COLORADO ENGINEER

FALL 2022: NEW HORIZONS ISSUE

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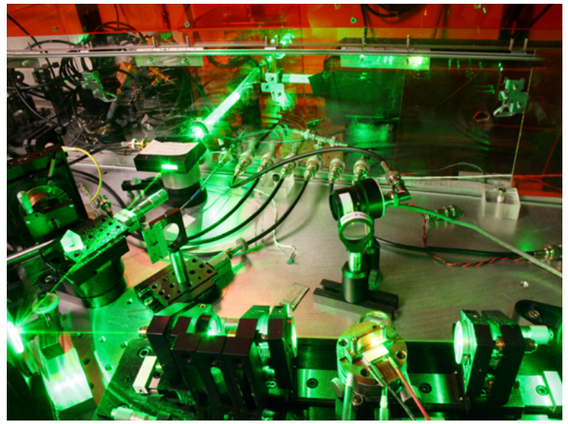

Quantum initiative laser experiment

Photo credit: Greg Kubler, JILA

Mission control for the Artemis Project

Photo credit: Crane, Aimee. NASA

New Horizens Issue

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MEET THE STAFF

Our CEM Mission

As staff of the Colorado Engineer, our mission is to inform and educate our readers and reflect pride in CU's College of Engineering & Applied Science world-wide.

Our student-led magazine seeks to provide a voice for CU's engineering students while also carrying on the 100-year CEM tradition: by students for students.

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The Colorado Engineer has been reporting on the "latest and greatest" from the engineering, science and technology community since 1904. We were there for the Model T, the jet engine, the IBM PC, the iPod — and we will continue to cover the future of human innovation. Today, we operate with a staff of 13 students and four advisers. We publish the magazine biannually, with a readership of over 8,000 individuals, reaching students at the university, researchers, professors and alumni. If you would like to join our staff or have questions and comments, email us at justin.wang@colorado.edu. Alternatively, check out our website at http://https://www.colorado.edu/studentgroups/colorado-engineer/. We always enjoy hearing our readers' feedback!

NEW HORIZONS ISSUE

Reminding ourselves of what inspires us as people brings our work to new heights.

Dear readers,

For the past couple of years, our minds have been on the idea of recovery. Here at CU, specifically, recovery from the Covid-19 pandemic and the wildfires that have devastated our community. Simultaneously as we reach a feeling of normalcy, the University has received a record $658 million for research.

As students, research can feel disconnected from our day to day experience. I urge us as students, however, to see that this culture of innovation is a reminder of what we are working towards.

It is worth stressing that the innovative work being done on the University's campuses receives funding because it matters. We receive funding from the Department of Energy and the National Institute of Health, for example, because people care about their energy bills and want more effective diabetes treatments.

Our innovation is not aimless but responds to concrete needs and problems. When there is a shortage of housing, we build. When there is population growth, we design ways to increase food supply. Related, but distinct, from the pure sciences, engineering considers solutions in their complexity, from cost, manufacturing, materiality, to life cycle, and more.

In essence, we use our knowledge to make life better for people. That sounds idealistic, and it is. For work to be meaningful, it should be backed by ideals. As engineers, our work is defined by the promise of precision and accuracy that science provides, but we cannot claim our work to be separate from our humanity. And, I would argue, our solutions are fundamentally better when we lean into what inspires us as people.

There is a reason that so many want to study aerospace engineering here at CU. For many, they were inspired to enter the program because the field of space exploration touches on so many questions fundamental to our humanity, such as where did we come from, and is there more life out there? Even with quantum engineering, the study of the smallest building blocks of matter is a means to understand the world that we exist in.

For those of us that are called to engineering, it is typically for a human reason- maybe a family member whom we admire was an engineer, or maybe a great mentor made it feel like the sciences bring you a sense of purpose. Increasingly, many students enter fields of engineering hoping to protect people from the effects of climate change.

We chose to focus this issue on the concept of New Horizons, because we are excited for what is coming, and we look forward to it with excitement for what our work will bring to communities.

Sincerely,

Hannah Sanders
Editor-in-Chief

INTERPLANETARY MEDICINE

New Medicine in Space and Surface Environment Course

SKYLAR EDWARDS| PHOTOS BY DAVID GUTIERREZ MENDOZA

As the possibility of landing a person on Mars approaches, engineers and scientists are beginning to explore what it means to live and work on Mars. What types of skills would you need to learn, and who would you bring with you? Would you bring an engineer? A geologist? A navigator? Perhaps a doctor? All of these questions are being answered by graduates and undergraduates taking Medicine in Space and Surface Environments or MiSSE, a new course at the University of Colorado Boulder.

Maintaining astronaut health and safety will be critical components for extreme exploration environments, such as the surface of the Moon or Mars. The journey to these surfaces will not be an easy feat and it imposes challenges for engineers and medical care providers as astronauts get ready to set foot on these surface environments. At the University of Colorado Boulder, students have the unique opportunity to learn about the medical challenges of human spaceflight in a completely immersive way, by becoming analog astronauts.

The MiSSE class has elements of hands-on lectures and field simulations. Students spend many weeks learning about medical care in remote desolate environments from trained professionals and /doctors.

They next immerse themselves in a field simulation where they engage in medical care in a simulated planetary surface environment. The field simulation occurs at the Mars Desert Research Station (MDRS) in Hanksville, Utah where the students are offered a chance to practice the material that was offered in the in-class lecture portion and learn about alternative considerations and how they might adapt their training.

The simulation is designed to test students in a wide variety of scenarios where they must navigate difficult terrain and organize into teams. Constrainst such as simiulated rapid-fire events, time constraints, and injured rewmates add to the challenge. Luca Bonarrigo, an undergraduate senior BAM student in Aerospace Engineering, took the class last spring.

"I was always interested in human spaceflight and the medical innovations that have come from space exploration, so when I first found out about MiSSE, I knew immediately I wanted to take the class. And I'm so glad I did - it's easily one of the best, most eye-opening courses I've taken in my undergraduate years. I gained so many unforgettable experiences, especially during the week spent as an analog astronaut practicing emergency medicine in Hanksville, Utah" Bonarrigo said.

While the class is offered to both undergraduate and graduate students, everyone who is in the class first has to apply. The class is also not restricted to just engineers, it is open to all students but applications are viewed on a case-by-case basis by the instructing team. Students may choose to take this class at a lower or upper division section with the distinction being participating in an additional project over the course of the semester. During the Spring of 2022, students were tasked with designing and building a payload delivery module that would transport medical supplies by rocket. The system was designed for rapid medical resupply in the event of an emergency on the surface of Mars.

"I learned a lot about being isolated from people and how to deal with that and how could astronauts on a real mission could feel about this and the amount of psychological training they need to have to deal with these stressors," said Daniel Gutierrez Mendoza, an Aerospace Engineering graduate.

At the end of the course, students understand the challenges and solutions employed in working in space and surface medicine, and are equipt with Wilderness First Aid and Cardiopulmonary Resuscitation training, In addition, they are involved in research on human spaceflight (physiology and medical care) and are exposed to common practice and learning devices.

Elaborating on his experience, Luca Bonnarrigo said, "Before MiSSE, I knew I wanted to study and work in bioastronautics, but MiSSE helped me discover the area I'm really passionate about - space medicine!"

Space Medicine MS-DS Program

Space is no place for humans; it wreaks havoc on our bodies' bones, muscles, skin, ears, and eyes. As the space industry prepares for interplanetary travel, astronauts must prepare for the extreme environment awaiting them. Humanity is set to return humans to the Moon soon and our next step will be Mars.

As the industry embarks on these future endeavors we need a team of skilled engineers and physicians to help prepare us for the long journey ahead.

Space needs doctors, and a new joint program between the CU Boulder Department of Engineering and the University of Colorado School of Medicine is preparing students with the skills needed to advance human spaceflight. This new joint MD-MS program is going to prepare students pursuing a medical degree with the skills and knowledge in the field of bioastronautics.

