity, inclusiveness, multi-disciplinary programs, and hands-on experimental unit operations summer session. The CBE department is also home to the Quantitative Biosciences and Engineering (QBE) program at Mines.

As of the Spring Semester 2023, the department has graduated 4,742 undergraduates, 531 of whom are Chemical and Biochemical Engineers and 17 are the inaugural Quantitative Bioscience Engineers, 620 MS students, and 289 PhD students. Prior to 1970, the undergraduate degree was a professional degree rather than a BS, and graduates received a silver diploma. The first graduating class in 1947 consisted of 11 undergraduate students and one MS student. The first PhD was awarded in 1951, and the first woman graduated from the department in 1949.

A Brief and Unorthodox History of Chemical and Biological Engineering at Mines

Figure 1 is a photograph of many of our faculty taken in 2019, and Table 1 gives a summary timeline of our department since it was first founded in 1944. Perhaps of greater interest, however, is the story of the person who initiated our department.

The Founder of Our Department: A Paean to the Human Spirit

James Ogden Ball (J.O. to his friends) was born to a coal mining family in Durham, England, and immigrated to Crested Butte, Colorado, with his family, including six siblings, at five years of age in 1899. J.O. quit school in the seventh grade to support his family, due to his father's ill health. In the Crested Butte coal mine, J.O.'s right leg was amputated below his knee by a runaway coal cart. While recovering, J.O. taught himself algebra, trigonometry, and geometry to design water runoff culverts.

In 1916, J.O.'s miner friends collected a donation to enable J.O. to obtain a fitted prosthesis in Denver. At the conclusion of that process, J.O. had $50 remaining and decided to attend the University of Colorado (CU) in Boulder. The engineering dean ultimately admitted J.O. as a special student, whose formal education had been truncated in the seventh grade. Through many challenges, J.O. completed his BS in Civil Engineering, working nights and weekends in Boulder during the academic year, and working summers at the Crested Butte mine.

Upon graduation, J.O. obtained a job at a Casper, Wyoming refinery, where through sheer diligence, he became plant engineer and taught himself oil refining. After 18 years

Figure 1. *Faculty and staff of Chemical & Biological Engineering in 2019. Front (l to r): Jechura, Sloan, Gomez-Gualdron, Luzeckyj, Carreon, Chauhan, Way, Ganley, Marr, Barankin. Back (l to r): Gambach, D. Wu, Sum, Herring, Wolden, Morrish, Krebs, Boyle, Ramey, Gardner, Koh, Samaniuk, Peters*

