Matthew Liberatore
of the Colorado School of Mines

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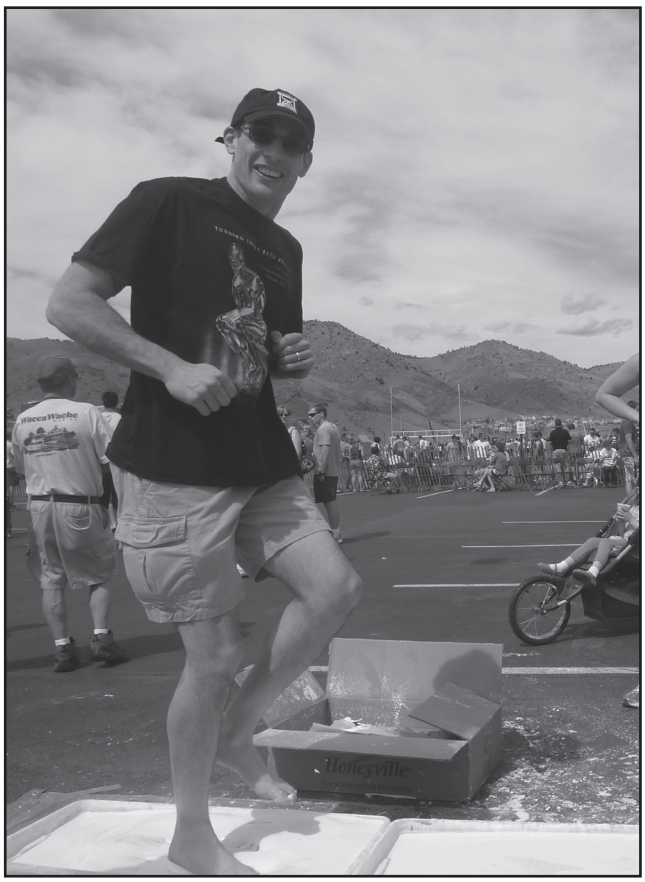
Hey, want to walk on water? Many students are introduced to Professor Matthew Liberatore during Engineer Days on the Colorado School of Mines (CSM) campus after answering this question in the affirmative. Matt and his rheology research group demonstrate the rheological properties of corn starch/water mixtures and get students actively involved and learning about chemical engineering. Active participation and learning are foundational to all of Matt's actions as a professor.

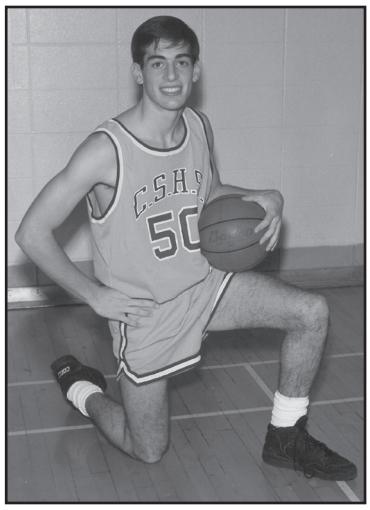
CHILDHOOD AND EARLY YEARS

Matthew Liberatore was born to a pharmacist (his father) and middle school art teacher (his mother), so becoming a chemical engineering educator involving both science and education is an oddly logical choice. Growing up a fan of *Star Wars* as many did in the late 1970s and early 1980s also influenced Matt's interest in engineering. His uncle, an electrical and biomedical engineer, built a homemade light saber—what could be cooler than building something from a *Star Wars* movie? Matt got his first taste of engineering in high school when his chemistry teacher pushed him into participating in the Junior Engineering Technical Society, which in addition to paper tests on topics such as math or chemistry, held competition to build machines with specified functions. The goal of one machine that Matt and his teammates built was to land a tennis ball on a target on the far side of a short wall (about 5 feet tall). Building the tennis ball cannon naturally occurred in his parents' garage late at night the day or two before the competition. The team decided to create a parallel ball launcher using wood, cardboard, rubber bands, and bungee cords. The launcher was functional with four parallel balls being projected at once. While the launcher was far from optimized, many of the balls cleared the wall and hit the target during the late-night testing. At the competition, the team competed to the best of their ability but they did not win or place in the competition. The next year Matt was very surprised to find that although his team did not win the previous year, the rules had changed to only allow one ball to be projected from the device at time.