The program was designed by Allie Anderson, Ph.D., an assistant professor of aerospace engineering at CU Boulder, and Ben Easter, MD, an assistant professor of emergency medicine and deputy element scientist for NASA's ExMC part of the Human Research program.

Easter and his colleagues first designed the MiSSE course and this new program is rooted within the MiSSE. This new program will focus on teaching students to speak both the language of medicine and engineering related to the field of human spaceflight. T

This program is designed to be a five-year curriculum that enhances the traditional four years of medical school with one additional year on the Boulder campus. Students will do the first few years in medical school and then take a year break to complete their Master's in Aerospace Engineering - Bioastronautics and then go back to finish their medical curriculum. The MiSSE course will make an appearance in this joint program during the time students spend at CU Boulder.

A grant was recently awarded to Easter and Anderson called the CU Next Award. They plan to use this grant to improve the technology and equipment at the MDRS and to create new tech-focused courses around medicine and human spaceflight. The first new class will be an elective for first-year medical students to introduce them to the challenges of medical care in extreme environments such as space flight. A new engineering projects course will be a part of the graduate curriculum at CU Boulder which will be an engineering projects course. One project that is currently being discussed is a simulated sick bay to bring on the analog mission at MDRS.

The new program is set to start taking applications in the Fall of 2022 and start its first class in the fall of 2023. The timing for this program could not have come at a better time, as the space industry is truly taking off and getting so much closer to establishing a planetary presence on the Moon again... and soon Mars!

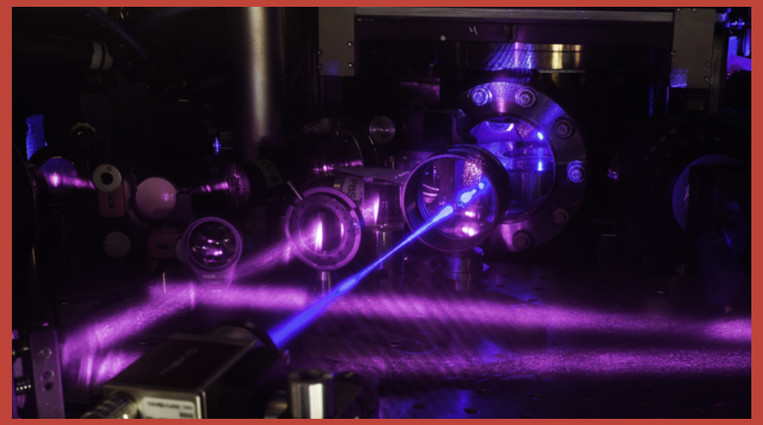
ENTANGLEMENT

New Quantum Engineering Initiative to establish ties between JILA research and industry applications

HANNAH SANDERS I PHOTO CREDIT G.E. MARTI, JILA

The university has long been a beacon of innovation in cutting edge physics research, and a new Quantum Engineering Initiative (QEI) led by Scott Diddams and Greg Reiker aims to focus on applications of this work.

JILA, a research powerhouse consisting of collaborators from the National Institute of Standards and Technology (NIST) and University of Colorado Boulder, has been the primary hub of anything and everything quantum for the past 60 years since it was founded. Now, the vision of the Quantum Engineering Initiative is to build off of the foundation of knowledge that JILA has to produce technology that can be applied in industry.



"On campus we have the fundamental state of the art [technology], and we hope to fill this gap, to translate [the research] into something that the industry could use," said co-founder of the QEI and NIST fellow Scott Diddams.

Quantum technology finds its way into our everyday lives through extremely precise clocks, integrated photonics in circuitry, lasers, and sensors that go into systems such as GPS navigation. Quantum research provides the chance to increase the capacity of such technology in speed, resilience, and reliability.

However, translating the research of JILA into industry applications is no small feat. JILA researcher Jun Ye currently works on the world's most precise clock, whose ticking is more accurate than anything in the field to the tune of five orders of magnitude.

Jun Ye's work is a great example of world class research that needs an engineering approach if it hopes to make it out of the lab.

"There is a real engineering trade space where we give up a few orders of magnitude. If [work done in JILA] is the pinnacle of perfection, say in clocks, we can give up a little of that and make a very useful device….The bottom line is there's this middle ground where, if we can give up a little… and make it portable, that's a massive advantage," said Diddams.

One of the foundational goals of the QEI is to meet industry where it's at. On the quantum scale, this looks like making sure that quantum technology components can integrate into systems seamlessly.

Dr. Diddams elaborates, "the technology that goes into these clocks, they are a new generation of technologies compared to what's in the field, if we're ever going to get that technology into commercial devices, there needs to be engineering done on that at many different levels, and so there's a real opportunity there, and we want to step into that gap and fill that opportunity."

Another key aspect of the Quantum Engineering Initiative is an emphasis on education. Undergraduate curriculum is ramping up its quantum content, namely with a new Quantum Minor that launched this year. Students can also participate in the Quantum Forge, where external companies support senior design students in their projects. The QEI will also incorporate a discovery laboratory where students can get hands-on experience with the fundamentals of quantum mechanics.

Associate Professor Greg Reiker explains that the initiative will lean into the cycle of technology in the research world. Cutting edge research takes cutting edge equipment, and why not develop such equipment in house?

Engineering quantum equipment within the College of Engineering, such as lasers and frequency combs is such a key opportunity to take advantage of the convergence of minds on campus.

"In the past decade or so there's been a new vision of tools, new ideas, that by manipulating the fundamental quantum properties of materials you can do some really previously unimagined things. (We can) take some of those technologies, refine them, and then feed them back in to make the next experiment that much better," said Reiker.

CU has long had a reputation for being a research powerhouse. Through establishing a research lab within the College of Engineering, the QEI will be a launch point for a new era of innovation that prioritizes placing the conclusions of research into the hands of people.

RECENTLY IN SPACE

New JWST Photos, Moon Probes, and Moving Asteriods!

DAVID KATILIUS| PHOTOS VIA NASA, JAMES WEBB TELESCOPE

2022 is a groundbreaking year in terms of space exploration. We've seen the first images come from the James Webb Space Telescope of which include the Carina Nebula, the Southern Ring Nebula, Stephan's Quintet, the analysis of the planet WASP-96b, and the galaxy cluster SMACS 0723. Scientists have also started experimenting with asteroid redirection attempts with the DART mission that had impact in September. Eventually in December we will witness a drone launched by South Korea analyze the moon in more depth, to collect information on the possibility of building habitats.

Astronomers are able to witness for the first time is the nebula cataloged as NGC 3132, more commonly known as the Southern Ring nebula. This nebula is currently about 2500 light years away, and it was chosen to be studied because the star in the center of the nebula has been spewing dust and gas all around it for thousands of years. With the James Webb telescope, astronomers will be able to witness this death of a star and gain a better understanding of what kinds of molecules are expelled by a dying star and where they are located within clouds of dust and gas. Currently there is not a whole lot of data about this topic, so hopefully the James Webb Space telescope will give astronomers a better understanding of stars in their last phases.

Two cameras aboard Webb captured the latest image of this planetary nebula, cataloged as NGC 3132, and known informally as the Southern Ring Nebula. It is approximately 2,500 light-years away.

The technology on the James Webb Telescope (JWST) is exceptional and definitely a great example of contemporary technological advancements. It was able to analyze with incredible precision and accuracy the atmosphere of the planet WASP-96b despite the planet being more than hundreds of light years away. This is all due to the fact that specific gas molecules decrease the brightness of the colors of light in different ways, allowing the telescope to detect specific types of molecules such as water. NASA hopes to use this technology to locate different planets which could be habitable for humans even if we may not get to them within this lifetime. More recently however the James Webb Telescope was able to take pictures of the Double Asteroid Redirection Test, more commonly known as the DART mission. In the DART mission, NASA launched a spacecraft into the asteroid Dimorphos in hopes of seeing if they could redirect it. Using both the James Webb Space Telescope and the Hubble Space Telescope, they were able to record several observations of the collision that occurred on September 26, 2022. When the DART collided with the asteroid, scientists looked specifically at whether fine dust or big chunks of material came off the surface of the asteroid to better understand the chemical composition of the asteroid.