TABLE 1
Chemical and Biological Engineering Timeline

1944	Petroleum Refining Engineering (PRE) Department formed with J.O. Ball as the first Department Head. Originally the department met in WWII barracks from Denver's Lowry Air Force Base.
1947	First graduating class. Eleven undergraduates obtained a Professional Degree (Petroleum Refining Engineer) rather than a BS and there was one MS graduate.
1949	First woman graduate - Jacquelyn Borthick
1951	First PhD awarded to William Horblit.
1953	Alderson Hall completed. This building housed Petroleum Engineering (PE) and Petroleum Refining Engineering (PRE) departments until 2012 when PE moved to the new Marquez Hall.
1954	Unit Operations building completed.
1956	ABET accredits the PRE department as Chemical Engineering.
1960	J.H. Gary named Department Head.
1962	PRE curriculum approved by AIChE
1965	Department renamed as Chemical and Petroleum Refining Engineering (CPR).
1970	Silver Diploma Professional degree eliminated and changed to BS Chemical and Petroleum Refining Engineering.
1972	P.F. Dickson named Department Head when J.H. Gary was promoted to VP Academic Affairs and Dean of Faculty (Provost).
1981	Anette Bunge hired as the first woman professor.
1984	A.J. Kidnay named as Department Head after the untimely death of P.F. Dickson.
1985	First woman to earn a PhD was Marcia Huber.
1985	Department renamed Chemical Engineering and Petroleum Refining Engineering (CEPR).
1990	R.M Baldwin named as Department Head when A.J. Kidnay promoted to Graduate Dean.
1992	Alderson Hall renovation completed (classrooms and new research wing).
1995	Coady Computer Laboratory established.
1999	R.M. Baldwin appointed to develop a proposal to establish the Abu Dhabi Petroleum Institute.
2001	J.F. Ely named as Department Head.
2002	Department renamed as Chemical Engineering Department (ChE).
2003	Interdisciplinary Bioengineering and Life Sciences (BELS) program developed. J.F. Ely, Director (2007-2012).
2003	Professors J.T. McKinnon, E. Riedel, and Angel Abbud-Madrid developed the Water Mist Fire Suppression Experiment (MIST) that flew on the ill-fated Space Shuttle Columbia and nine missions to the International Space Station.
2006	Professor R.M. Miller becomes director of the Center for Engineering Education at CSM.
2010	D.W.M. Marr named as Department Head.
2010	Coady Computer Laboratory doubled in size.
2012	Department renamed Chemical and Biological Engineering (CBE). Two undergraduate degrees offered – BS Chemical Engineering and BS Chemical and Biochemical Engineering.
2012	Petroleum Engineering moved to Marquez Hall.
2013	D.W.M. Marr named as Director of the BELS program.
2013	Studio-Bio Laboratory established.
2016	C.A. Wolden named as Interim Department Head.
2017	J. Wilcox named as Interim Department Head.
2018	C.A. Koh named as Interim Department Head.
2018	A. Chauhan named as Department Head.
2022	Quantitative Biosciences and Engineering program initiated.
2022	D. Knauss named as Interim Department Head.
2023	N. R. Boyle named as Interim Department Head.

in Wyoming, Mines Petroleum Engineering (PE) Professor Clark Barb convinced J.O. to come to Mines as the petroleum refining faculty of a two-faculty PE department.

In 1944, J.O. obtained an MS in Chemical Engineering from CU while teaching full-time at Mines, whereupon he was offered several positions, including the chair of the new engineering research division at CU. Instead, Mines President Coolbaugh convinced J.O. to stay at Mines and to form the new Petroleum Refining department.

Like most chemical plant or academic startups, the founding of our department required substantial energy, diligence, and character, as the previous four paragraphs attest. With this fledgling beginning, the department has blossomed into one of the largest undergraduate departments in the US as shown in Table 2.

TABLE 2
Numbers of Departmental Graduates Over Time

	Undergraduate		Masters	PhD
1944 – 1959	239		27	8
1960 – 1969	207		42	10
1970 – 1979	388		96	38
1980 – 1989	752		120	27
1990 – 1999	716		91	36
2000 – 2008	597		65	50
	Chem E	**CBE**	**Masters**	**PhD**
2009 – 2021	1052	531	140	105
2022 – 2023	243	17	39	15

FACULTY

Mines has long been and will always remain strongly focused on providing an excellent educational experience for both undergraduate and graduate students. Thus, a major criterion in all faculty hires is that the candidate must demonstrate high proficiency in teaching. For example, many faculty in CBE are also active in pedagogical research and present and publish at the American Society for Engineering Education (ASEE), in *Chemical Engineering Education*, and at the American Institute of Chemical Engineers (AIChE) in the Education Division.

Mines' teaching and learning center, the Trefny Innovative Instruction Center (TIIC), offers many professional development opportunities to help faculty learn best pedagogical practices. For example, many faculty at Mines have taken a summer intensive course to redesign one of their own courses following an engineering learning model created at Mines. Also, an Engineering and Facilitating Online Learning course is available to help faculty develop and facilitate fully online courses. The center has Online Learning Experience Designers (OLEDs) who work one-on-one with faculty as they develop rigorous and engaging courses.