Matt grew up very active and loved playing sports, especially baseball and basketball. Pick-up basketball games on his parents driveway or wiffle ball games with his brothers and friends were part of his daily (now considered brain healthy) activities in suburban Chicago. Matt's primary extracurricular activity during his high school years was playing on the basketball team. While Matt entered high school at a relatively tall six feet, he left high school at basically the same height. Thus, his skills as a "big man" led to less playing time over the years. However, he was a student of the game of basketball and became interested in John Wooden's unprecedented coaching success. Studying Wooden over many subsequent years has clearly contributed to Matt's teaching style. While admiring Wooden's core Christian values in his pyramid of



Matt walking on water at CSM's engineering days 2012. Yes, his hat has the logo of the Society of Rheology on it.



Left, Matt's basketball photo during his high school years. Right, the early 2000s produced many academics from Illinois' Chemical and Biomolecular Engineering Department including: a. Matt; b. Jason Ganley, Colorado School of Mines; c. Ty Johannes, University of Tulsa; d. (in white, center) Josh Ramsey, Oklahoma State University; and e. Cory Berkland, University of Kansas.

success, Matt especially appreciated the philosophy that each student may need a different instructional style and the credo that you haven't taught until they have learned; this mindset proliferates in his classes today.

UNDERGRAD, GRAD, & POST-DOC YEARS

Commuting to school while living at home was the formula Matt's parents and older brother had followed during college, and Matt did likewise. Driving the 25 or so miles to the University of Illinois at Chicago (UIC) taught Matt patience in Chicago's famous traffic jams on the Dan Ryan expressway as well as time management (*i.e.*, getting up early to beat the rush). Matt still gets up early, is commonly in the office at 6:30 a.m., and normally teaches 8 a.m. courses. Working as a part-time janitor during his first two years of college helped both to pay for books and gas and to encourage him to work hard at his studies—since a repetitive blue collar job was not the life for him. Despite the commuter-student base, UIC offered great Chicago experiences, particularly great food. Located on the near west side of Chicago, UIC is nestled just south of Greek town and east of Little Italy. Matt's love for Chicago style deep-dish pizza and desserts like cannolis has led to his passion for baking.

After his sophomore year, Matt obtained a summer internship at Argonne National Laboratory that turned into a part time co-op lasting more than two years. Matt was introduced to research and studied nuclear waste separation and electrochemistry of nuclear materials. Matt had many great mentors at Argonne (Cliff Conner, George Vandegrift, Ralph Leonard), including one who had worked on the Manhattan project (Jacob Sedlet). The group's mentorship influenced his decision to get a Ph.D.

Matt participated in a number of extracurricular activities while at UIC including being a teaching assistant for the one-credit freshman engineering orientation course (which gave him an introduction to mentoring and advising students), joining the student chapter and local section of AIChE, and serving as vice president of the Illinois Zeta chapter of Tau Beta Pi. These same extracurricular activities have resurfaced in Matt's faculty life as chapter advisor for both AIChE and Tau Beta Pi at CSM as well as attending and helping host local AIChE section meetings in Denver and on campus.

Moving south about 150 miles to the rural college town of Champaign-Urbana provided great opportunities for personal and professional growth while earning his Ph.D. at the University of Illinois. Not only did Matt meet his wife at Illinois (she also earned her Ph.D. in chemical engineering there), but his interest in working with students also grew. Through a series of workshops that led to a graduate teaching certificate, Matt was introduced to the idea of active learning as well as robust evaluation and assessment practices. While the application of active learning led to strong teaching evaluations and a teaching (TA) award for Matt, his wife contends his incentives for the students propelled his recitation sections to do so well on exams. (Matt promised home-baked cookies to the weekly recitation students if their section outscored the other sections; he regularly had to follow through.)