Researchers get particularly accurate data with the JWST's mid infrared instrument which tracks the wavelengths of light from anywhere between 5-28 microns (10-6 m), as well as the near-infrared spectrograph, which can track wavelengths of light in the ranges of 0.6 to 5 microns.

Prior to the DART mission, the South Korean moon pathfinder Danuri was launched on August 5th of this year, with a planned arrival in December. The

data that Danuri will obtain will be crucial in the next steps of human exploration on the moon. NASA gave the ShadowCam, a camera which is able to visualize and take images of extremely dark spaces, to the South Korean space agency in hopes that Danuri will be able to take images on the dark side of the moon and larger craters that are permanently shaded. NASA hopes to find frozen water in the craters of the dark side of the moon, as some scientists believe that there are ice deposits available for use in these craters on the moon. This could be a valuable resource for the future construction of moon habitats. If water is discovered on the planet, it won't have to be transported from earth to the moon.

Over the next handful of years, there are going to be more and more interesting developments in space. As our society has been putting more instruments into space, we have been able to reach outside of our atmosphere at a much more effective rate, with many different companies and countries starting to show promising progress in various aspects of space exploration.

ARTEMIS: MANNED SPACE EXPLORATION

Artemis mission signals new era of discovery

DAVID BRENNAN I PHOTOS VIA NASA

On April 12, 1961, with a soaring "Poyekhali!" from cosmonaut Gagarin and a boom from a Vostok-K rocket engine, humanity abandoned its status as an exclusively terrestrial species and launched its way towards the stars with the first human to leave the atmosphere. From the first missions carrying humans on suborbital space flights to the Apollo program landing 12 astronauts on the surface of the Moon, the 1960s and 70s brought about an unprecedented era of progress in rocketry, spaceflight, and the next frontier of human exploration. It was a time when we truly reached for the stars and the barrier between science and science fiction felt practically nonexistent. What was next? A permanent Moon colony by 1980? Mars by 1990? And then, just as soon as it had started, it was over. No human has visited another world since.

Subsequent decades brought robotic landers to Mars, Venus, Saturn's moon Titan, and even a few asteroids and a comet. Probes have visited all of the eight planets, and even Pluto has been visited by a probe that was launched shortly before it lost its

"When it is launched, it will be the most powerful rocket the world has ever seen."

own planetary status. Other missions such as the Hubble and recently launched James Webb Space Telescopes have brought both an immense amount of information about our universe and stunning views of the cosmos.

Manned space exploration has continued in the form of several permanent space stations and other programs like the Space Shuttle missions. However, humans have yet to venture beyond low Earth orbit since the Apollo 17 astronauts left the Moon

in 1972. There was barely a decade between the first manned spaceflight and our first visit to another world, yet in the nearly fifty years since our last trip to our celestial companion, not one person has left the orbit of Earth. It's time to change that.

Artemis, Greek goddess of the hunt and twin of her brother Apollo, is humanity's return to the Moon after five decades of absence. This endeavor, a collaboration between NASA and several international space agencies, will continue and expand upon the work the Apollo program began a half-century ago, sparking a new age of exploration and study of the universe and our place in it. Of course, before we do that, we have to actually get there. The Apollo missions used the Saturn V, a colossus taller than the Statue of Liberty weighing in at 310,000 pounds. Even though its last launch was in 1973, it is still the most powerful rocket ever launched with approximately 7.6 million pounds of thrust. The new Space Launch System (SLS) surpasses that by a cool 1.2 million pounds of thrust. When it is launched, it will be the most powerful rocket the world has ever seen. This rocket will be the principal launch vehicle for the Artemis program, carrying infrastructure, cargo, and of course, astronauts to the Moon.

So why does the SLS need so much power? Artemis differs from Apollo in that Artemis is designed to establish a permanent settlement on the Moon, allowing astronauts to live and work on the surface for up to a month at a time, rather than just a few days. This requires the transportation of a significant amount of infrastructure to the Moon so as to enable such long stays. Part of this infrastructure is the Lunar Gateway station. In the Apollo missions, when the spacecraft reached lunar orbit, two of the astronauts descended to the surface in the Lunar Module while one astronaut remained in orbit on the Command Module. The Lunar Gateway station is like a permanent Command Module, staying in lunar orbit so that astronauts who are coming from Earth or returning from the lunar surface can resupply and refuel. It also allows astronauts to live and work in lunar orbit, letting them perform experiments that wouldn't be possible on Earth.

The next step is getting down to the lunar surface from the Lunar Gateway. This aspect of the mission is called the Starship Human Landing System (Starship HLS) and is being developed by SpaceX. The Starship HLS acts like the Lunar Module from the Apollo missions; it takes astronauts from lunar orbit to the surface, sustains them while on the surface, and returns them to orbit. Because the Starship HLS can use the Lunar Gateway as a base of operations, it is capable of supporting astronauts on the surface for a longer period of time than the Apollo Lunar Module could, as it can return to the Gateway station for refueling

Photo credit: Loff, Sarah. "Practicing Orion Spacecraft Recovery after Splashdown." NASA, 22 Sept. 2016,

and resupply. This makes it possible to bring more advanced technology and infrastructure to the surface than what was possible on the Apollo missions.

Perhaps the most exciting aspect of Artemis, the Artemis Base Camp, is unfortunately the most uncertain. It is scheduled to be established sometime near the end of the decade, and in its current form consists of three main parts. The first part is the main habitat for the astronauts, a combined home and office that will allow up to four astronauts to live and work on the Moon for a month at a time. The next part is the Lunar Terrain Vehicle, an unpressurized car that astronauts can drive while wearing their spacesuits. They will be able to use this vehicle to travel more than 12 miles away from their base of operations. The Apollo missions brought something similar to the Moon, called the Lunar Roving Vehicle, whose iterations in Apollo 15, 16, and 17 drove a combined 56 miles on the lunar surface. There is also the Habitable Mobility Platform, a pressurized rover that would allow astronauts to drive on the surface of the Moon without wearing their bulky spacesuits. This would act as a mobile home and significantly expand the operational area of a lunar mission by eliminating the restriction on travel time caused by the need to carry oxygen in the astronauts' spacesuits.

Any permanent base on the Moon would need to be able to power itself; constant refueling missions would be costly and inefficient. Many spacecraft and rovers use solar panels, and the Artemis Base Camp will be no exception. However, the nature of the Moon's orbit and rotation makes depending on sunlight for power rather complicated. The Moon is tidally locked with Earth, which means that the same side of the Moon always faces towards Earth, so a day on the Moon is the same length as its orbital period around the Earth, or about 27 Earth days. This means that about half of the time, any particular spot on the moon will be in darkness and unable to collect any power from solar panels. Prolonged lunar nights pose another danger as well: the intense cold can be dangerous to electronics and equipment—as well as human life.

To mitigate some of these effects, NASA plans to establish the Artemis Base Camp at Shackleton Crater. Named after the explorer who was famous for his own expeditions to Earth's south pole, Shackleton Crater is located at the south pole of the Moon. A location like this has several benefits. Due to its polar location, the crater receives sunlight differently than most other places on the moon.

"Both poles of the Moon contain regions where the Sun literally never shines. This is a result of the Moon's orientation relative to the Sun: its spin axis is always within about 1.5° of being perpendicular to the Sun's rays. As such, craters and other depressions near the poles will be naturally shielded from sunlight. Interestingly,

"Water at the lunar poles could be a vital resource. Human missions will need it for drinking water, bathing, and even producing rocket fuel. "

the same effect creates areas of nearly perpetual sunlight, typically on the summits of mountains and crater rims," says CU professor and planetary scientist Dr. Paul Hayne.

