Collaboration

I’m not usually one to make groundbreaking announcements, but the engineer of white socks, pocket protectors, and stereotypical nerdiness may soon be a forgotten relic. The engineering students of today are bucking stereotypes left and right and creating stories and lives that are all their own. At Colorado State University, we pride ourselves on shaping the engineers of the future, ready to take on challenges that seem more numerous and daunting with each passing day.

This publication focuses on the stories of some of our excellent students, most of whom take their excellence beyond the walls of the classroom. In my time at this university, I’ve had the opportunity to attend leadership retreats at CSU’s gorgeous Pingree Park campus, work with student leaders in the ASCSU office, and be a part of cutting-edge tissue engineering research projects. All of these opportunities fall outside the requirements of my electrical engineering degree, yet I believe these experiences make me a more motivated, successful, and passionate student.

The engineering programs at Colorado State continue to bring new and exciting offerings to our students in an effort to create diverse programs attractive to prospective students, employers, and graduate school recruiters. Our faculty continue this trend by earning record amounts of dollars in research awards and bringing groundbreaking research into our labs and classrooms. The College of Engineering continues to expand with a significant addition to the award-winning Engines and Energy Conversion Laboratory, and the soon-to-open Engineering II Building, and many other exciting projects that pepper the horizon. It’s a fantastic time to be a CSU Ram, but it’s especially fantastic to be a CSU Ram Engineer! I hope you all enjoy these stories as much as I have.

Ram, but it’s especially fantastic to be a CSU Ram Engineer! I hope you all enjoy these stories as much as I have.

Mission

The College of Engineering’s mission is to do purposeful work that impacts our global society. This important work includes:

• providing an excellent education for students,
• generating new knowledge,
• applying that knowledge to develop and implement solutions for global problems,
• working with internal and external partners to conduct meaningful engagement, and
• stimulating local, regional, and global economic development.

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This publication was funded by generous gifts from our alumni and friends. We are deeply grateful for your support! Printing of this publication represents less than 0.01 percent of the College’s annual expenditures.
Bridging the Divide Between Classroom and Real-World Design

Sugar beet farming once dominated Northern Colorado and spurred the region’s development, before declining with changes in agriculture and giving way to increased population growth. The legacy of the industry, however, has left behind some unsightly and even dangerous elements, such as piles of lime-waste byproducts and decrepit, unsafe structures.

In Fort Collins, a historic conveyance flume, which dates back to 1926, formerly moved lime effluent waste into disposal sites but now stands abandoned next to the Cache la Poudre River. The structure looks like a small suspension bridge halfway through completion with no flooring to safely walk across, so curious or mischievous passersby who sometimes climb over angled and open trusses and concrete piers risk a fall and injury. Due to its proximity to a popular riverside biking and walking trail and the Kingfisher Natural Area, the flume is a significant hazard and liability.

Concerned about the potential for a dangerous accident and vandalism, city officials in charge of natural areas and historic preservation have turned to Colorado State civil engineering students for a remedy. The project - to turn the flume structure into a safe and accessible pedestrian bridge - is being tackled by a senior design team of six student engineers.

“It’s really an outside-the-box project,” says Hilary Lehr, a team member from Hilliard, Ohio. “We didn’t have a set design. It was pretty much, ‘Here’s this thing that already exists; what can we do to make it usable to the public?’ It’s definitely nice to think it could be made into something we can use here in Fort Collins.”

The project has presented its share of challenges, forcing the students to apply concepts and skills developed throughout their academic careers. For starters, the students began from scratch in modeling its construction.

“We couldn’t find any existing blueprints of the structure, so we had to create our own,” says team member Emie Waterpauh, from Telluride, Colo., “and we didn’t have an actual date of how old it was until we got on top of the piers and found a date scribbled in the concrete.”

After the group created a new blueprint, they used Abaqus, a computer-aided engineering software program, and other modeling programs to study loading scenarios, reaching out to several engineering professors and professionals in the community for ideas and advice.

Paula Miller, the project’s team leader from Loveland, Colo., says the project allowed the students to become proficient with the programs, while enabling them to ensure the structure could safely withstand weights associated with repairs, building a decking system and handrails, and future pedestrian use.

In drafting modifications and a new design, the students had to consider how a renovated structure can meet building codes and floodplain rules, as well as the different regulations and values of the city’s natural areas and historic preservation departments. Filling the different standards and goals while working with the city government staff has given the students a taste of the complexity of real-world design projects and is preparing them for career challenges after college.

“The whole project is an excellent opportunity for all of us to work together in a professional atmosphere and with the clients,” says Lehr, “because [the city officials] hadn’t really talked to each other and had two different ideas of how the project would go.”

Considering the balance between meeting technical necessities and the clients’ visions, the team is exploring several design options for a pedestrian bridge that the city will have to assess as officials determine the direction the project will proceed.

Through research and fieldwork, the students have realized that the original flume is a work of ingenuity and innovation. The structure, in fact, is constructed of reclaimed railroad car wheels and tracks. Nearly a century later, the student team – with guidance from CSU professors, engineering professionals, and the clients – is similarly marshaling its own resourcefulness to engineer the redesign and even contribute to the future development and integration of the city and its natural resources.

“A project like this makes you reflect on your undergraduate education,” says team member Scott Kallase, from Fort Collins, “and it’s important that we’ve been trained to identify a problem and locate the resources that we need to solve it.”

Brad Jackson
“In industry, you work in teams with people from different disciplines, so it’s been a really good experience to be on a team that has people who have concentrated in different areas. We play off and allow each other’s strengths to come out.”