Teaching Faculty

The Colorado School of Mines has two parallel Academic Faculty tracks: Tenured/Tenure Track (T/TT) Faculty and Teaching Faculty (TF), the latter of which includes Professors of Practice (PoP) along with Teaching Assistant, Teaching Associate, and full Teaching Professor titles. The historical growth of the number of Teaching Faculty is shown in Figure 2.

The first full-time Teaching Faculty in the Chemical and Biological Engineering Department, John Persichetti, was hired in 1997. From that time until the present, CBE has had 14 different TF, nine of whom are still teaching in the department. Those nine faculty have been here from three to 24 years, with an average amongst them of 12.4 years in the department. Three of the other five retired from the department with an average of 12.7 years of service to the department (two having come from previous careers elsewhere and one from a different department at Mines), one left the department after 24 years of service to begin a new degree in a new department at Mines, and one tragically passed away after teaching in CBE for 10 years.

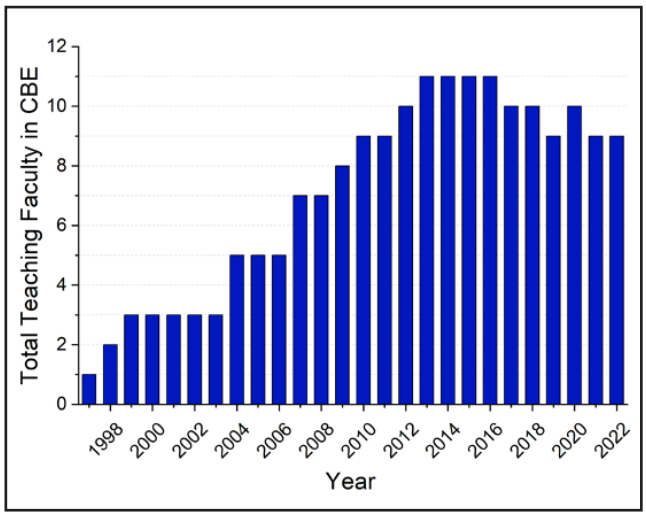

***Figure 2**. Number of Teaching Faculty in CBE at Mines by year.*

Teaching Faculty at Mines have nearly all of the same rights and roles as T/TT Faculty, including serving in the same capacities on university councils and committees and in Faculty Senate, being eligible for leadership roles such as Department Heads or Deans, serving as the faculty representative to the Board of Trustees, taking sabbatical (instruc-

tional development assignment for TF), eligibility for major university awards, and eligibility for Graduate Faculty status to supervise graduate students.

Currently, roughly a third of the 30 faculty in CBE are TF. Teaching Faculty positions are typically 80% teaching and 20% service compared to the 40% teaching, 40% research, 20% service split for T/TT Faculty. Hence, TF typically teach twice as much as T/TT Faculty. Like T/TT Faculty, many TF do research, either in their science or engineering fields, in engineering education, or both. There are opportunities for TF to buy out of courses to do research, get support from the university to travel to conferences, and to get internal grants to do projects or obtain equipment for courses or research.

Major Research Areas

Table 3 lists the individual faculty research areas. CBE has a comprehensive research program and counts among its faculty eight NSF CAREER Award winners, one PECASE Award winner, and one DOE Early Investigator Award winner. CBE faculty conduct cutting-edge fundamental and applied research with the support of federal and state agencies, industry, and private foundations. The department's research may be broadly divided into three thrusts:

- Renewable & Unconventional Energy
- Advanced Materials
- Bioengineering and Biotechnology

Many CBE faculty working in the energy thrust have strong ties with the National Renewable Energy Laboratory (NREL) (Agarwal, Ganley, Herring, Jechura, Koh, Kwon, Samaniuk, Wolden), located just ten minutes from Mines. Much of this collaboration is facilitated through Nexus**,** a strategic Mines-NREL partnership. The variety of research topics includes solar cells, fuel cells, batteries, electrons to molecules, circular economy for energy materials, and biomass conversion. The department houses the world's foremost center dedicated to understanding the critical role of hydrates in energy production as well as their potential for energy storage and CO_2 sequestration (Koh, Sum, D. Wu).