Both the light and dark regions are useful. The illuminated regions can be used to collect sunlight for solar power, and the unlit regions have their own precious resource: water.

"NASA's selection of landing sites near the lunar south pole stems directly from the desire to investigate and utilize ice in the [permanently shadowed regions]," said Hayne."

Water at the lunar poles could be a vital resource. Human missions will need it for drinking water, bathing, and even producing rocket fuel. Robotic missions could also benefit from gathering water and other chemical compounds that could be useful for a variety of industrial processes necessary to build and maintain infrastructure. Although living near a region in perpetual darkness doesn't sound ideal, having access to this water could be a huge step towards establishing a permanent

settlement on the Moon. At any rate, if power is still an issue and solar panels just aren't enough, NASA is working with the U.S. Departments of Energy and Defense to develop a nuclear fission reactor capable of producing 10 kW of power that could be brought to the moon.

Clearly, landing humans on the moon—in any capacity, much less to the extent we are attempting to do with Artemis—is an arduous task. The immense investment in resources and manpower required for such a program may cause some to ask, "why are we spending so much time and money trying to land people on the Moon, something that we already did?". There are several answers to this question. For one, we are far from having exhausted all that the Moon can teach us.

"Scientifically, the lunar poles could be a treasure trove of information about the Moon and the rest of the solar system. As the Earth and Moon careen through space, they encounter water, dust, and debris in interplanetary space. Most of this space junk is burned up in Earth's atmosphere or vaporized in hypervelocity collisions on the lunar surface. However, the permanently shadowed cold traps at the Moon's poles could retain a relatively intact record of water delivery to the Earth-Moon system. Volcanic eruptions early in the Moon's history could also be recorded there. Collecting samples from the lunar poles would enable a forensic analysis of how water moves around the solar system," said Hayne.

According to Dr. Jack Burns, CU professor and director of the Network for Exploration and Space Science, "other goals include doing low frequency radio observations of the early universe from the radio-quiet lunar far side [and] finding ancient rocks to understand the bombardment history of the Moon." But it is also true that one of the most important things about the Artemis program doesn't really have anything to do with the Moon at all. Artemis is serving as a trial run for our next challenge: Mars.

A manned mission to Mars is an entirely different beast than a mission to the Moon. There are significantly longer travel times, a huge amount of radiation exposure, and at least 30 million extra miles between the astronauts and help if something were to go wrong.

The entirety of Apollo 17 took less than two weeks, while any manned mission to the red planet is likely to take at least a year. To even attempt a Mars mission, we need to be sure that all of our technology and infrastructure will be able to perform in peak condition during a months-long trip to Mars, on its surface, and for a months-long trip back. There will be no material assistance from Earth and a significant communications delay if there are any problems. If there are problems, they could be deadly.

During the Apollo 13 mission, one of the Command Module oxygen tanks exploded while en route to the Moon, causing significant damage to many spacecraft systems and causing the astronauts to abort the mission. Such an event while on the way to Mars would almost certainly be a death sentence for the crew. Artemis is a way for us to test and refine our current technology and to develop new technology so that when we do make that next step towards Mars, we are able to do it safely and with full confidence in our abilities and technologies.

"It is both a stepping stone to Mars and a scientifically exciting doorway to understanding the history of the forumation and evolution of the Earth and the moon."

"The Moon is where we will learn to explore in a sustainable fashion. It is both a stepping stone to Mars and a scientifically exciting doorway to understand the history of the formation and evolution of the Earth and the Moon," said Burns.

So Artemis is an important step towards Mars. That's great, but why should we go to Mars? Why are we spending so much money and so many resources on trying to get there? Firstly, there is much to be gained scientifically from a mission to Mars. One of the most important questions a mission to Mars could help answer pertains to our own origins; where did life come from?

"It's a good place to look for the possibility of life. Mars was once (billions of years ago) covered with liquid water, like the Earth, before the atmosphere thinned. Microbial life might have started there," says Burns. However, our push towards Mars is for more than scientific data.

The reason why we are going to Mars is the same reason why we climb mountains, why we sailed across oceans, why we dived to the deepest depths of the ocean, and why humans first ventured out of the cave and into the unknown. It is in our nature to push the boundaries, to go where nobody has gone before, and Mars is the next step. As engineers, we like to see results. We don't leave things to our imaginations. We want to design something, test something, build something, and then see it in action. For far too long, manned space exploration has remained dormant, a series of what-ifs and what-could-have-beens. However, for the first time in many of our lifetimes, manned exploration beyond low-Earth orbit is stepping out of the realm of science fiction and into reality. It's a good time to be alive and looking skyward. It's a good time to be an engineer. Let's get to work.

DIGGING INTO CAMPUS COMPOSTING

Increased contamination threatens campus composting program

AINSLEY COX | PHOTO BY KAT AVEDOVECH

Since 2011, compost has been the main way that CU Boulder takes care of its campus. After the campus discontinued its use of pesticides, they looked to the more sustainable option to care for their grounds. However, compost in the Front Range is in jeopardy, and we are partially to blame.

Compost is a fertilizer made up of food waste, decomposing plants, and recycled materials. This fertilizer is then used to maintain the grounds on CU and farmland in the surrounding areas. Currently, there is only one compost provider serving the entire Front Range, and that is A1 Organics. Since 2000, A1 Organics has managed to divert over 7 million tons of organic material from Colorado landfills.

"Composting has so many benefits, the first one I can think of is that it keeps a lot of food scraps out of the landfill. When food scraps go into the landfill, they get really hot underneath piles and piles of trash and they start producing methane fumes which is an extremely more potent pollutant than carbon dioxide," said Kat Avedovech, a member of the Zero Waste Outreach Team at CU.

Unfortunately, recently A1 Organics has been receiving a lot of contaminated compost batches, making it impossible for them to use them in their products. This is where we may be contributing to the downfall of compost at CU.

From Your Meal to Your Mulch

Located all around campus are compost bins. In the classrooms, the dining halls, the on-campus restaurants. Compost is everywhere. But that doesn't mean that everyone knows how to use them. Only certain waste items are compostable, and it only takes a small thing that doesn't belong to ruin a whole batch.

"A lot of the common contamination objects we see are like candy wrappers and chip bags all in the compost. I've also seen a lot of tin foil… a lot of the students I've talked to really do care, it's just a whole matter of education," said Avedovech.

After a bag of compostable materials is sent to A1 Organics for the composting process, they will sort through the bag and search for contaminants. If they find contaminants, they will send the waste to the landfill and fine the school. Recently, A1 Organics have been receiving a lot of contaminated batches, leading CU to consider scrapping composting on campus.

"I had no idea that was happening," said freshman Victoria Starishinova, "I didn't even know that discontinuing the compost program was something that the school could do," she said.

The Manufacturing Process

There are many steps involved in commercial manufacturing of compost: separating, grinding, composting, curing, screening, and distributing. Contamination stops this process at step 1. Grinding gets the compost into a uniform mixture where it is then laid out and wetted in order to kill any weeds and seeds present as well as make it more uniform. Curing allows the carbon and nitrogen levels to finalize and screening once again serves to break up large pieces of compost. The distribution process comes at the end when the compost is sold to customers.

What We are at Risk of Losing

With continued fining of the university for contaminated compost, soon it may be something that they cannot afford to do. If compost goes, there isn't really a clear picture at what the results will be, but for the environment, they won't be good.

"If compost is gone, there's going to be so much more stuff crowding landfills… extreme environmental benefits come from composting," said Avedovech.

In a place like Boulder, with abundant outdoor opportunities, more methane in the air could dampen the natural beauty that surrounds CU. Methane gas suffocates the roots of trees and plants, making it harder for them to survive in areas with higher volumes of it in the atmosphere.