Team members (from left): Paula Miller, Loveland, Colo.; Emie Waterpauh, Telluride, Colo.; Hilary Lehr, Hilliard, Ohio; Katelyne Podharsky, Longmont, Colo.; Brad Jackson, Parker, Colo.; and Scott Kallase, Fort Collins, Colo.
Researching the Mysteries of Cyanobacteria

Paul Gallogly hadn’t even finished elementary school when he decided his career path. With an affinity for math and science and a desire to be “playing with chemicals all day,” Gallogly knew he wanted to study chemical engineering.

Gallogly has followed his interests at Colorado State University, and it’s no surprise that the young man from Colorado Springs was studying in a research laboratory almost as soon as he started school. As a sophomore, he is beginning to contribute to groundbreaking efforts to genetically manipulate cyanobacteria in order to engineer productive biofuels and other chemicals with impacts spanning the energy and pharmaceutical industries.

“I’m working on a tool that will help us make these genes work at optimal rates with each other,” Gallogly says. “This is my first real whack at genetic engineering.”

Gallogly works in the lab of Christie Peebles, assistant professor in Colorado State University’s Department of Chemical and Biological Engineering, where he is collaborating with a graduate student. The opportunity is launching his research aspirations and preparing him to tackle his own projects.

“Paul will be gaining hands-on experience in experimental design, molecular biology, and transformations of cyanobacteria,” says Peebles. “This experience will hopefully lead to a good foundation for his honors thesis project. He asks great questions and has been consistent in his commitment to research.”

In his first two years, Gallogly has learned basic techniques and protocol and accomplished some small studies to gain a deeper understanding of the processes behind genetic and metabolic engineering and microbiology. He spent his freshman year reading materials and learning the vocabulary before beginning lab studies as a sophomore. When he leaves his workspace, he confesses that he runs through mental experiments that sometimes keep him up late at night.

Gallogly’s research in Peebles’ lab will use molecular engineering techniques to test the strength of different ribosome binding sites in cyanobacteria. The knowledge from the study will allow the lab to optimize gene expression within an operon – cell-signaling genetic tools that are either activated or repressed with the presence of certain chemicals or enzymes – which will allow the researchers to optimize production of biofuels and biochemicals.

“There’s a huge range of steps that happen between going from the living cyanobacteria to the biofuels,” Gallogly says, of the complex chain of actions. “It’s really cool to be able to tell (biological) things what to do.”

By engineering the different production patterns for the cyanobacteria, the research should contribute to the goal of more efficiently producing biofuels and making their integration into energy systems a reality. The ongoing explorations could have outcomes that also produce chemicals with a number of pharmaceutical and other applications.

Gallogly plans to continue the research, as he moves through his course work and studies, and to apply the classroom lessons he’s gaining through the College of Engineering.

“The research is increasing the dimensions of my education because it gives me a real-world view, not just through textbooks,” Gallogly says. “CSU has a very good research emphasis, and the size of the school is really good for getting involved. And because there’s so much research going on, you can coordinate with other research groups for their additional knowledge on topics.”

His immersion in the lab is also helping Gallogly learn the ropes of science communication and how to effectively speak about the science and experiments unfolding among Peebles’ research group and in the field of chemical engineering in general.

Gallogly says he’s looking forward to eventually compiling and analyzing study results and presenting his research at academic conferences.

With a strong start in the field, Gallogly hopes to find a research job after he graduates, whether it’s in genetic engineering or microbiology or another aspect of chemical engineering. Years after playing with chemicals as a kid, Paul Gallogly still appreciates the curiosity sparked through experiments.

“It’s like being a detective and you’re trying to solve the case,” Gallogly says.
The Cache la Poudre River plunges from the top of the Rockies through its canyon before flowing through Fort Collins and eastward to the plains. The Poudre is the lifeblood of Northern Colorado, and monitoring and protecting its health and water quality is an important part of managing the entire river basin.

Mazdak Arabi, assistant professor in Colorado State University’s Department of Civil and Environmental Engineering, has proposed an innovative monitoring system to allow managers to virtually observe the Poudre with an unprecedented amount of detail and data in order to make management and planning decisions. Known as the Watershed Innovation Network, the initiative will use online software tools, which Arabi calls the environmental Risk Assessment and Management System, or eRAMS.

Getting the project going has required the hard work of a team of six student engineers and a graduate student who are setting up the first high-tech monitoring stations on the river. Working for the city of Fort Collins and with the support of Arabi and several local environmental and engineering consulting firms, the students are helping to launch eRAMS. The outcome should improve how water managers monitor and plan, and the system will serve as a model for river managers around the world.

“There’s great potential for it to do a lot of good for the city of Fort Collins and for the general public,” says environmental engineering student Jesse Jankowski, from Durango, Colo., who has served as the project manager for the senior design team.

During his time at CSU, Jankowski’s been a member of the Engineering College Council, through which he helped members of the dean’s office pass a new student fee to help fund the new Engineering II Building. He’s also served as a Presidential Ambassador, a liaison position between students and administrators. Jankowski worked at a local engineering firm during his final year, and he took his passion for the environment abroad during an alternative spring break, removing invasive plants from Catalina Island in California.

“My experiences with the college council and with review boards at Colorado State University have really increased my analytical thinking skills and my understanding of the interactions of the University, making the overall experience that much more rich,” Jankowski says, “because it isn’t just about academics, it’s about being part of something bigger than yourself.”

The eRAMS project is yet another example of a project with individual and societal benefits for the team members. Typically, river managers have collected and measured water data through “grab samples,” sending a person to a stream to gather water and then analyze it in a lab. Through eRAMS and the network, remote sensing technology and software will do the fieldwork and provide real-time analysis, allowing scientists to study river health around the clock.