The second core strength and thrust focuses on the design and synthesis of advanced materials for a host of applications. Examples include atomic layer processing and nanoscale thin films (Agarwal, Morrish, Wolden), biomaterials (Barbari, Chauhan, Krebs, Farnsworth, Pak), catalysts (Gomez-Gualdron, Herring, Kwon), inorganic and polymeric membranes (Gardner, Gomez-Gualdron, Herring, Way, Wolden), and nanostructures based on self-and-directed assembly (Marr, Pak, Samaniuk, N. Wu, D. Wu). CBE faculty participate and advise graduate students in the interdisciplinary Materials Science program.

The third thrust within the department is biotechnology. Strong research programs exist in the areas of biomedical devices (Cash, Krebs, Marr, N. Wu), drug delivery (Chauhan, Krebs), tissue engineering (Farnsworth, Krebs), and metabolic engineering (Boyle, Ramey). Much of this research is done in collaboration with local medical institutions such as the Children's Hospital of Colorado and the CU Anschutz Medical Campus in Denver. CBE faculty also participate and advise graduate students in the interdisciplinary Quantitative Biosciences and Engineering program.

Our graduate student recruiting page (https://chemeng.mines.edu/graduate-program/) provides an excellent overview of the current research occurring in CBE laboratories as well as additional links to individual investigators. Much of the research is organized through internal centers that provide shared facilities and resources for their members. These include the Center for Hydrate Research (CHR), the Colorado Institute for Energy, Materials, and Computational Sciences (CIEMACS), the Colorado Fuel Cell Center (CFCC), and Micro-integrated Optics for Advanced Bioimaging and Control (MOABC).

QUANTITATIVE BIOSCIENCES AND ENGINEERING (QBE)

Biology at Mines has a long history of starts and stops, but CBE has always been a leader in the development and offering of biology on campus. In 2003, the Bioengineering and Life Sciences (BELS) Program was initiated by nine departments across campus to formalize biology curriculum on campus and offered students the ability to minor in BELS. In 2013, the BELS program was sunsetted in favor of bio-based minors or tracks housed within individual departments. That same year, CBE debuted a new introductory studio biology course. The course is taught in a specially designed lab and gives students hands-on experience instead of the traditional lecture style. Despite the plethora of bio-based minors on campus, students were still clamoring for more biology-related courses and programs.

Then the COVID-19 pandemic happened. As we all know, this drastically changed a lot for all of us. At Mines, it highlighted the need to educate students at the interface of biology and engineering so they could contribute to important global problems, such as the pandemic. One of the most remarkable scientific advances from the pandemic was the development of mRNA-based vaccines; Moderna delivered a vaccine just 42 days after the sequence of the spike protein was made publicly available. From design to use, it was only a single year — which included design, manufacture, test for efficacy and safety, and finally gain FDA approval. This whirlwind project would not have been possible were it not for biologists, bioinformaticians, and engineers working together. In much the same way as the mRNA vaccine,