Matt spent many evenings during graduate school participating in different sporting events. He accepted the fact that he would have to play softball using a glove and a 12-inch ball instead of the "real" Chicago softball with a 16-inch ball and no glove (ball dimensions are circumference). Little success was enjoyed by the chemical engineering graduate students in flag

TABLE 1
Summary of Student-Centered Classroom Approaches Developed/Adapted by Matt

I know your name	Photographs and a short biography are required of each student during the first class period. Each of the photographs is then correlated with the student name and memorized. Even in classes of 150+ students, students are called on by name. Many of the sophomore students state that he is the first professor at CSM to know their name.
Minimizing lecture	During a typical 50-minute class period only about 10-15 minutes are devoted to professor lecture covering new material. Most of the time is spent allowing student teams to work concept or computational problems illustrating the new material and reinforcing concepts previously covered. Problems are posted on the course management system in advance of the class and the full solution worked out by the professor is posted immediately following the class. As students work on these problems, the professor and TAs walk throughout the classroom answering questions from teams and individuals.
Teamwork	Almost all of the work in class is done in teams. Teams are assigned using the technology available from <www.catme.org> according to a set of rules developed by the professor. Teams are expected to sit together in the classroom and do not know in advance if they will be called on to provide an answer nor do they know if the in-class problem will be turned in for a grade. Some written homework assignments are completed by teams and a YouTube Project (discussed later) is completed in teams. Peer reviews are a critical assessment of this approach.
Online homework	Homework is assigned using both Blackboard© and Sapling©. Typically, the Blackboard system is used to pose multiple-choice concept questions and the Sapling system is used for full computational problems.[2] Grades are assigned by these systems and immediately available for the student to know how they scored. Students are encouraged to work in study groups or their assigned team to complete these assignments. The Sapling system assigns a different set of problem data to each student and allows multiple attempts to solve the problem. The Blackboard system assigns the same problems in a random order to each student but only allows one attempt.
Just-in-time reviews	Electronic homework is assigned using both the course management system and the Sapling Learning System©.[3] Assignments are due at 6 a.m. on the due date so questions and concepts that show the lowest student averages can be immediately addressed during the first part of class at 8 a.m. Correcting misunderstandings or clarifying concepts before they propagate and become part of students' long-term memory is an important result of these JIT reviews.
Detailed Notes	A Livescribe© pen is used to generate talking portable document format (pdf) files for quiz and exam solutions. Each of the files addresses the concepts necessary to solve the problem as well as the grading rubric.

football or basketball, but a few intramural championships were secured in softball when joining forces with graduate students in chemistry (who shared the same building). These exploits on the field and court have led to reunions at AIChE meetings as a number of professors are among those from the group who completed their Ph.D.s at Illinois during this time period.

Jason Ganley, one of Matt's colleagues at Illinois and now a faculty member in the CBE Department at CSM, vividly recalls Matt's efforts in organizing and successfully coaching the ChE department's graduate student basketball team at Illinois. "In my opinion, it showed his ability to teach in a pretty interesting way—taking a diverse group of students with meager levels of athletic ability and showing them how they could work together as a team. He organized practices, managed the team while playing, and instructed us in basketball techniques ranging from the very basic passing and shooting skills to defensive styles and the coordination of offensive plays. Over a few seasons, the graduate student team played against teams of players used to organized games, and held their own pretty admirably," recalls Ganley.

Under the guidance of Professor Anthony McHugh, Matt's dissertation focused on the rheology of drag-reducing polymer solutions. Rheology is still the central theme in Matt's research laboratory. In his research, he used a custom built rheo-optic device (measuring viscosity and optical properties simultaneously) to identify shear-induced structuring in drag-reducing solutions. Matt's project worked in parallel with large turbulent flow experiments and he benefitted from the mentorship of Professor Thomas Hanratty during this collaborative work.