Over the course of a year, the design team of civil and environmental engineering students has worked to establish the system’s initial two monitoring sites, with plans for several more. The mix of tasks led the team to split into three groups, which focus on collecting data and performing surveying fieldwork to choose the monitoring sites; choosing and setting up the instrumentation, working with the consulting firms; and developing the software to analyze the information. The data should enable city utilities managers to prepare for new government water-quality standards and avoid pollution problems.

“One of the major goals is to link these data sites to optimize wastewater treatment,” says Kirk Reimann, a team member originally from Fort Collins. “It’s the first time to do this with real-time data in this country.”

Arabi and the students plan for the online information to be available to the public and have a user-friendly interface. Tyler Wible, a Loveland, Colo., team member, says the software will also be made available, so the project originating through the College of Engineering can eventually be replicated on river systems around the world.

The collaboration between government agencies, industry, and CSU is broadening understanding between agricultural and urban areas, adds Brandon Hruby, another team member, from Rye, Colo. For the students, it has also been an outstanding opportunity to gain experience working with professional clients on a groundbreaking project.

The network initiative — and other aspects of the civil and environmental engineering department at CSU — is teaching students beyond traditional applications by incorporating technology and computer programming, says team member Jeff Ditty, from Seoul, South Korea. “Now, civil engineers are being taught how to program themselves,” Ditty says. “It’s a new aspect of civil engineering. We can help many people by making one program and putting it on eRAMS, and that’s better suited to our generation.”

Jesse Jankowski

“My experiences with the college council and with review boards at Colorado State University have really increased my analytical thinking skills and my understanding of the interactions of the University, making the overall experience that much more rich, because it isn’t just about academics, it’s about being part of something bigger than yourself.”
When a military unit is stationed in the desert or another isolated outpost, Jeff Showen makes sure the soldiers can communicate through a computer network. Showen is a military contractor and systems engineer who builds tactical systems, called a Tactical Area Land Network, or TACLAN, for United States Special Operations Command.

"A TACLAN essentially is a data center in a box," Showen explains. "You take it all out there, you rack and stack it all up, you cable it all up, [and] you turn it all on. My role is to make it smaller, make it faster, make it better, and, what the government says, make it cheaper," Showen says.

But packing a computer network into a box, and then figuring out how to strip away weight without losing reliability is a very tricky puzzle.

Showen was born and raised in West Virginia and joined the military after he graduated high school, working as a "ground rat," learning and performing radio maintenance. Over two-plus decades, Showen and his wife, who has also served in the military, lived all over the United States and spent three years in Germany. Along the way, he earned his bachelor's degree in electronics technology and then later got an M.B.A.

His background in electronics has served him well, moving through the military and into the private sector as a contractor. But while Showen has worked in systems engineering and gained plenty of practical experience, he wanted to gain a more formal and fundamental education in the field.

"I started learning on the job about systems engineering, and at some point, I thought I needed more. [On-the-job training] is great, but I need the formal training that stands behind it, so I can understand better and be a better engineer," Showen says.

Seeking an online master's degree in the field that accommodated his schedule and needs, he selected Colorado State University. The College of Engineering “seemed to have real talent and ability to attract high-quality instructors, and that was one of the big draws,” he says.

Shownen recalls taking his first class while living in the Philippines in 2009, which meant keeping odd hours because of an 18-hour time difference. Showen tries to participate in classes when they happen “live” online, but the ability to watch recorded lectures – and rewatch them to process complex lessons – is a major benefit. Many professors’ experience in both industry and academia has also proved meaningful to Showen.

“The online format is fantastic,” Showen says. “It lets me work on my schedule. Sometimes, frankly, I can’t get to a class when it’s actually happening, so being able to go back and look at it is ideal for me.”

Beyond gaining the foundational education he was looking for, Showen has benefited from course work in risk management and reliability engineering, both of which have major applications for his projects for the military – in particular, designing lighter and cheaper TACLAN units.

The networks enable military units to set up computer networks that run on virtualized software in the field, including war zones, such as Afghanistan and Iraq, and all over the world. The systems allow units to run their laptops, phones, and radios and even communicate with soldiers who leave a station and head "outside the wire.”

While impressive, the boxes aren’t petite. Including servers, storage, and uninterruptible power supplies and routers, the TACLAN gear packs in huge cases that require two people to lift and carry them, weighing in at roughly 160 to 170 pounds. Using the principles and lessons he’s gaining through CSU, Showen is designing prototypes to shed weight and retain purpose. The benefits will save the government money and also protect the lives of soldiers.

“Systems engineering is really the linchpin of doing all this. What I’m learning at Colorado State directly applies to what I am doing, so I am very satisfied,” Showen says. “My goal was to become a better systems engineer, and I am a better systems engineer. I get better all the time.”
The national parks serve as outdoor laboratories that preserve natural systems for science and recreation. But that doesn’t mean park lands are impervious to environmental threats. In Rocky Mountain National Park, perched in the Rockies along Colorado’s rapidly populating Front Range, changes are unfolding due to an increase of nitrogen in the environment, and scientists are scrambling to figure out the causes and consequences.

“This is one of the National Park Service’s big questions, because they’re really concerned about the ecology of the national parks,” says Katie Benedict, a doctoral student in atmospheric science, who is originally from Vermont. “Nitrogen deposition is increasing and acts like a fertilizer, but the national parks are protected, and we don’t want the plants to change.”

Benedict is focusing her dissertation on how nitrogen – which can come from automobile emissions, agricultural applications, and natural sources – moves into parks and other areas. The opportunity to research the subject at Rocky Mountain and Grand Teton national parks, with the support of federal scientists and Jeff Collett, professor and atmospheric science department head, attracted Benedict to come to Colorado State University as a master’s student and to pursue her doctoral degree.

“The societal implications are a pretty significant factor in doing this work,” says Benedict, who adds that the field work has its ups and downs, literally. The travel between parks is a bit exhausting, she confesses, but hikes to high-country monitoring sites make for a wonderful commute.