TABLE 3
Faculty Research Areas

Faculty	Status	Area of Interest
Sumit Agarwal	Professor	Photovoltaics, plasma processing of materials, atomic scale processing of thin films for microelectronics
Michael Barankin	Associate Teaching Professor	Senior design and unit operations laboratory, process modeling (Aspen Plus®)
Timothy Barbari	Graduate Dean	Mass transfer, polymer science, and separation processes
Suzannah Beeler	Assistant Teaching Professor	Quantitative and computational approaches to biological problems
Nanette Boyle	Associate Professor, QBE Graduate Program Director, Interim Department Head	Genomic engineering to produce fuels, feedstocks, and fine chemicals
Kevin Cash	Associate Teaching Professor	Optical nanosensors for monitoring metabolic dynamics in microbial systems and organisms
Anuj Chauhan	Professor	Biomedical applications with a strong focus on ophthalmology
Matthew Crane	Assistant Professor	Design rules for colloidal nanomaterial devices via in situ spectroscopy
Nikki Farnsworth	Assistant Professor	Biomaterials to develop therapies for Type 1 Diabetes
Jason Ganley	Teaching Professor	Alternative fuels production, instruction for experiential learning
Tracy Gardner	Teaching Professor	Inorganic membranes, pedagogy, online teaching and learning
Diego Gomez-Gualdron	Associate Professor	Molecular science for energy-related materials
Andrew Herring	VP Strategic Initiatives	Renewable energy
John Jechura	Professor of Practice	Energy technologies, petroleum refining, biofuels & computer methods
Carolyn Koh	Coors Endowed Chair	Inclusion compounds, especially clathrate hydrates
Melissa Krebs	Associate Professor	Biopolymers for tissue regeneration and therapeutics
Ramya Kumar	Assistant Professor	Accelerating discovery of polymeric vectors for gene delivery
Stephanie Kwon	Assistant Professor	Kinetics of heterogenous catalysts
David Marr	Weaver Endowed Chair	Colloidal particles as micro-structured materials, biomedical microbots
Rachel Morrish	Associate Department Head, Teaching Professor	Technical and historical thermodynamics courses
Cynthia Norrgran	Associate Teaching Professor	Biology, biophysics, and neuroscience
Alexander Pak	Assistant Professor	Computational design of soft and biological materials for energy, sustainability, and health care
Josh Ramey	Associate Teaching Professor QBE Program Director.	Biology, genetics, and entrepreneurship
Joseph Samaniuk	Associate Professor	Soft matter and complex fluids, energy, and the environment
Justin Shaffer	Teaching Professor	How students learn both biology and chemical engineering
Amadeu Sum	Professor	Molecular thermodynamics, water science and engineering, phase transitions
Colin Wolden	Professor	Material and process development for energy and sustainability
David Wu	Professor	Microstructured materials with novel properties
Ning Wu	Associate Professor	Nanoscale self-assembly into functional macroscopic structures

the ideas behind the interdisciplinary undergraduate quantitative bioscience and engineering (QBE) degree had been percolating behind the scenes for years, and the pandemic helped to fast track its roll out starting in Fall 2021.

QBE was the answer to a large need on campus; students passionate about biology couldn't major in something with a biological focus, and the lack of this type of degree meant that the university was losing top-notch students to other universities. The QBE undergraduate degree is a biology degree with a heavy emphasis on math and computer programming. Unlike many typical biology degrees, Mines QBE students must complete Calculus I, II, and III, differential equations, and probability and statistics, which provides them a much stronger math background than typical interdisciplinary biology degrees. Another unique feature of the degree is the computational content – students are required to take a two course series called Introduction to QBE that teaches them many of the most widely used programming languages and how to apply them to study biologically relevant data. Finally, the signature Mines experience wouldn't be complete without the field session. QBE students, some shown in Figure 3, participated in the first field session during the summer of 2023. During this field session, they combined their laboratory skills and computational skills to perform metagenomics on soil samples from garbage dumps to identify bacteria present that degrade plastics. They also engineered bacteria to increase the rate of plastic degradation with the help of researchers at NREL.

Unlike other majors on campus, QBE is a truly interdisciplinary degree program. QBE is an independent, stand-alone program drawing from three difference colleges on campus, and faculty across nine different departments participate in the program. CBE faculty lead the way in the number of faculty in the program: 13 of the 38 QBE faculty hold primary appointments in CBE, and the two leadership positions are held by CBE faculty. In 2003, the CBE department made a commitment to increase the number of tenure track and teaching faculty involved in biology-related research and teaching. In 2023, CBE has six tenure track faculty (Boyle, Cash, Farnsworth, Krebs, Kumar, and Pak) and four teaching faculty (Beeler, Ramey, Norrgran, Shaffer) who are part of the core QBE faculty. This is a result of the early investment of CBE in the development and offering of biology-based courses at Mines.

