WALTER SCOTT, JR.
COLLEGE OF ENGINEERING
COLORADO STATE UNIVERSITY

ENGINEERING SENIOR DESIGN SHOWCASE

2020

Presented By
Colorado State University
Engineering College Council

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April 8, 2020

Dear Engineering Seniors:

Congratulations on the completion of your Senior Capstone Design class!

While the unprecedented circumstances associated with our necessary COVID-19 response have resulted in the suspension of the hands-on fabricaton of many of your projects, your experience in design, analysis and teamwork on these projects will prove to be extremely valuable to you as you transition into the engineering profession. Having taught senior design for many years, I truly appreciate the significant effort and long hours required to complete these design projects, and I have been impressed with how hard you have continued to work on these projects remotely.

Under normal circumstances, your project would culminate in the public presentation of your designs to faculty, industry representatives, family and peers during our E-Days festivities, which enable us to celebrate your success to CSU community. While we cannot proceed with a face-to-face celebration of your efforts, the Engineering College Council has encouraged us to do all that we can to celebrate your work, which includes producing the annual E-Days booklet summarizing all of your projects, and a virtual Awards Ceremony recognizing your accomplishments.

On behalf of the Walter Scott, Jr. College of Engineering's faculty and staff, I wish you the very best in all your future endeavors. I look forward to seeing the results of your projects this year!

With high regards,

David I. McLean, Ph.D., P.E.
Professor and Dean

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RESEARCH

BIOMEDICAL ENGINEERING

AlloSource Periosteum Processing

Erin Solis, Will McCormick, Sarah deBoer, Analia Quirk

Our team has been tasked by AlloSource to create a device and method to efficiently remove the periosteum from long bones. Periosteum is a fibrous tissue rich in both growth factors and osteoprogenitor cells that participates in bone repair processes. AlloSource desires to add periosteum into their current bone putty products to enhance bone healing, promote angiogenesis, and reduce recovery times; however, the current removal technique is time consuming, physically challenging, and yields minimal amounts of tissue. Our team has created an automated device that fixates a femur while a spring-loaded blade is driven across the bone surface by a linear actuator. This design accounts for 360° bone rotation, can be adjusted for different bone lengths, and is easily sterilized between uses.

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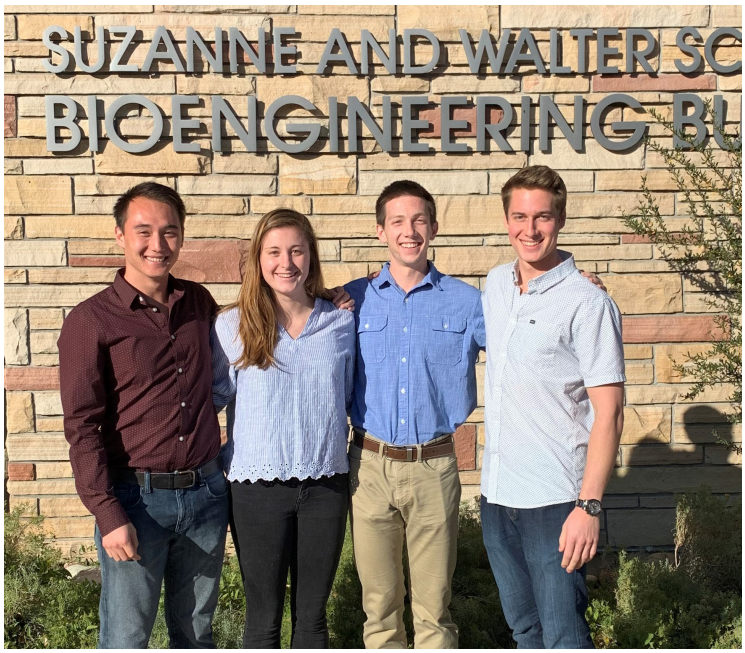

BrainTrain

Corey Lauck, Juliette Talarico, Zach Haigh, Jeremy Tabke

BrainTrain is a closed-loop EEG + tACS system for neuroregeneration, optimization, and modulation. As neurodegenerative disorders rise, there is a clear need for early-onset therapy and prevention. With the application of specifically generated waveforms, BrainTrain has the functional capability to interact with underlying neuronal activity. When integrated alongside EEG, a level of capability is achieved unlike anything else in the market. This allows for patient-specific treatment and optimization with minimal side effects compared to current standards of care.