Rocky Mountain is a unique national park study area because of its relative proximity to both cities and farms. Together, the urban and agricultural area emissions combine to create particles that last longer and travel farther than the gas phase of nitrogen, Benedict says, meaning park researchers are already seeing issues that other protected areas could face in the future.

So far, Benedict’s work has improved what scientists know about the processes at work, including how precipitation carries nitrogen compounds, namely ammonia and nitrate, into the environment. One major finding is that organic nitrogen is a much greater contributor to the total nitrogen documented at park study sites than scientists previously considered. Whether those results are from human-caused or natural effects or some combination of the two, however, still isn’t clear.

Potential sources for the increased nitrogen could be biogenic, or plant-based, carbon compounds that then interact with NOx emissions associated with vehicle traffic and power plants, Benedict says. To gain an adequate grasp of the chemistry at work, she has turned to Sonia Kreidenweis, professor in the Department of Atmospheric Chemistry at CSU, and other professors to assist her.

“In the department, there’s a lot of support and different areas of research,” Benedict says, “so it’s really great to have people who can help me better understand air patterns as I’m trying to understand the [nitrogen] transport.”

Research funds for the project come from the National Park Service, allowing Benedict’s academic work to contribute to the government scientific knowledge base. Scientists at the Cooperative Institute for Research in the Atmosphere – a research department in the College of Engineering that partners with the National Oceanic and Atmospheric Administration – have also provided support.

Benedict’s focus and settings put her in good company with other CSU researchers looking at changes occurring to air, water, land, and wildlife communities in national parks. Benedict’s monitoring sites in both parks have also served as water-sampling stations for Jill Baron, a research ecologist at CSU’s Natural Resource Ecology Laboratory and the U.S. Geological Survey.

Research on nitrogen deposition and changes in the nitrogen cycle have applications to everything from global food production to auto emissions rules to climate change. Benedict has already published and presented aspects of her peer-reviewed research, and she is considering postdoctoral opportunities and an academic career to continue her inquiries.

Building on her research and communications skills, Benedict took part in a National Science Foundation research flight while at CSU, during which she collected cloud water aboard a C-130 plane, outfitted with scientific instruments, above Chile to study pollution. She was also named an Environmental Science Communication Fellow in 2011 through CSU’s School of Global Environmental Sustainability and supporting programs.

“There are a lot of air-quality questions out there,” Benedict says. “I really like that my research has environmental implications.”
Making Dogs Safe With Digital Sensors

The long and hot afternoons of summer are often referred to as the dog days, but the extreme heat of the season can prove fatal to pooches. Since dogs lack sweat glands to help them cool down, it’s difficult for their bodies to recover after overheating.

In recent years, Vicki Campbell, of the Department of Clinical Sciences in the College of Veterinary Medicine and Biomedical Sciences at Colorado State University, has noticed numerous dogs being brought into the CSU Veterinary Teaching Hospital suffering from summer heat stroke and exposure.

Campbell realized no product exists to tell a dog owner when conditions are turning critical, so she approached Kevin Lear, the Rockwell Anderson Associate Professor of Electrical Engineering and a pioneering expert in the use of biosensors, to devise a solution. The collaboration led to the concept of a dog collar with biosensors, and College of Engineering students Diana Peterson and Michael Taylor have helped build the system through their senior design project. The SAFE (Saving Animal Friends with Electronics) dog collar uses biosensors to monitor a pup’s vitals and alert human companions about any life-threatening distress.

"It’s a project with direct, real-world applications," says Peterson, "for dogs that are left in cars on hot days, dogs out exercising, military dogs, and police dogs."

After a previous student design team started building the wireless system for the collar, Peterson and Taylor have moved along the design and integrated the electrical components and other parts of the patent-pending collar system.

The SAFE collar will use a set of attached probes and sensors that are pressed against the dog’s skin to read its body temperature and also measure ambient humidity. The electronics are housed in a small circuitry box on the collar, running on coin-cell batteries. When the humidity outside or the dog’s body temperature reach critical points, the collar is programmed to produce a warning sign, so a person knows to cool down the animal.

Previous iterations of the product used analog sensors, which are relatively expensive, so Peterson and Taylor have worked on reconfiguring the design to use digital sensors. Their course work in electrical and computer engineering have proved essential to executing their ideas.

Taylor, a computer engineering major from Littleton, Colo., was particularly drawn to the opportunity to work with microcontrollers, which are tiny computers that run embedded systems, such as implantable medical devices and power tools. A self-proclaimed tinkerer and the son of an electrician, his fascination with electronics dates back to kits he experimented with when he was growing up. Taylor even built his own theremin, an electronic musical instrument that makes a spooky sound when a person waves a hand, or object, between its antennas, which is well known to fans of classic suspense and horror films.

Peterson, an electrical engineering major from Fort Collins and a fourth-generation Ram who is following in the career path of her father, says she was drawn to the project because it provided an opportunity to take a conceptual design into production.

"There are always so many more components you have to take into account once it’s something real, instead of a project for a lab demonstration," Peterson says. "We’re definitely gaining skills to actually turn the design into something physical."

The collaboration with veterinary researchers has given the students a chance to work on an interdisciplinary project with scientists in different fields with distinct strengths. Peterson says, with a laugh, the vets talk about dogs and humidity; the students respond with explanations of algorithms. Despite the different technical languages, the student engineers and veterinary scientists have achieved their initial goals and devised a promising instrument that will help protect dogs, with potential applications for other animals and even people.

In order to improve the collar’s utility as a consumer product, engineers will build on the work of Peterson and Taylor to configure the sensors’ display to provide basic information that average pet owners can comprehend. The impact for pets and their owners should be readily discernible, and the SAFE collar system should prevent the summer dog days from turning into dire situations.