Having decided to pursue academia as a career, Matt took a post-doc position at the University of Delaware under the guidance of two additional mentors: well-known rheologist Norman Wagner, and Eric Kaler, the dean of Engineering at the time and current president of the University of Minnesota. His post-doc research topic was surfactant rheology and he got his first experiences performing neutron scattering experiments at the National Institutes of Standards and Technology (NIST) in Gaithersburg, MD. The theme of completing 24-hr. scattering experiments (on little sleep) has resurfaced in his own laboratory in recent years, prompting the retelling of Matt's many stories from his post-doc days to enlighten/bore his graduate students.

The year 2005 was an important milestone for Matt as he got married and packed up a moving truck and drove from Newark, DE, to Golden, CO, to begin his career at the Colorado School of Mines.

AT COLORADO SCHOOL OF MINES

In a 2010 CEE article,[1] the phrase "digital natives" was used to describe the electronically savvy, technology dependent, interconnected students in today's classroom. To connect with each of these students, Matt has developed a number of student-centered approaches to his pedagogical style and course content (Table 1). Each approach attempts to overcome students' short attention spans and electronic distractions, and to give his students

experience working as part of a team and developing a more professional approach to learning the course concepts.

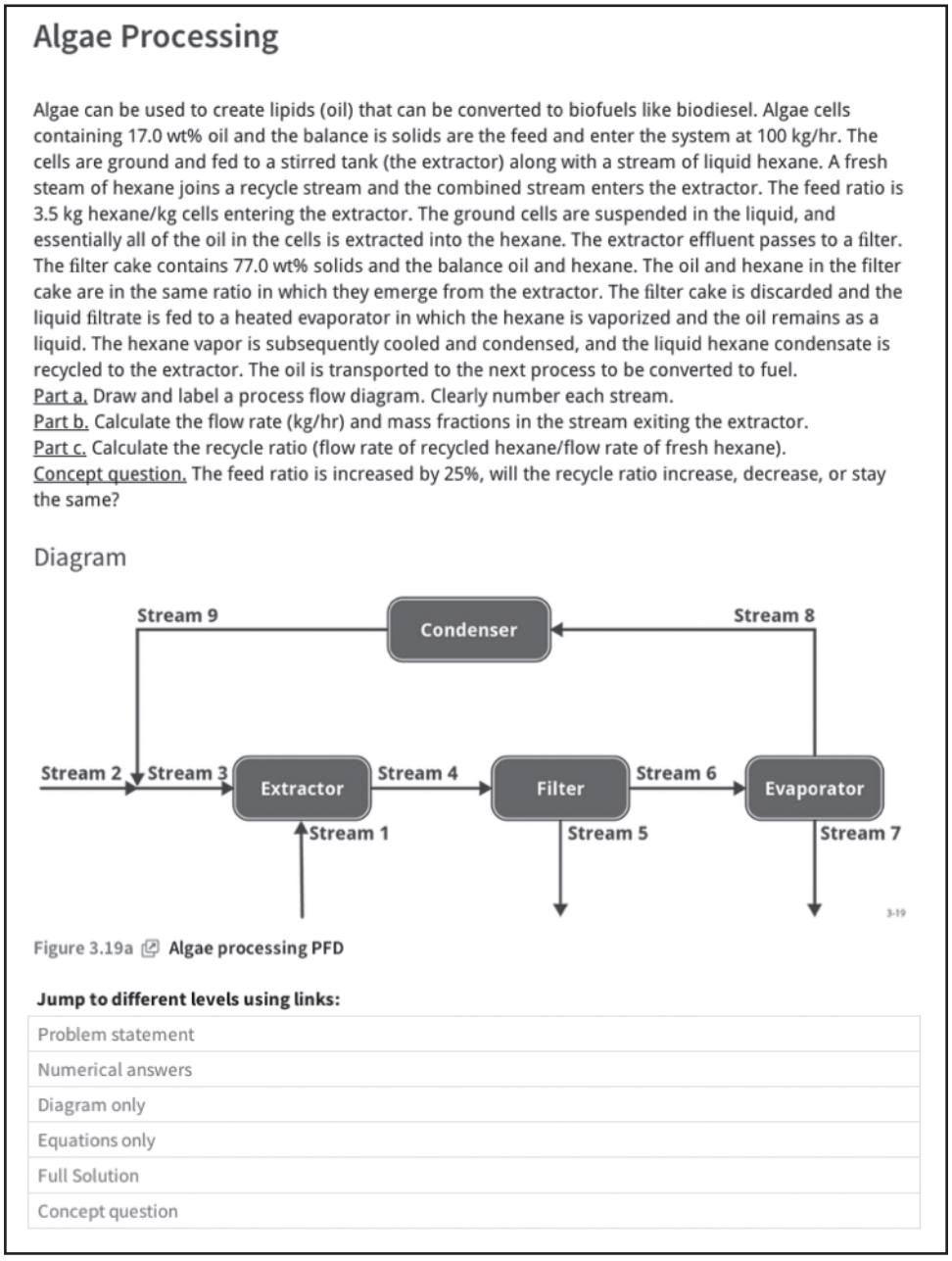
In addition to these successful student-centered classroom techniques, Matt has also developed the concept of YouTube Fridays[1, 4, 5] in which student teams are charged with finding a suitable YouTube video and writing a homework-style problem (and solution) based on the video. These student-generated problems are then used in subsequent semesters to provide another active learning methodology.