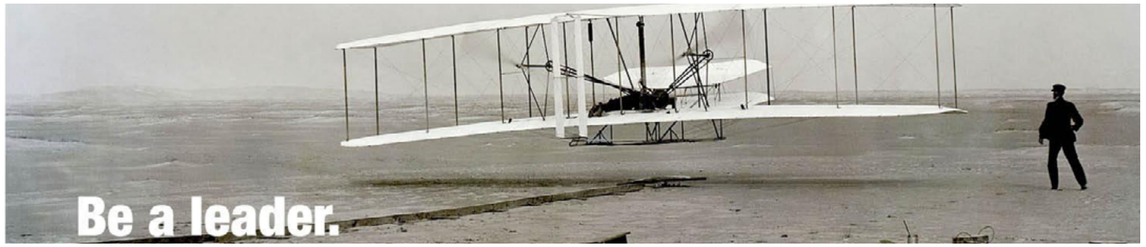
As the future comes, many programs like the Environmental Centers Zero Waste team are seeking to educate students about composting on campus, but it is also important that we educate ourselves. In order to keep this amazing option open to our university, we must begin to take more responsibility for compost on campus, and we must do it now.

"I think the school should definitely have students learn more about it. Maybe through mandatory learning or something through canvas so they at a minimum know what goes where," said Starishinova.

LEADERS AND ENGINEERS

Learn more about how ENLP can help you become a better leader

AARON SCHURMAN



Students in STEM often don't associate leadership with science and technology. This is especially true in engineering, where the focus tends to be on math, modeling, and technical problem solving. At CU, however, the College of Engineering wants students to look at leadership in a different way. Not as something students might associate only with politics or business, but as an activity and study that is integral to understanding modern society and the future of technology.

CU's Engineering Leadership Program (ENLP), directed by Dr. Paul Diduch, wants to ensure that CU's engineers not only have the technical skills to succeed, but also the self-awareness, openness, and mental agility necessary for tackling the increasing complexity of our world. For Diduch, the core of leadership is the core of leadership is "an ability to see problems with new eyes, provide direction or vision to achieve goals, and to be free enough mentally to glimpse some aspect of the future."

"An ability to see problems with new eyes, provide direction or vision to achieve goals, and to be free enough mentally to glimpse some aspect of the future."

The Engineering Leadership Program pursues the study of leadership in the spirit of liberal education, which values free and open engagement with divergent ideas and perspectives. This approach allows ENLP to move away from a "textbook" approach to leadership and to integrate original source materials from different disciplines like philosophy, anthropology, history, literature, and social sciences. In addition, ENLP tries to organize its classes around the Socratic seminar model, a method that allows for the departure from usual patterns and the consideration of novel perspectives and ideas. ENLP tries to incorporate aspects of the Socratic Seminar into all of its classes, a method that involves students in class seeking a deeper understanding of complex ideas in texts through rigorous dialogue. This means small class sizes where students investigate texts in order to build a definition of leadership.

One such student is Olivia Epstein, an ENLP senior studying Aerospace Engineering, has high praise for the program's class style saying,

"They encourage better relationships with other classmates and the professor, which enhances the learning experience and makes coming to class more fun and engaging."

"It is important for everyone to be heard and permits the bandwidth to have everyone share their input, [classes] encourage better relationships with other classmates and the professor, which enhances the learning experience and makes coming to class more fun and engaging."

ENLP plans to keep this teaching style and expand their class selection with more professors slotted to come on staff in the coming semesters.

With the completion of four ENLP classes, or three ENLP courses and one approved elective, students can achieve a certificate for engineering leadership that is recognized by companies around the world.

Complex problems such as climate transition, automation and labor displacement, intrusive surveillance and cyber security, are pressing companies to look for students with skills well beyond physics and calculus.

Engineering and technology firms want people with the awareness and soft skills to understand that tackling major problems isn't going to be simply a matter of straightforward technical problem-solving. Team work, leadership, and the ability to see and understand trade-offs are essential to ambitious projects.

Dr. Diduch pointed out that, "STEM students today are going to face a future that is increasingly threatened by problems rooted in technology itself." Thus, ENLP hopes to prepare students with the tools to counter these problems and build more resilient companies in order to help companies protect themselves from the novel problems of the future.

Many engineers struggle to find the time in their busy schedules to pursue humanities and their education in a non technical way, and even when they manage to squeeze a non-technical class into their day, it is often an intro class with a hundred plus students. ENLP, in contrast, allows for small class sizes and an avenue for engineering students to get the most out of their few humanities credits.

"The most important takeaway I have gotten was a new outlet to practice critical thinking, critical listening and expanding my understanding of myself, others, and the world," said Epstein.

If critical thinking and intellectual freedom are qualities you seek to grow, consider looking into ENLP and check out what the program can do for you.

NEW LECTURE SERIES ON RESPONSIBLE ENGINEERING

How do we create technology that makes the right call?

HANNAH SANDERS

To educate students on the importance of engineering ethics, Lucky Vidmar has launched the Moulakis Lecture Series on Responsible Engineering. The lecture series is named after Athanasios "Thanasi" Moulakis, a former CU professor and mentor of Vidmar. In his time teaching at CU, Thanasi was a strong advocate for liberal arts education for engineers, specifically philosophy and classical literature.

Drawing inspiration from Moulakis' published work, *Beyond Utility: Liberal Education for a Technological Age,* Vidmar brings CU students an updated look at what it means to be a responsible engineer today.

Technology is neither good nor bad, nor is it neutral

The inaugural lecture, "Technology Is a Very Human Activity", focused on one of Kranzberg's six laws of technology: technology is neither good nor bad, nor is it neutral. In particular, Vidmar described the very real danger of considering technology to be neutral, stating, "neutrality is anti-intellectual and moral laziness." As the head of Intellectual Property litigation for Microsoft, Vidmar provided insight on how we can do better with our designs.

Considering controversies in tech such as privacy and algorithmic bias, it is more important than ever for software engineers to consider how their work will impact users. By accepting that technology is inherently not neutral, it is possible to see that often issues that arise are not a fluke bug, but are rather ingrained in the software because of how it was developed, and who it was developed by.

Vidmar strayed from Moulakis' ideas to propose a new approach to engineering ethics education. Where Moulakis would stress the importance of exposure to classical literature as a means to teach an engineer to do the right thing, Vidmar argues that times now call for us to be more intentional.

"Having this Herbst program for [over] 30 years is a differentiator. Jointly working with the [Herbst] foundation, I came up with the new lecture series to… support responsible engineering at CU. The [lecture] format [allows for] students to hear some voices that sometimes they might not hear just from their academic pursuits," said Vidmar.

The history of technological advancement has been one of deliberate, incremental, intentional change. Worldwide connectivity and access to information have expanded so much, however, that the industry has power over consumers everywhere on a scale never before seen.

The stakes are higher, and Vidmar argues that the industry is making negative decisions more than they used to. The ease with which consumer data can be collected and consumed by large companies is certainly not neutral.

With the speed that technology is progressing, the days of clear cut ethical situations are long gone. So how as engineers do we navigate this new moral gray area? Vidmar calls for engineers to return to their humanity, stating "responsibility is doing what people would do if they could."

Responsibility is doing what people would do, if they could do it

So much of the moral ambiguity we see in tech doesn't seem intentionally bad on paper, but distrust is growing. From his work in the industry, Vidmar knows well the challenges of companies profiting from consumer data. "It's this game of attrition right, where they'll always be able to play more of the long game than all of us."

So how do we make this game of attrition easier on the consumer side? Vidmar points to company culture. The lecture explored the power of companies that are psychologically safe. Psychologically safe describes companies that encourage employees to ask questions, bring up concerns, point out mistakes, and speak up when they don't know. In short: bringing humanity back to the table.