"I like to imagine the time when the collar will make it through production," says Peterson, "and to think it will save some dogs’ lives."
Pushing the Boundaries of Neurological Rehabilitation With Augmented Reality

Neurological disabilities associated with strokes, cerebral palsy, and traumatic brain injuries impact more than 1 million Americans each year. Medical breakthroughs are helping more individuals to live with such impairments, but rehabilitation to regain motor skills, strength, and range of motion is an evolving and expensive field. To develop a simple, accessible, and affordable rehabilitation regimen, Colorado State University College of Engineering students Jacob Poore and Baris Tevfik have turned to “augmented reality,” which uses real objects to interact with computer-generated environments.

Augmented reality relies on technology that enables users to physically control directional movement and other actions on a computer screen. Anyone who has played a driving or flying simulation on a smartphone or tablet has explored augmented reality.

Neither Poore nor Tevfik proclaims to be a gamer, so the chance to innovate a new video game wasn’t what drew them to the senior design project. By applying augmented reality to neurological rehab, they’re pushing the boundaries of the technology and exploring an innovative collaboration between computer and electrical engineering and occupational therapy.

“We were really interested in this because augmented reality is taking hold through smartphone and other devices,” says Poore, who grew up in Saudi Arabia before coming to Colorado to attend boarding school as a high school student. Sudeep Parischa, assistant professor in the Department of Electrical and Computer Engineering, and Matthew Malcolm, associate professor in the Department of Occupational Therapy, originally teamed up for a National Science Foundation grant to explore the concept behind the project. A previous student group made some initial progress, leading Poore and Tevfik to pick up the effort and advance it significantly. Both professors have served as advisers.

Poore and Tevfik began developing their iteration of the project by combing the Internet for open-source and public-license software that already exists and could be used in their project. Using their backgrounds and studies in computer and electrical engineering, the student engineers adapted and combined several different applications, which allowed them to create a framework for their augmented reality program.

A test version of one game they created operates by using a wood block covered with a squiggly-lined QR code that can be detected by a camera connected to a computer. On the screen, the block shows up as a spaceship, which a patient then controls and moves around to highlighted spaces to navigate a game. Another program developed by the students replicates the classic amusement park game, Whac-A-Mole.

The movements represent important exercises for patients recovering from brain injuries and strokes who need to rebuild upper limb strength and control. The motion is considered more manageable for such patients than operating typical popular video game console systems. As a person regains strength, a heavier block, or other object, can help with continued progress.

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“A whole slew of users with different types of abilities can use the software,” Poore says. “We wanted to develop rehabilitation software you can use at home because people have developed virtual reality programs that are absolutely incredible, but it’s a $2 million setup to use in a lab. With our project, you print out the [QR code] trackers with your printer at home, and that’s basically it.”

Tevfik, who came to CSU from Turkey with the encouragement of his father who also attended college in Colorado, adds that the project has been a crash course in coding and programming language. Parischa has helped the students prioritize their tasks, but he has also largely left them to solve challenges on their own – an approach they both appreciate.

“We’d never really programmed a game before this,” Poore adds, “so it’s been a great learning experience.”

The interaction with Malcolm and graduate students at the Department of Occupational Therapy, in the College of Applied Human Sciences, has also been essential.

“Having an occupational therapy department at CSU gives us the opportunity to put our software into practice,” Poore says. “As programmers and designers, we can make games do whatever we want, but what is it from the doctors’ perspective that they want control over? Having that connection is wonderful.”

Sometime soon, thanks to Poore and Tevfik’s ingenuity, when occupational therapists prescribe neurological rehabilitation, there may just be an app for that, too.

Jacob Poore

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“Having an occupational therapy department at CSU gives us the opportunity to put our software into practice,” Poore says. “As programmers and designers, we can make games do whatever we want, but what is it from the doctors’ perspective that they want control over? Having that connection is wonderful.”

Sometime soon, thanks to Poore and Tevfik’s ingenuity, when occupational therapists prescribe neurological rehabilitation, there may just be an app for that, too.
Passion for Engineering Leads Student to Classroom

The collective fields of science, technology, engineering, and math, known as STEM, are expected to offer millions of job opportunities in the coming decades. But many educators and policymakers are concerned about the decline in test scores among secondary students and a drop in the number of college engineering majors across the country.

Noah Sandoval is ready to help reverse the trends. The Colorado State University senior from Los Alamos, N.M., is finishing the engineering science and education program – and also tackling on a Spanish major – and looking forward to stepping in front of a classroom to motivate students to pursue and stick with STEM courses and careers.

Through the engineering education program, which graduates 10 to 15 students per year at CSU, Sandoval and others receive a bachelor of science that combines fundamental course work in mechanical, civil, and electrical engineering with a complete education curriculum. Sandoval will have a teacher’s license when he graduates, and he hopes to apply his enthusiasm and experience in a high school classroom or, possibly, in lower-level college courses. As he’s finishing his own education, he’s also contemplating an independent study to research what sparks entry-level college students’ interests in STEM concentrations.

“The College [of Engineering] is interested in retention of its engineering students because it’s a rigorous major,” Sandoval says, “so I’m looking at doing a study on different ways to teach classes and keep students interested, especially while they’re trudging through calculus, physics, and chemistry.”

Part of that challenge is keeping students engaged and also letting them know about the career opportunities and job security that await students who graduate with an engineering degree. It’s a topic Sandoval understands well, since an engineering career is “a beaten path” in his family. Both his parents are engineers, and his siblings are also moving into engineering jobs.

An avid mountain biker and rock climber, he chose Colorado State after coming to tour campus and being overwhelmed by the surroundings and outdoor opportunities at the University and in Fort Collins. “Campus is what brought me here,” he says, “I love Fort Collins, and CSU makes it what it is and gives it that funky college vibe.”