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BIOMEDICAL ENGINEERING

Design & Manufacturing of a Multi-Sensor Device for Measuring Metabolism for Cell Culture & Live Tissues

Sam Ritter, Jacob Alfieri, Alden Tennison

The Multi-Sensor Device for Measuring Metabolism for Cell Culture and Live Tissue is a comprehensive project that aims to further improve the quantitative data available to researchers in their measurements. The device uses calibrated circuitry, electrochemical sensors and refined microfluidics to test concentrations of metabolites within cell cultures and live tissue while supporting optical observations. The device aims to provide controlled fluid motion and analysis of glucose, oxygen, glutamine, lactate, and pH levels within the well.

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Magnetic Tweezers

Nick Mitchell, Lyndsey Nold, Chandler Birrell, Stephanie Pascua, Claire Fenton

Magnetic tweezers make up an electromagnetic device utilized with a microscope to produce a magnetic field directed at a cell or tissue with a magnetic bead for the purpose of measuring its rheological properties. Our design creates a three-dimensional magnetic field from a hexapole system that allows the magnetic bead to move in all 3 planes. Video-tracking and post-process analysis of the bead movement allows for the identification of the rheological properties via the displacement of the bead and the force applied. Our project allows for micromanipulation and generated fields in picoNewtons. Understanding the rheological properties helps researchers to understand disease states of cells, allowing for this to be a potential diagnostic tool in clinical settings.

BIOMEDICAL ENGINEERING

MAVEN Dx

Skyler Hochmuth, Elias Espin, Nick Peters, Marina Larson

Current rapid testing methods to diagnose influenza are severely lacking in accuracy and financial feasibility. Project MAVEN Dx (Multiplexed Amplified Virus Etiology Network) aims to develop a product with improved accuracy and reduced cost for quick clinical influenza diagnosis. Our prototype uses a novel electrochemical impedance spectroscopy method to detect virus particles embedded in a paper-based microfluidic pad to achieve a cheap and portable point-of-care test kit. MAVEN Dx is currently focused on influenza, but this technology possesses the ability to be fitted for other viruses such as Zika and Coronavirus.

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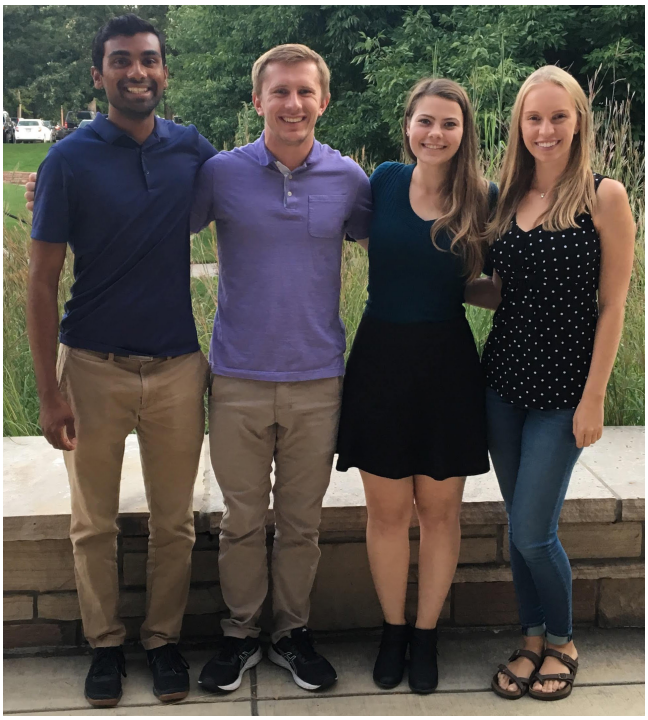

Mechanical Bladder

Anu Mathew, Emma Hurley, Teryn Degenhart, Jordan Schlitzer

Every year, about 1,600 babies are born with spinal cord separation called spina bifida, and there are over 17,000 new cases of spinal cord trauma. Many of these patients lose partial or complete control over their bladders and undergo procedures to divert urinary flow. The goal of the mechanical bladder project, which is in its third year, is to create a total bladder replacement that will allow patients to regain control over the normal urinary pathway. This year, the team focused on developing a controlled outlet to the bladder that can connect to the native urethra.