Matt's work using all of these different approaches has convinced him that the future of textbooks lies in electronic adaptive texts embedded with numerous interactive components and formative assessments. He has developed the first version of the "Fundamentals of Material and Energy Balances" (FMEB), an introductory text using the cross platform framework (iOS, Android, Web) provided by Inkling (<http://www.inkling.com>). CSM copyrighted his unique delivery method called the Scaffolded Tool for Active Reading (STAR)©. As the introduction to the book states, "This book is for reading, interacting, and building conceptual knowledge and problem solving skills."

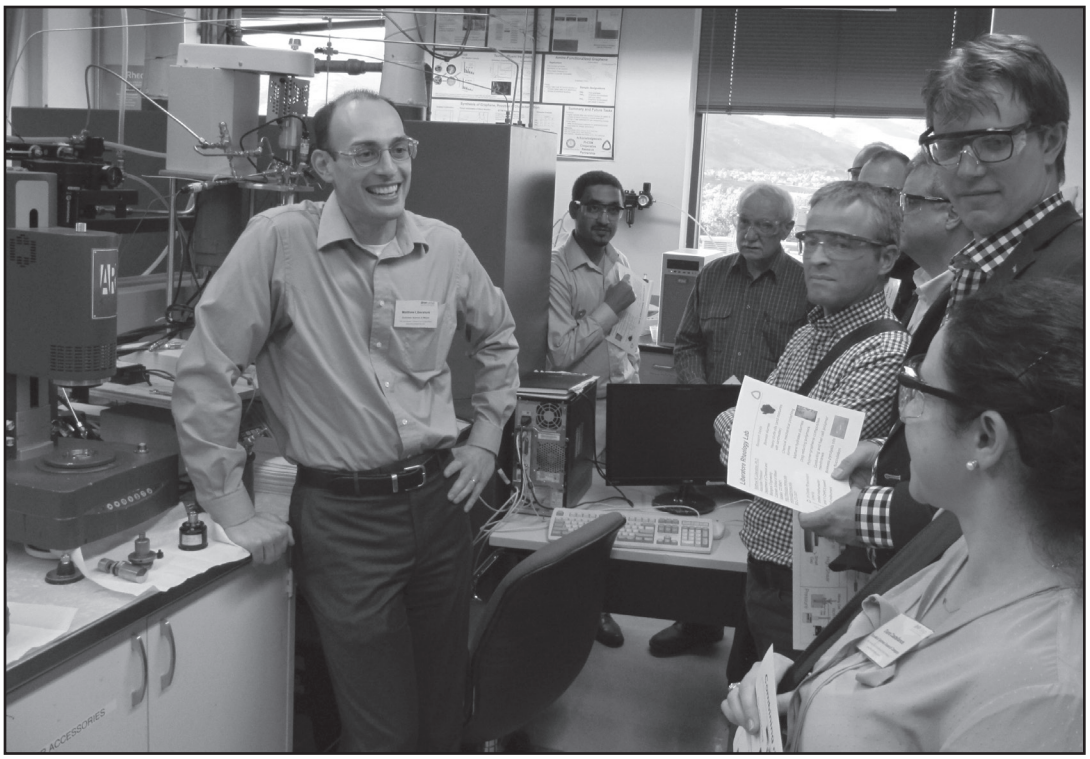
Matt's efforts have been recognized by a number of teaching awards including Professor of the Year voted on by the graduating seniors in the department, Alfred E. Jenni Faculty Fellowship at CSM, Raymond Fahien Award from the ASEE Chemical Engineering Division, and the 2014 Award for Innovation in Chemical Engineering Education from the AIChE Education Division. All of these awards come from a combination of teaching effectiveness and pedagogical innovation/scholarship. The citation for Matt's most recent award states: "For developing innovative pedagogical methods including web-based tools such as YouTube Fridays and personalized online homework that resonate with this generation's students."