At CSU, Sandoval found his calling to education through the Honors Peer Mentors program, through the University Honors Program, in which older students help orient and advise incoming students to plan for their academic careers and introduce them to campus resources. After serving as a mentor for three years, he led the group of 36 peers during his final year and credits the experience for getting him excited about teaching.

He has also served as a tutor in the College of Engineering and on the curriculum committee of the Engineering College Council, which has exposed him to the real-world discussions over the direction of education. His tutoring experience also includes volunteering for The Institute for Learning and Teaching, which has given him a chance to take advantage of the resources of the Academic Village, a residential living and learning community at CSU, which has its own engineering laboratory and which Sandoval compares to a “hotel for motivated students.”

Beyond campus, Sandoval has reached out into the local community, teaching at several middle schools, and he has also volunteered at a bilingual-education elementary school in Fort Collins, letting him practice science teaching and Spanish at the same time. While at CSU, Sandoval also took advantage of a semester abroad in Spain, an experience that allowed him to gain fluency in Spanish and inspired him to consider teaching abroad after graduation.

“My mind is geared toward engineering and my passion is teaching,” says Sandoval, who has also benefited from several scholarships to support his education and pursue a STEM teaching career. “With the engineering education program, I want to develop the next students and work with kids to enable and empower them. I want to get students excited and let them know what engineering is and what they’re getting into for the next four years, so that we keep retention high.”

Noah Sandoval

“With the engineering education program, I want to develop the next students and work with kids to enable and empower them.”

Noah Sandoval

www.engr.colostate.edu
The Sounds of Algae Harvesting

The race to develop next-generation energy sources and alternative fuels is influencing research efforts around the world. At Colorado State University, algae-derived biofuels have gotten a boost through laboratory studies, technology transfer, and the commercial spinoff of Solix Biofuels, co-founded by CSU scientists and engineers. Now, a team of CSU student engineers has taken the innovative approach of using acoustic soundwaves to harvest algae for biofuels and other products with promising results.

Algae supporters and researchers see several market prospects for applications in energy, pharmaceuticals, and other fields. But efficiently and economically separating algae from the water it’s grown in remains a research and development roadblock. Previous efforts have used centrifuges, filtration, and chemical processes to separate the components, but those techniques remain costly.

The group of six mechanical engineering students has collaborated with Bryan McCarty, vice president of engineering at Solix; scientists at Los Alamos National Laboratory in New Mexico; and researchers at CSU’s Engines and Energy Conversion Laboratory, including adviser and associate professor Anthony Marchese.

The insight and direction from some of the leading visionaries in the biofuels industry has proven very valuable, especially as the team has squared up to tackle development and design challenges. Initially, the group was given a device design developed at Los Alamos, but they quickly realized that replicating the system and scaling up its size for production were major parts of their task. Ultimately, the students had to design their own prototype before they could even begin engineering ways to optimize the device’s efficiency.

“[The advisers] all have a really good understanding of the technology and the implications, so we’ve gotten really good suggestions for the best way to move forward with the project and to make sure we’re following good engineering practices,” says Kevin Warner, a team member from Littleton, Colo.

Along the way, the mechanical engineering students realized the project required some basic electrical engineering to set up the amplifier and wave generator components that make the device function, says Brendan Penny, a team member from Englewood, Colo. The additional labor is a useful reminder that professional projects often reach beyond classroom lessons.

Acoustic harvesting works through the use of ceramic piezoelectric transducers, which in the students’ prototype is attached to a length of tubing filled with an algae-water solution. The transducer basically converts electric pulses into mechanical vibrations. With the incorporation of a wave generator, the system realigns the molecules, causing the algae to separate into a concentrate.

“It is a very simple process with a ton of variables that must be refined in order to make the phenomenon happen,” says Mike Brunson, a team member from Northern Colorado. “Our team has been successful in taking this technology and tweaking the parameters enough so that we can repeatedly get algae to fall out of solution in a variety of devices that we have tested.”

Meeting the scientific and practical goals of both the federal government and Solix has presented the design team with a balancing act between research and business development.

Mike Brunson

“People are excited about what we’re doing. This is the technology that is going to get Solix and the [algae biofuels] industry past the bottleneck.”

Team members (from left): Abdulla Al-Mulla, Qatar; Christopher Dar, Yorba Linda, Calif.; Brendan Penny, Aurora, Colo.; Kevin Warner, Littleton, Colo.; Mark Goudreault, Chicago, Ill.; Mike Brunson, Loveland, Colo.

Through regular phone calls and meetings with all the partners, the students learned to think in terms of theoretical and applied goals at the same time. The group members realize that similar challenges likely await them in their careers.

Since they’ve created a prototype and started generating positive results, future efforts can build on the students’ work to further increase the efficiency and flow rates of the algae concentrate produced by the acoustic action. The design and findings may one day enable Solix and other companies to bring algae biofuels to market as an economically viable alternative to gasoline.

“We’ve definitely seen some progress throughout the process, and our main goal now is to figure out how to collect that concentrated algae in the most efficient way possible,” says Mark Goudreault, a team member from the Chicago area.

“People are excited about what we’re doing,” Brunson adds. “This is the technology that is going to get Solix and the [algae biofuels] industry past the bottleneck.”
Born in Honduras and raised in Fort Collins, Lucas Suazo has maintained a close connection to the Latin American home country of his father’s family. Regular visits back to Honduras have helped, and so did an experience Suazo had when he was in middle school—an experience that also influenced his academic interests and his decision to study at the Colorado State University College of Engineering.