Artificial intelligence and automation make it more important than ever to be humans before we are engineers. When we design systems that will quite literally take on a life of their own, I suggest we come back to Vidmar's key point: "Responsibility is doing what people would do if they could."

A PIONEER IN ENGINEERING ETHICS

Revisiting Moulakis on the Importance of Liberal Education for Engineers

PAUL DIDUCH

In 1994, Athanasios Moulakis, then Director of CU's Herbst Program of Humanities for Engineers, published a book titled *Beyond Utility: Liberal Education for a Technological Age*. As he notes in its introduction, Moulakis took up the project of writing the book to better articulate for himself the meaning and purpose of the Herbst Program, since it wasn't really obvious to anyone how to situate or make relevant a program of humanities for engineers. Over the thirty-five or so years since its inception, Herbst's successes attest in no small way to Moulakis' leadership, insight, and vision. Now, with the recent debut of the Moulakis Lecture Series in Responsible Engineering, I think it is appropriate that we revisit and refresh for ourselves some of the main features of his defense of liberal education for STEM. In my own view, intervening developments in technology and culture have only made Moulakis' concerns more pressing and the value of the Herbst approach to education increasingly salient.

Beyond Utility is structured roughly around three key insights into technology and its governance that help make intelligible the value of liberal education for engineers.

First, technology is morally and even practically ambiguous in its value and utility. Moulakis refers to Sophocles' use of the ancient Greek word deinon to capture this notion. In the so-called "hymn to technology" from Antigone (332-72), human ingenuity is a "terrible (deinon) wonder – not merely admirable, but awesome, dreadful" (143). By the powers of their practical intelligence, humans have both liberated themselves from the harsh rule of necessity, while simultaneously magnifying their capacity for destruction. What makes the root of our own power over nature both positive and negative in its valence is that, on the one hand, by utilizing things like fire and technology, we provide ourselves relief and abundance where there was once scarcity; on the other hand, however, these same powers give us the equipment that intensifies the range and depth of our violence and brutality.

What is more, as humans free themselves from

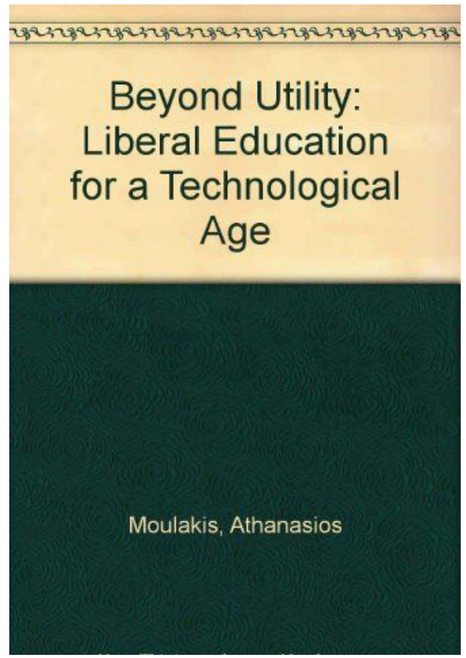
the direct rule of nature, we emerge into a world where our desires and appetites are not strictly governed. While humans become more resistant to nature they also become, therefore, more prone to greed, pleasure, error, illusion, and self-deception; or to put this differently, the question of how to live or how to structure one's life becomes a problem as the direct governance of our instincts gives way to the competing claims of culture, religion, and law. What makes technological empowerment dreadful, then, at least in part, is that we humans have to become responsible for tending the source and distribution of the goods we need to survive and thrive, that it is up to us to ensure that this very same source doesn't become harmful, and that we have to do this despite the fact that it is not obvious how to resolve all of our disputes or even whether any complete or lasting resolutions are possible.

Second, the ambiguity of technology and the burden of its governance means that humans must assess technology from a non-technical standpoint. For Moulakis, this standpoint is best understood as moral or political; it involves the kind of judgement expressed by the wise lawgiver, the discerning judge, and the prudent statesman. To be effective, serious, and empowered citizens of our technological societies, we have to learn to see technology in the light of its problematic aspects and must be ready with freedom and agility to create or modify institutions to supply the appropriate guidance and correctives.

What this means in practice is that we cannot take for granted the goodness of the systems we depend upon. So, for instance, are we willing as a culture to think seriously about the good and bad effects of smartphones or social media? If we find that social media causes harmful effects for certain users at certain times in their lives, do we have the will to respond meaningfully with regulation or correctives?

Analogous questions can be posed to any number of devices. On the one hand, we in the West have set up numerous think tanks, academic institutes, lobby groups, and professional associations all aimed at addressing the potential problems of one form of innovation or another. But unless there is a serious commitment to rigorous critical assessment and an openness to action – action that might require suspending profit or growth for the sake of health or some other good like excellence or virtue – then our cultural capacity to meaningfully govern technology diminishes to mere tokenism or symbolic action.

Third, the path to cultivating the kind of awareness and judgement we most need is the path of liberal education. By liberal education, Moulakis means the close study of the great texts and great achievements of the past. The value of this kind of education has multiple expressions. For one thing, it is important to make explicit for our own self-understanding the dominant political, moral, and philosophical positions that have structured Western civilization. That is, just because we are born, raised, and "professionalized" to become citizens of the



West does not mean that we also understand the ideas, thoughts, and intentions that went into the institutions that influence and govern our lives. Each generation, if it hopes to see its own future clearly must make its past explicit to itself, if only to better understand what its institutional resources are and why it believes the things that it does.

In addition, and perhaps more importantly for today's purposes, by thinking through the intellectual diversity of the West, we learn to see and inhabit a spectrum of viewpoints and build thereby the kind of agility we need to respond to the novel challenges that innovation brings in its wake.

Herein lies the liberating quality of Moulakis' conception of liberal education. Because the West is itself not unified, that is, the West contains many tensions, whether it be between Greek philosophy or biblical religion, classical republicanism or classical liberalism, ancient metaphysics or modern science, learning the different arguments and positions in this history is itself a powerful source of individual freedom and awareness. If one can learn to appreciate Homer and Aristotle alongside Nietzsche, Picasso, Douglass, and Darwin – even or especially when one doesn't agree with them – one thereby greatly expands and enriches one's capacity to inhabit sympathetically multiple viewpoints. This ability is especially useful when it comes to identifying the dominant ideas that govern one's age, particularly when those ideas are used to justify, often falsely, the political or technological status quo.

In 1994, Moulakis' ideas about the value of liberal education for engineering students were new and, in some sense, quite radical. Thinkers from different traditions have long since recognized that technology needs to be oriented by some form of external constraint. But in the United States, very few engineering schools had done much to integrate a serious and intentional approach to learning as a way of offsetting the rigors and often narrowed values of professionalized technical education. In the last three decades the West has seen dramatic shifts in innovation, especially in the domains of communications technology and artificial intelligence.

Given three more decades, these developments, especially when mixed with other innovations in genetics, energy, weapons, and robotics, could have even more radical effects on our civilization.

Moulakis' worries about the danger of what is deinon in technology ring to us now in clarion tones and help to sharpen our sense of purpose.

Now more than ever, we need engineers willing to think broadly and deeply about their practice in various contexts. It is precisely the liberally educated engineer who is best poised to help form a future society that can effectively steward our technological inheritance.

RAILWAYS OF THE FUTURE

Is a high speed railway system in the US feasible?

DAVID REMICH

For many of us, the daily commute consists of leaving home earlier than we'd like to sit in traffic we'd rather avoid. With high levels of congestion and frequent accidents on our roads, commute times are unpredictable and sometimes there's nothing to do except be late. With the technology available today, there should be a better option. We need a more reliable way to commute and high-speed railways offer a practical and efficient solution.

The lack of effective public transportation in Boulder and across the United States has caused an unchecked increase in traffic and a devastating decrease in public safety. According to the American Public Transportation Association (APTA), people who use public transportation are 90% less likely to get into a traffic accident when compared to those who ride in private automobiles.