UNIT OPERATIONS LABORATORY

The Unit Operations Laboratory is a hands-on experimental laboratory focusing on demonstrations of laboratory hardware discussed in heat and mass transport as well as fluid mechanics. It is a ubiquitous course typically offered to chemical engineering undergraduates in one- or two-semester sequences during the regular academic year. As it

Figure 3. *First QBE Summer Laboratory students in the Edgar Experimental Mines.*

is usually a junior-level course, it is not always considered as a "capstone" course in most departments within the US. At Mines, this laboratory is offered in a dedicated summer session for rising seniors. Two, six-week summer "field sessions" provide laboratory resources and instruction for approximately half of the students following completion of their junior year.

The summer session scheduling allows for extended laboratory time for in-lab experience, shown in Figure 4, as well as for pre-lab preparation and post-lab analysis done outside of the laboratory. In eight-hour shifts, student teams perform lab experiments twice weekly with different laboratory experiments and different student teams throughout. Instruction for the course is designed to take advantage of the extended time frame and the lack of distraction by other courses that the summer session allows; emphasis is placed on experimental design, data interpretation, and instruction/practice related to the communication of laboratory results via oral and written reports.

In report analysis, instructors play the role of a project supervisor and carefully examine student reasoning throughout. This process includes Socratic questioning during each phase of the laboratory experience. Socratic questioning is a supportive, coaching approach by instructors to encourage reflection in the student learning process. Student reflection on laboratory planning/design, in-lab work, and the analysis/judgment or results creates a learning cycle that improves performance of both teams and individuals.

Figure 4. *The 2023 Summer CBE Unit Operations Laboratory.*

As was the case in most hands-on laboratory courses, challenges arose during the COVID-19 pandemic. In the summer of 2020, the summer sessions were offered remotely. In only two months, various professors created virtual lab experiments in which student teams would select ranges of system operation parameters to explore as they would have done if performing the lab in person. Instructors would then run system simulations or calculations and return raw data sets to the students. Fortunately, due to the course's focus on planning, advanced data analysis, and communication in reporting, other valuable aspects of the course remained intact and unchanged.

A highly unique aspect of this laboratory as offered at Mines is that most professors across the department have been involved as instructors – even those who are new to the institution, those who participate heavily in sponsored research, and those primarily assigned to graduate instruction. This gives students access to a wide range of supervisorial perspectives and expectations and also allows broad contribution to a capstone course by our faculty. Instructor enthusiasm for the laboratory as it is presently taught is self-evident; each year all slots for participation in the summer labs are filled despite the significant time and effort required.

The student experience is similarly positive despite the course's rigorous nature and significant demands on individual time management and teamwork. This is especially true for alumni who have had a chance to put these skills into practice in their early careers. Compilations of data from course evaluations indicate that students enjoy having planning-level control regarding lab work and that they take intellectual ownership of both data analysis and reporting. Two students completing the Unit Operations Laboratory in the summer of 2022 share details of their insights below.

Excerpt from Undergraduate Irena Lizier-Zmudzinski regarding Unit Operations

By needing to design the experiment and plan trials, I was required to understand the experiment in depth, sit with the purpose of the experiment and decide what data and measurements mattered and which ones did not, and feel comfortable operating the equipment because there were no step-by-step "recipes." Experimental design for the final lab was an extra challenge because we needed to design an experiment even further than what we had managed to come up with previously. Experimental design exercises in field session increased my critical thinking skills and my sense of independence in being able to run unit operation experiments. My increased sense of independence was one of my most notable take-aways from field session.

As a seasoned junior, when I was told I had to design an experiment or analyze a data set in a different way, I thought, "no problem." But it's much more difficult than it seems, it's quite intimidating to hear your professor say, "show me something new." .The same theme showed up in senior design where there was never one correct answer or direction to take. My group and I had to decide for ourselves. It was a challenge, but I believe it prepared me for my career to come after graduation.