According to long-time ChE professor Ron Miller, "Matt has been a delightful breath of fresh air—a young, energetic, capable faculty member who is at ease developing innovative and effective uses of technology in his undergraduate classes while at the same time managing a growing technical research group and mentoring graduate students."

Matt's research group has made significant contributions in the areas of rheo-optics and rheo-scattering in polymer and surfactant solutions. Additionally, numerous new lines of research at the interface of rheology and energy research have been developed including rheology and enzymatic hydrolysis



Screenshot of "Fundamentals of Material and Energy Balances," a new interactive "textbook" for the most important chemical engineering course (or so Matt says).



Matt, donning his safety glasses, gives a tour of his rheology lab to engineers attending a conference at CSM.

of biomass slurries, viscosity mapping and aging in biomass pyrolysis oils, increasing the viscosity of drag-reducing polyelectrolytes by the addition of salt, correlating chemistry and viscosity of heavy crude oils, and high-pressure rheological studies of clathrate hydrates. Overall, the group's research contributions are reflected in significant competitive research funding, with collaborations across numerous departments at CSM and other academic institutions, industrial partners, and government laboratories. Four Ph.D. students and three M.S. students have completed theses under his direction with more than 55 peer-reviewed publications, including work published in high-quality journals such as *Nature Materials*, *Langmuir*, *Soft Matter*, and *Journal of Rheology*. He loves to show off the unique features of his laboratory as well as his undergraduate and graduate researchers, who have earned 10 poster and paper awards under his guidance. Recently, Matt hosted a tour of 30 engineers attending a conference at CSM and received several compliments on his enthusiasm for rheology, his lab, and his students.

Finally, Matt has been very active serving both the students and the university in various capacities. He has been the faculty advisor to the Student Chapter of AIChE and Tau Beta Pi, the Engineering Honor Society. The Colorado Alpha Chapter of TBP has received a number of regional and national honors in recent years and maintains one of the largest groups in the nation. The student chapter of AIChE is active at all levels including hosting local section meetings, participating in regional and national meetings, the Chem E car competition, and winning many awards in paper competitions. A third student group is the Catholic Students at Mines. Matt helps the student leaders traverse the university's logistics to find rooms to host Mass on campus every Sunday.

Matt balances many service responsibilities in the department from being a member of the department's executive committee to spending three years running a Research Experiences for Undergraduates (REU) program and distributing very highly qualified students across the department. Matt serves as the chair of the undergraduate affairs committee and keeps the undergraduate program in balance and curriculum continuously evaluated and up-to-date. While Matt's internal service list is much longer, he also finds time to contribute to external groups. He actively participates in the Society of Rheology and will host their annual meeting in Denver in 2017. Matt also just completed his first year as 2nd vice chair of the Education Division of AIChE.

Working with Matt is like trying to tame a whirlwind, says Charles Vestal, a co-instructor in the sophomore-level thermodynamics and mass and energy balance classes. "Matt's enthusiasm, drive to teach, outreach to students, knowledge, etc., are passed on to every class. Active learning isn't a strong enough phrase to describe Matt."

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