Even though it's about 10 times safer per mile to take a bus or a train, a majority of Boulder residents still rely on their personal vehicles for their basic transportation needs. On average, 76.4% of American communities drive to work on a daily basis, which is much higher than in Boulder where it's about 50.9%. However, the public transportation system within Boulder county only accounts for 7.9% of people, the rest bike, walk, or rideshare for their everyday commute. With a lack of viable public transportation, there are numerous predictable consequences such as more hectic commuting and higher accident rates, but there are some unexpected consequences as well. It's not just individual drivers who are impacted; with over 70% of all domestic goods being transported by truck, congestion-related delays also have a significant impact on supply chains.

Anybody who drives to work in the Denver metropolitan area is subjected to horrendous traffic jams on a daily basis; this is caused by a multitude of factors. Of the roughly 706,000 people living in this metropolis, 70% drive to work by themself every day. Traffic fatalities are the leading cause of death for persons aged 1-54. The sheer mass of people on the roads is enough to cause major headaches throughout the region, not to mention the amount of truckers on the roads adding to the congestion and safety concerns.

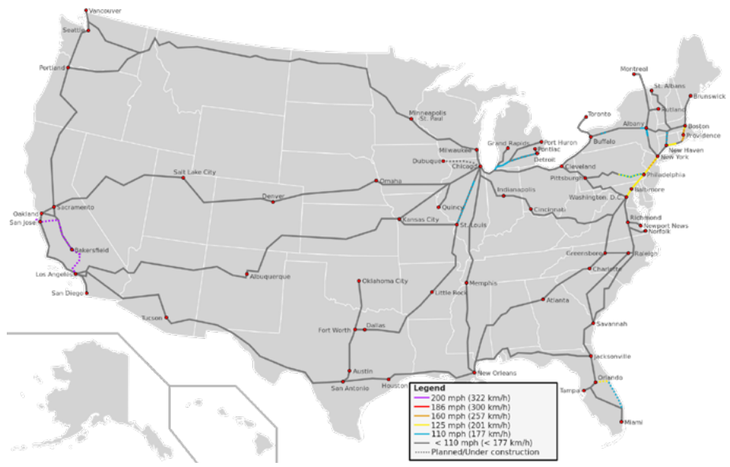


PHOTO VIA FORBES MAGAZINE

The current transportation system forces companies with a major dependence on materials and shipping to rely on trucking for a majority of their domestic transportation needs. This is because there are very few other efficient and reliable ways to deliver large payloads to specific locations within cities. Today, roughly 70% of all domestic goods are shipped by truck, with only 25% of goods being transported by rail. Trucking's domination in tandem with a lack of viable public transportation is not sustainable because of the threat to public safety and the increasing amount of carbon emissions it continues to produce. 29% of all the carbon emissions in the United States come from transportation, 16.4% from personal vehicles and 7% from trucking directly while railroads account for only 0.6%.

High-speed railways are an untapped, efficient form of transportation that offers solutions to many of these pressing issues. In general, railroads are used for long distance transportation because they can carry heavier payloads and maintain better fuel economy than trucks. Trains are also significantly more cost effective, have temperature controlled cars for special cargo and continue to be more secure than trucks because it is extremely unlikely for a train to get into an accident or get caught in traffic.

The Association of American Railroads (AAR) states US railroad mileage exceeded 200,000 miles in 1902 and reached a peak in 1920. During this time period, railroads accounted for almost all transportation within the country, but by 1978 it dropped to just 35%.

This dramatic rise and fall of the industry is attributed to the economic and societal influences of the Great Depression, both World Wars, and technological advancements. As of 2022, rail transportation accounts for roughly 25% of all commercial transportation but only 3% of business, commute or pleasure transportation.

Today's US freight railroads are four times more fuel efficient than trucking and a single train removes hundreds of trucks from the roads. This tackles the carbon footprint from two sides. According to AAR, moving freight by rail reduces the greenhouse gas emission of the entire process by 75% on average. Additionally, AAR states that "if 50% of the truck traffic moving at least 750 miles went by rail instead, greenhouse gas emissions would fall by approximately 26.2 million tons."

Despite the numerous benefits of shipping by rail, most companies still rely on trucking as their primary means of transportation across the continental United States. The main reason for this is that there are no avenues to deliver packages to specific addresses by rail. This is where trucking takes over, for example, a train travels significantly faster from San Francisco to Chicago than a truck, but it has a preset location it goes to. The cargo is unloaded onto trucks at these locations to make the shorter deliveries. Shipping entirely by truck offers a major time advantage, even with all the transportation issues associated with driving across the country. This is because of how long the final unloading and reloading process of shipping by rail takes. Through the addition of an effective high-speed rail system there will be huge cuts to carbon emissions, a boost to the economy from greatly reduced shipping and leisure travel costs, and provide thousands of jobs from coast to coast.

Over the years there have been several attempts by US Representatives to set aside funding for high-speed rail projects. In 2022, 10 US Senators and 65 Members of the House asked for $3.5 billion dollars from the 2023 fiscal budget to begin development of high-speed rail infrastructure. Two years prior, Rep. Seth Moulton, D-Mass., rolled out a national plan to invest $205 billion dollars into creating a network of high-speed rails. These efforts are just the lastest in a long string of unfruitful attempts to begin a high-speed rail system dating back to 1965. Currently, there are three projects in development, but only one is under construction: the line from Los Angeles to San Francisco. The line from Las Vegas to Southern California is expected to break ground in 2023 and the line from Dallas to Houston is in the works, but has had some legal difficulties over land rights.

The need for a network of high-speed rails spanning the United States is obvious, so what is the hold up? Since 2008, China has built 23,500 miles of railway connecting all of its major cities and they are expecting to double this total by 2035. With max speeds of 217 mph, the Chinese train system has revolutionized the efficiency and convenience of intercity travel.

It is critical to note that while the Chinese rail system is making great progress, it comes with legitimate concerns over ethical development and foreign policy implications. Namely, the railway system is part of the Belt and Road Initiative, an infrastructure project connecting East Asia to Europe, and the financing strategies may prove problematic. China is being accused of 'debt trap diplomacy' where they fund major infrastructure projects in developing nations who have unsustainable loans, then use the accrued debt to leverage those nations governments.

AMTK 505 SNOW TRAIN, PHOTO VIA DREWJ1946 LICENSED UNDER CC BY 2.0

The California line, by contrast, has been slow in development, largely owing to cost. The typical infrastructure cost in China is about $20M per kilometer, while the current project in California is totalling a whopping $56M per kilometer! Nearly double the cost and with each new estimate, the total continues to grow. The reason it is significantly more expensive to build in California is because US public transit agencies do not have the authority, experience or support to deliver a major transit construction project. The support of local government officials are essential in acquiring the necessary permits and land required for such a project. Additional problems include high methane zones underground near Los Angeles and an average increase of 50% per mile of domestic rail transport projects when compared internationally.

The primary benefits of constructing effective high-speed railway systems across the United States include easier access to travel, less carbon emissions, safer travel, faster shipping, jobs for those building the railways and jobs for those who will be operating and servicing them. This new system will create safer roads, make commuting easier and serve as an investment to our future. High-speed rail is a viable and realistic solution to a lot of problems, so why is nobody doing anything about it?

For citizens wanting to make a direct impact today, commute with a nearby coworker tomorrow, pick up an RTD bus pass for local trips and spread the word about the benefits of creating a high-speed rail system here. To get involved locally here in Boulder, contact your city council representatives, the Colorado Front Range Rail District Chainman, Jim Souby and Colorado Department of Transportation officials about the Front Range Passenger Rail project14. For further information about getting involved on the national level, contact your congressional representatives and visit the US High-Speed Rail Association website15. Together, we can revolutionize the transportation industry!