In 2004, Dr. Lee Gordon, a family friend and local physician in Fort Collins, called Suazo’s family for assistance after bringing a young Honduran boy to the states to help him through a crippling congenital malady. The boy, Wilian Fuentes, suffered from the rare disorder called arthrogryposis, which locks up joints and, sometimes, even a person’s jaw. The young boy, not even 10, was confined to a wheelchair and couldn’t even feed himself when he came to the United States for surgeries. Suazo’s family agreed to house him during his convalescence and help him feel at home, where he could speak Spanish and share a common culture.

Suazo, a middle school student at the time, developed a brotherly relationship with Fuentes. The operations improved Fuentes’ mobility so he could feed himself—although he remains in a wheelchair—and the treatments impacted Suazo’s desire to help others at home and abroad. Suazo stays in touch with Fuentes and has visited him in his hometown in Honduras. To show their continuing support, Suazo and his family started a fund, which purchased Fuentes an electric wheelchair, built him a house closer to his school, and bought him a laptop.

“The impact that Wilian had on me is to really inspire me to look into applications in medicine and see how I can do something to better someone’s life, like Dr. Gordon did for Wilian,” Suazo says.

Already thinking about following in his mother’s profession as a chemical engineer, Suazo decided to stay close to home and attend Colorado State University after visiting campus during the College of Engineering’s annual E-Days showcase of student design projects. The College’s offering of a dual degree to combine biomedical and chemical engineering sealed the deal.

“I knew I wanted to do something with chemical engineering, and I’m really interested in medicine and improving health, so to see a dual degree like that really appealed to me,” Suazo says.

During Suazo’s freshman year, Brad Reisfeld, associate professor in the Department of Chemical and Biological Engineering, who studies biomedical science for human health applications, and Brett Beat, who serves as the School of Biomedical Engineering dual degree advisor, both worked with him to hone in on his research interests and offer guidance.

Suazo is also gaining valuable laboratory experience through the Honors Undergraduate Research Scholars Program. The HURS program connects high-performing student applicants with faculty mentors to learn investigative practices and to tackle independent research, fostering their academic interests and improving their career prospects.

Through the program, Suazo is working with Melissa Reynolds, professor in chemistry and biomedical engineering, and studying the effects of nitric oxide in killing bacterial infections and improving wound healing through its applied use in engineered biomaterials.

Reynolds, who studies how to engineer biomaterials and polymers that can be used in medical devices to release medicines and improve healing for amputees or sick patients, says Suazo is already contributing to her research group’s progress and designing experiments that can have impacts for populations at risk of widespread disease or suffering from traumatic injuries.

Lucas Suazo

“I feel like the College of Engineering really wants me—and everyone—to succeed. I feel like I have an opportunity to make myself here.”

“So far, it’s been a great, hands-on research experience with medical aspects that could apply to a developing country,” Suazo says. “I have a great mentor with Dr. Reynolds, and I’m getting to learn responsible research protocol and data acquisition and how to organize a report. It’s been my first year, but I’ve already learned a lot, and I’m excited for where it’s going.”

Suazo also participates in the President’s Leadership Program, a three-year initiative that weaves in academic and experiential courses and service work to build leadership qualities beyond the classroom. In building students’ social and community commitments, Suazo calls the program an ideal complement to the offerings through the College of Engineering.

With aspirations toward a career in the medical or pharmaceutical fields, rooted in his dual degree and multicultural background, Suazo hopes to apply his experiences and knowledge gained at CSU in the developing world.

“I feel like the College of Engineering really wants me—and everyone—to succeed,” Suazo says. “I feel like I have an opportunity to make myself here.”
Academic Village

The Academic Village was designed for students with integrated living and learning spaces. It consists of three residence hall buildings and a dining center. The Honors and Engineering Residence Halls were built in 2007. Aspen Hall was completed in 2009 and is designed for 217 students. The Honors hall houses 165 students, hosts the Honors program, and has some classrooms. The Engineering hall houses 261 students and includes four Lockheed Martin design studios; apartments for graduate teaching assistants and a member of engineering faculty or staff; two classrooms, including a state-of-the-art electronic classroom; and many work and study rooms. The College of Engineering also provides residents with tutoring on site to help engineering students succeed.

Engineering Co-op Program

The Engineering Cooperative Education Program was initiated as a pilot with two students in Spring 2010. This is an academic program in which students work at least three semesters, two of which are full or spring, in a position related to their major. Students alternate between full-time work related to their major and full-time study. Co-op participants gain at least a year’s worth of experience with the same employer and earn a competitive salary while working.

Total Students Participating to Date* = 26

* at least one full or spring semester rotation

Total Co-op Employers to Date = 11
Agilent – Loveland, Colo.
Ball Corporation – Broomfield, Colo.
Cummins – Columbus, Ind. / Charleston, S.C.
Delta Airlines – Atlanta, Ga.
Dow Chemical – Houston, Texas / Midland, Mich. / Minneapolis, Minn.
FHWA – Fairplay, Colo. / Tuolumne, Calif.
Pratt Whitney – Hartford, Conn.
Sierra Nevada Corp. – Lakewood, Colo.
Toyota – Erlanger, Ky. / Georgetown, Ky.
Western Summit – Denver, Colo.
Wolf Robotics – Fort Collins, Colo.

Engineering Internships

Colorado State’s engineering internship program places students with organizations to work part-time during the academic year or full-time in the summer.

Alexa Garfinkel, senior, Mechanical Engineering

“I had my first internship with Navistar in Chicago, Ill. I got a taste of the real world with a 40-hour work week for 10 weeks. Not only did I learn all about the company, I also got to do hands-on engineering, networking, and traveling. It was a journey I will never forget.”