There's no getting around group work in an engineering program, but in both field session and senior design, my most difficult moments were when interpersonal relationships, communication, and cooperation failed. I was surprised at how often it occurred in both cases. I can summarize it nicely as I went into these courses expecting more from some of my classmates. The biggest lesson I learned through these trying relationships was how to handle myself and react. Difficult personalities and relationships will exist in every job or grad program I pursue, and so my ability to navigate those situations and attempt to remain composed will always be important. I definitely failed many times at doing so, but I believe these two experiences give me something to reflect back to when I encounter the next trying relationship in my career.

Excerpt from Undergraduate Kevin Dunn regarding Unit Operations

I learned to examine the equipment present for the experiment to determine what data I could collect (along with learning how to use the equipment). I could then figure out

how to go from the data to what my group needed to calculate for the experiment. Along with the original objectives, I used creativity whenever I had to come up with an extra objective to pursue for the experiment – this involved looking again at what data could be collected, and thinking of what else I could calculate or determine aside from the given requirements. Furthermore, I learned to be resourceful – to gather information and ideas for how to analyze the data for both the required and the extra objectives. Textbooks, handouts, professors, and other students were all helpful in generating ideas and providing knowledge for the experiment and data analysis.

I found that statistical analysis is a good way of encouraging extra thought about the experiment, especially with identifying how the data may be inconsistent or inaccurate. What could be the cause? What could be done to minimize error? In Unit Ops, I identified how an experiment could be redesigned to eliminate potential error or inconsistencies. This later helped in Chemical Engineering Design, where my group and I constantly modified our design to account for both existing and newly discovered problems.

Teamwork and communication are the most important skills to find success in Unit Ops. I needed effective communication throughout to effectively work with several groups simultaneously. I had to be a great teammate to complete each experiment at a high level. Along with pulling my own weight, I found ways to help others to be more effective. I definitely developed the skills to motivate people while keeping spirits high.

SERVICE TO THE PROFESSION AND TO THE FUTURE

We are fortunate that Colorado provides a healthy outdoor environment to host conferences of both a technical and a pedagogical nature. In 2022, two international conferences were hosted by our department, and one regional pedagogical conference was hosted by Mines in 2023.

From July 10 – 13, 2022, the 96th Annual Colloid and Surface Science Symposium was organized on our campus by Ning Wu, David Marr, Carolyn Koh, and David Wu. After an in-person hiatus due to the COVID-19 pandemic in the preceding two years, the conference had 420 attendees, 367 oral presentations, and 40 poster presentations. The Symposium included 14 sessions highlighted by 38 invited oral presentations and 3 areas that relate strongly to Colorado, including energy systems and catalysis, environmental science, and colloids in life science. The conference hosted a joint poster/networking session with the Mines/NREL Nexus, highlighting collaborative research activities between Mines and NREL.

From July 24 – 29, 2022, ASEE and AIChE co-sponsored a national Summer School for Chemical Engineering faculty (ChESS) with 160 participants and 80 presenters on the Mines campus. These Summer School workshops have been held at five-year intervals on different campuses since 1931, principally for early career faculty. The July 2022, ChESS at Mines had a Teaching Institute, two plenary sessions, 11 workshop sessions each with 5-6 parallel offerings, two poster sessions, an industry day, a banquet, and an afternoon of outdoor activities.

From May 15 – 17, 2023, the Rocky Mountain Regional ASEE Conference was held at Mines. The conference hosted visiting engineering schools from Utah, Colorado, Wyoming, and South Dakota with over 120 participants. There were two keynote addresses, 16 posters, 11 workshops, and 32 papers at the conference, with three CBE faculty presenting.

CONCLUSION

The Chemical and Biological Engineering Department at the Colorado School of Mines offers a wonderful place to increase your education, whatever your present level. The department is an energetic, helpful, and connected learning community, as indicated in this profile. As we consider our future societal challenges, our department will continue to provide the resources to address them with intellect, energy, empathy, and goodwill. We hope this short manuscript has encouraged you to interact, to visit, and to study with us in a way that is helpful. ❑