HERBST FELLOWS

The Herbst fellows demonstrate ethical practice and engaged scholarship through their research papers.

Read the complete works of the Herbst fellows at www.colorado.edu/herbst/

Taylor Bata
Junior in Aerospace Engineering

Is the Cold War in Your Pocket? Cybersecurity, the New Arms Race

All humans are imperfect, therefore all of humanity's creations are inherently built with flaws. Nothing online is truly secure. Hackers know this and break into systems to wreak upset on a personal and international scale. One day you could fall for a phishing scam on your phone, revealing personal information from keystroke tracking. The next day a foreign government official could mistakenly install malware designed to worm its way into an unseen system weakness, resulting in an enemy state destroying their country's entire nuclear program. This espionage is achieved with no boots on the ground.

Whether you like it or not, a copy of yourself lives on the internet in electronic databases containing tax and health records, credit reports, and social security numbers. Social media may make it easier for interpersonal surface level searching, but the people who really want your data know where to look in the internet's catacombs. The best offense is a robust defense. Measures can be taken to protect your immediate online circle. However, society may be too acclimated to data leaks for third party accountability to become a reality.

The Intersectionality of Race, Medical Research Innovation and Eugenics

Herman Klein-Hessling Barrinetos
Junior in Biochemical Engineering

The Problem at hand:

A common misconception is that eugenics practices rooted in pseudoscience and racism first originated in Nazi Germany. However, well established eugenics movements existed within the United States as early as the 1920's. Actions such as the encouragement of fertility amongst those high up on the socioeconomic totem pole were encouraged whereas forcible state mandated sterilization of those from lower socioeconomic groups and communities of color was set into action.

Presently significant investments have been poured into furthering genetic knowledge and biotechnological innovation.To fully grasp the advantages that biotechnological innovation sets forth, as well as the potential risks we must consider the intersectionality of the current state of healthcare/medicine, genetics, and race. Reconciliation and moving forward proves challenging in a race conscious society such as the United States, in which historical events and contemporary relationships are still shaped by distinct and inherently different racial groups.

Recommendations:

The acknowledgement and education of how disenfranchised groups were stripped of their human rights in order to advance medical research, must be done intentionally and broadly.There needs to be further opportunities for disenfranchised communities and individuals to have their voices heard in forums about genetic research and technology.

As new technologies are introduced, adequate control measures to ensure equitable accessibility and protection for groups traditionally taken advantage off in the research and development stages.

Zahraa Abbasi
Senior in Computer Science

Clarifai : an AI Startup

Clarifai, an AI startup, was committed to philanthropic practices such as donating software to charities and socially-beneficial causes. This was the Clarifai that employees were familiar with when they joined the company. Several months later, they found themselves in a workplace with a vastly different character. The office, which had paper covering the windows, was dubbed "The Chamber of Secrets" due to the clandestine nature of their meetings.

Outsiders,along with the engineering team themselves, were unsure of what they were building but the CEO assured them that they were saving lives. Shockingly, the team discovered that they were creating software for autonomous weaponry. Despite the unethical nature of their work, only oneperson decided to leave Clarifai.

Indeed, stories in the media exposing tech companies, such as Clarifai, highlight the gap between the ethical behavior people believe they ought to have versus the behavior they actually have. So, why do people continue to contribute to unethical projects when their intent is to do what is right? Ultimately, this article discusses the five compelling situational and social forces that corrode the ethical decision-making process in tech.

Climate Migrants: People on the Move

Climate change has impacted many aspects of the environment as we know it and will continue to do so in significant ways in the future. One of those ways will be reshaping human migration patterns. Migration can happen within a country or to other countries.

The UN predicts anywhere between 25 million to 1 billion environmental migrants by 2050. There is a growing number of climate migrants or people who leave their homes because of climate stressors, although they differ from refugees fleeing conflict, it is important to recognize the reasons for human migration and what people can do to help those displaced.

As a future engineer myself, I would like to shine a light on those opportunities and actionable items of both the technical and social solutions to this ever growing challenge.

Madeline Karr
Junior in Aerospace Engineering

Samiha Singh
Senior in Environmental Engineering

The Impact Engineers have on Climate Change

Throughout my career, I have had the opportunity to interact with many people who are ready to tackle the climate change challenge. All of these engineers strive to develop technologies and systems that can be used to mitigate the impacts that humans have on the environment. However, engineering alone is not enough to "solve" the climate crisis. In fact, many of the technologies we need to combat climate change already exist. The fundamental issue is not the lack of technology, but the fact that these technologies haven't been implemented on a wide scale due to limitations in politics, public perceptions, and the implications that new technologies have on people's lifestyles.

To overcome these challenges, engineers need to understand not only the technical aspects of how to build solutions, but also the social aspects of how to gain public support, advocate for, and implement these solutions. If engineers serving as policy advocates in their local communities becomes commonplace, the role that engineers play as experts in their field who advise new policies could help to, not only propel meaningful change, but to rebuild a sense of trust in science among the general public.

ARTISTS & ENGINEERS: ONE & THE SAME

Engineers are too often seen as students who only excel at math and sciences, but these engineering students defy the stereotype

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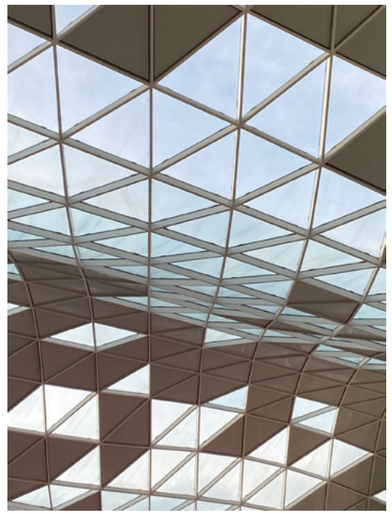

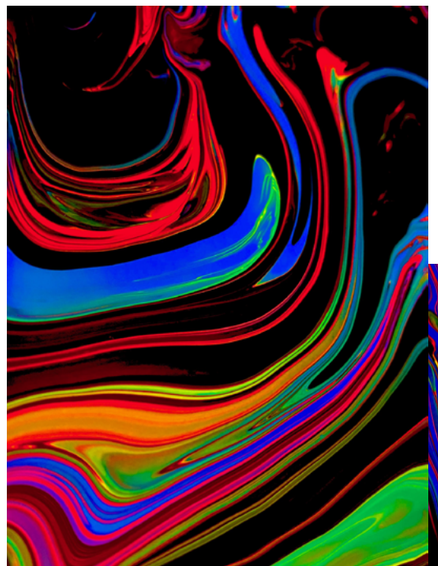

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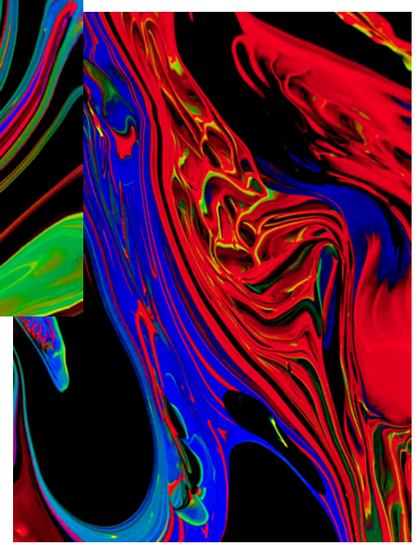

3.

1. Easha Jammu: Junior
Major: Architectural Engineering
Medium: Acrylic

1. Easha Jammu: Junior
Major: Architectural Engineering
Medium: Digital photography

3. Sam Plunkett: Sophomore
Major: Exploratory Studies/ Mechanical Engineering Aerospace
Medium: Oil Pastel on paper

If you would like to submit your own artwork, please email Hannah.Sanders@colorado.edu!

The Colorado Engineer
University of Colorado Boulder
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Boulder, CO 80309

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