Engineering Student Organizations

- American Indian Science and Engineering Society (AISES)
- American Institute of Aeronautics and Astronautics (AIAA)
- American Institute of Chemical Engineers (AICHE)
- American Society of Civil Engineers (ASCE)
- American Society of Mechanical Engineers (ASME)
- Biomedical Engineering Society (BMES)
- CHI EPSILON
- Engineering College Council (ECC)
- Engineering Student Technology Committee (ESTC)
- Engineering Without Borders (EWB)
- Entrepreneurship Club
- Environmental Engineering Society (EES)
- International Association for the Exchange of Students for Technical Experience (IAESTE)
- Institute of Electrical and Electronic Engineers (IEEE)
- International Society for Pharmaceutical Engineering (ISPE)
- Pi Tau Sigma
- Society for the Advancement of Material and Process Engineering
- Society of Asian Scientists and Engineers (SASE)
- Society of Hispanic Professional Engineers (SHPE)
- Society of Women Engineers (SWE)
- Tau Beta Pi
- Triangle Fraternity

Alexa Garfinkel, senior, Mechanical Engineering

“I co-oped with the Federal Highway Administration for two rotations. While at first I was hesitant of taking time off of school, it has been the best learning experience I have ever had. I grew as an engineer by learning about construction, road design, and management. I was able to see two projects from the beginning of construction to the end (a rarity for summer internships). I did design work as well. My only regret is that I did not start sooner in my college career so that I could have time for more rotations.”

3.79
average incoming freshman high school GPA

68%
seniors completing at least one internship

27.2/1218
average freshman ACT/SAT composites

2,047
undergraduate enrollment

102/19
mean class sizes for freshman lectures/labs

$65,438,658
research expenditures in Fiscal Year 2011-1012
Honors Program
The goal of the University Honors Program is to provide an enriched educational program of study for academically talented and motivated students at Colorado State University. Honors students benefit from small, discussion-based seminars taught by some of the University’s finest faculty members; personalized advising; priority enrollment; opportunities for leadership, research, and community service; and special scholarships.

- Honors program size: 1507, with 234 (15.5%) engineering students. Engineering students make up only 8.4% of the entire population of undergraduates at Colorado State.
- For the incoming freshman class, 355 new students joined the honors program, and 75 (21.1%) are engineering students.

Recent Undergraduate Honors Thesis Projects
- Using Meteorological Radars to Estimate Rain Rates: A Comparison of Polarimetric and Non-Polarimetric Radars (civil engineering)
- Seeing the Invisible: A Look at Leak Detection in the Oil and Gas Industry (computer engineering)
- Agent-based Modeling of M. Tuberculosis Growth and Drug Treatment (chemical and biological engineering)
- The Past, Present, and Future of Anaerobic Digestion for Feasibility of Anaerobic Digestion for Odell Brewing Company (environmental engineering)
- The Evolution of Chip Design Open Class Aircraft (engineering)
- Evanescent Array-Coupled Biosensor (biological engineering)
- Design Open Class Aircraft (engineering)
- Growth and Drug Treatment (chemical and biological engineering)
- Civil Engineering of CSU’s 2007-2008 Aeronautics Center (civil engineering)
- Embedded Systems in Musical Instruments (computer engineering)
- Rain Rates: A Comparison of Polarimetric and Non-Polarimetric Radars (chemical engineering)
- Seeing the Invisible: A Look at Leak Detection in the Oil and Gas Industry (physical sciences)

Professional Learning Institute
The College of Engineering’s Professional Learning Institute provides students with real-world skills and experience to complement the outstanding technical curricula they receive at Colorado State. The PLI helps students achieve their employment goals by complementing engineering classes with skills highly valued by employers. After numerous discussions and planning sessions with engineering companies, the PLI framework was designed to meet the needs of industry.

PLI Certification Areas
- Civic and Public Engagement
- Ethics
- Global Culture and Diversity
- Innovation
- Leadership

3rd happiest U.S. metro region
300 average days of sunshine each year
280+/30+ miles of bike lanes/bike trails
In Top 15 best places for triathletes to live and train
3rd happiest U.S. metro region

Study Abroad Opportunities
Colorado State University offers study abroad programs in 72 countries and specific programs for engineering students. Last year, engineering students went abroad to a variety of countries including:

- Germany
- Hungary
- Austria
- United Kingdom
- Mexico
- Australia
- United States
- Chile
- Argentina
- Japan
- China
- New Zealand
- France
- Spain
- Israel
- Italy
- Ukraine
- South Korea
- South Africa
- Switzerland
- Tanzania
- Trinidad and Tobago
- Peru
- Botswana
- Costa Rica
- Fiji
- Greece
- India
- Ireland
- Italy
- Jordan
- Malaysia
- New Zealand
- Oman
- Panama
- Peru
- Spain
- Sweden
- Tanzania
- Trinidad and Tobago
- Turkey
- United Arab Emirates
- United Kingdom
- Vietnam

To find out more about the study abroad programs at CSU:
www.studyabroad.colostate.edu

Bachelor’s Degree Programs
- Biomedical Engineering (dual degree, interdisciplinary minor)
- Chemical and Biological Engineering (major)
- Civil Engineering (major, concentration)
  - Soil and Water Resource Engineering (concentration)
  - Computer Engineering (major)
  - Electrical Engineering (major, concentration)
  - Lasers and Optical Engineering (concentration)
- Engineering Science (major)
- Teacher Education (concentration, licensure)
- Space Engineering (concentration)
- International Engineering and International Studies (dual degree)
- Liberal Arts (dual degree)
- Environmental Engineering (major, minor)
- Mechanical Engineering (major)

Master’s and Doctoral Degree Programs
- Atmospheric Science
- Bioengineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Systems Engineering

Honors Program
Professional Learning Institute
Study Abroad Opportunities
Bachelor’s Degree Programs
Master’s and Doctoral Degree Programs