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BIOMEDICAL ENGINEERING

Optical Neurolink

Justin Southerland, Sarah Maclean, Kieran Simske, Mauri Richards

A solution for spinal cord injuries resulting in paralysis may lie in the development of brain-computer interfaces (BCIs) to bypass spinal lesions. Development of wired BCI systems are well underway, but they require a permanent hole in the scalp for direct connections to the brain. The goal of the Optical Neurolink senior design project is to design and prototype an optical device that sends brain-like signals from an electrocorticogram (ECoG)-like array to an external receiver without data transmission cables. In this year's project, brain-like signals are sent through a tissue phantom to avoid the use of biological materials while maintaining similar optical and thermal properties to that of skin.

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PhotonPharma

Katherine Conger, Andy Hegemann, Isaac Griess, Jacob Stockebrand, Cameron Taylor

The goal of the PhotonPharma senior design team is to engineer a medical-grade device that will produce a cancer immunotherapy treatment. Based on the scientific principles of the Mirasol Pathogen Reduction Technology, the device will inactivate cancer cells using riboflavin and ultraviolet light. This treatment acts as a vaccine that triggers an immune response based on the surface antigens of the deactivated cancer cells. The device will be designed to expand the accessibility of immunotherapy treatments.

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BIOMEDICAL ENGINEERING

Quatro Socket Analysis

Olivia Hahn, Zach Leighton, Sean McClure, Emily Bergum

The primary project goal is to develop and conduct an efficiency analysis of the patented Quatro above knee adjustable prosthetic socket developed by Quorum Prosthetics. Anecdotal evidence has been collected indicating that the Quatro socket is more comfortable than other designs, but empirical data needs to be collected to back up that evidence. Metrics used by the senior design team include volume change analysis, pressure mapping, and finite element analysis. The data collected will be used by Quorum Prosthetics in order to improve the design of the socket.

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Repurposing Microbes as Living Biologic for Antibiotic Resistance

Jasmine Akers, Kyle Howe, Torin Moore, Samantha Rosenberry, Sabina Vidales, Hayden Yarbrough

This senior design team aims to use genetically engineered E. coli to fight off the antibiotic resistant strain of bacteria called methicillin-resistant Staphylococcus aureus, or MRSA. By taking advantage of quorum sensing, the engineered E. coli can detect the presence of Staphylococcus aureus, and in response, deliver lysostaphin to the site of infection and aid in killing the bacteria. This product will be able to aid in fighting off MRSA that is prevalent in hospitals all over the world.

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BIOMEDICAL ENGINEERING

Self-Suturing Laparoscopic Port

Blair Whitworth, Kirsten Kauk, Michael Poland, Meghan Morrill, Annie Elefante

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The Self-Suturing Laparoscopic Port Capstone project was created by the students of the SBME Clinical Immersion Program. At the Medical Center of the Rockies, we shadowed in various surgeries, and identified that clinical teams were in need of a time-saving laparoscopic suturing device that also provides the patient with a safe abdominal closure. With the guidance of surgeons and Medtronic R&D engineers, we have created a surgical instrument that will mitigate time spent in the operating room.

Spine Phantom: Medtronic Restorative Therapies Group

Joe Clouse, Megan English, Ryan Henry, Matt Helmreich

The Spine Phantom team has designed and developed a physical spine model that will be valuable for the Enabling Technologies Group of Medtronic and their work on spine robotics and navigation technologies. The primary aim was to create a lumbar spine model that has both physiologically realistic motion and an ability to return to a repeatable home position. The resulting 3D printed model is intended to serve as a tool for both R&D testing and marketing demonstrations of Medtronic's surgical navigation technology. By creating this customized spine model, Medtronic engineers will save both time and effort in their drive to continually innovate global healthcare.

View Presentation View Poster **Project website:** https://sites.google.com/rams.colostate.edu/spine-phantom-website

BIOMEDICAL ENGINEERING

Sensor Technology for Enhanced Prosthesis Production (STEPP)

Bella Demiranda, Stephen Haag, Josh Floyde, David Kimmey

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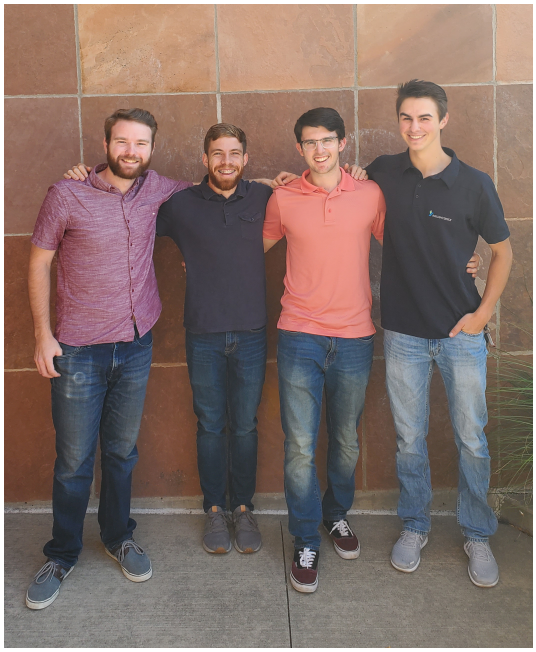
The Sensor Technology for Enhanced Prosthesis Production (STEPP) team is addressing the increasing need for prosthetic care in developing countries. The Range of Motion Project estimates that roughly 80% of the world's amputees live in developing countries and only 2% have access to proper prosthetic care. STEPP merges 3D scanning technology with a custom probe to map out the topology and tissue properties of residual limbs. The main objective for this year was to create an intuitive and simple tool that can quickly identify and distinguish different tissue types. STEPP aims to revolutionize prosthetic manufacturing through an intuitive and effective implementation of this technology.



Terumo BCT Cell Separations

Cole Watkins, Evan Dummer, Jake Stewart, Daniel Corbett

There exists a clear need for clinicians and researchers to separate whole blood into its components through the use of continuous counterflow centrifugation with apheresis machines. The goal of this project is to maximize throughput of cells through an apheresis centrifuge while maintaining cellular viability. With maximal throughput, patients will receive better treatments for a wide range of blood diseases using separated components of whole blood. Additionally, to further validate the flow, a blood mimic will be created and matched with the viscosity of whole blood in order to be used in non-biohazard validation experiments. Finally, a simulation of a magnetic debeader, used to collect target cells, will be created to optimize the magnetic flux and targeted cellular separation.

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CHEMICAL AND BIOLOGICAL ENGINEERING

Algae Green Diesel, Open Pond

Mackenzie Radandt, Austin Reed, Austin Banks, Edrees Al-Abdali, Kolton Fieselman, Lucas Smith

This project aims to model the harvesting of algal culture in open ponds, separations and extraction of algal lipid oils, and subsequent downstream hydroprocessing into liquid renewable drop-in fuel grades. The primary goal of the project is to harmonize existing literature and design a functional Aspen model to complete a process techno-economic study for feasibility analysis. Additionally, a life cycle analysis will be performed to compare the finished renewable product to conventional petroleum fuels.

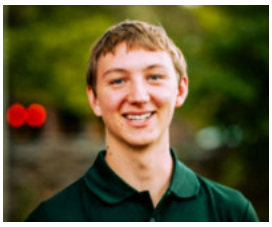
Waste Not, Want Not: Conversion of Food Waste in the Larimer County Landfill

Kyra Jensen, Max Hostetter, Scott Powers, Sajjad Aljamam, Peter Meyer

The Larimer County landfill is continuing to fill up and space is becoming limited. One option to combat this problem and produce green energy at the same time is the use of an anaerobic digester. Our design team seeks to build on previous work to model a full scale digester as well as select the best use of the biogas produced, from green electricity generation to liquid fuel. an alternative to fossil fuels, having a more positive impact on the environment.







Brewer's Spent Grains to Fuel-Grade Ethanol

Cameron Cross, Gavin Dietel, Jaysen Yakobson, Matthew Rodriguez, Noah Beck, Bailey Coker

Our team is developing and modeling a process to produce fuel-grade ethanol using brewer's spent grains as biomass. The goal of this project is to utilize "waste" biomass, providing an economically competitive process to rival that of corn sourced ethanol production. The team's process includes the use of pre-treatment, hydrolysis, fermentation and separations, combining the efforts of chemical and biological engineering to achieve our goal.

CHEMICAL AND BIOLOGICAL ENGINEERING

Demineralization Bone Matrix Scaffold

Bailey Robbins, Megan McDonnell, Maliea Van

This project aims to combine Demineralized Bone Matrix with a synthetic polymer and NaCl as a porogen to create porous foam-like scaffolds. By combining a biological polymer, such as DBM, with a synthetic polymer, we hope to create a scaffold that is compatible with cell growth, while reducing variability in manufacturing. The salt as a porogen will create uniform pore sizes while maintaining affordability. This type of scaffold would be biocompatible and indicated for use in orthopedic surgeries to promote the growth of new bone cells.

Downstream Process for 2,3-Butanediol Produced by Cyanobacteria in a Photobioreactor






Helena Kragel, Jonathan Baumann, Charlie Byrd, Emily Funk, Marley Goetz, Michelle Foster

Cyanobacteria are a promising mode of sustainable production of fuels and chemicals. However, the economic feasibility of this process is still questionable due to high costs of photobioreactors, low productivity of the product, and expensive recovery processes. This project aims at developing an economically feasible downstream recovery process for separating 2,3 butandiol produced from cyanobacteria in a photobioreactor.

Hydrothermal Liquefaction of Algae, Open Pond

Kalin Wiersma, Juan De Paz, Deepak Dileep Mansuli, Rafael Almaraz, Julio Alves-Rocha

This project aimes to improve environmental footprint through producing a renewable fuel source to compete with fossil fuels via hydrothermal Liquefaction of algae.

CHEMICAL AND BIOLOGICAL ENGINEERING

Enzyme Membrane Reactor

Cody Hawthorne, Nick Bruns, John Yuen, Ethan Richardson

In collaboration with research groups at CSU and the National Renewable Energy Laboratory, this group has developed a model for an enzymatic membrane reactor for the conversion of carbon dioxide to bicarbonate; helping to inform the development of both the membrane material and the sizing of the reactor itself. The purpose of this reactor will be to deliver an alternative carbon source (bicarbonate) to algae farms as a replacement to traditional sparging systems. This will drastically increase carbon uptake efficiency (CUE) as well as avoiding the large amount of carbon dioxide (CO2) that is released to the environment by sparging systems.




Algae HTL Closed Reactor

Evan Farris, Darilyn Craw, Khaled Aljaber, Holland Dierl

The proposed project encompasses the production of a biofuel from algae input through the processes of a photobioreactor, hydrothermal liquefaction unit, hydrotreating unit, a hydrogen plant and an anaerobic digester. The origin of this project is derived from National Renewable Energy Lab (NREL) and was used within prior years' projects. The motivation for the project is to ultimately produce a fuel source alternative to fossil fuels, as fossil fuels release harmful amounts of waste gasses versus that of a biofuel. Also, fossil fuels will one day be depleted, so an alternative and renewable source for these fuels is very desired. With carbon sequestration and several units for operation, algae is produced to be converted to a hydrocarbon biofuel for jets in particular as an alternative to fossil fuels, having a more positive impact on the environment.

CHEMICAL AND BIOLOGICAL ENGINEERING

Hepatitis B Vaccine from Recombinant Yeast

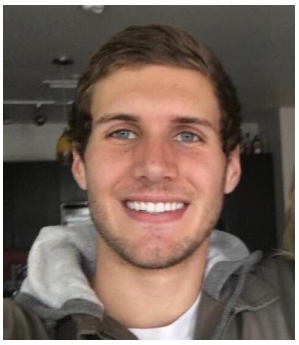
Natalie Rios, Sarah Hartley, Kahli White, Alyssa Smith, Taylor Baker

This design project strives to develop a hepatitis B vaccine from recombinant yeast at a low cost. Cases of Hepatitis B spread through lower in communities, like developing countries that do not have readily available access to vaccines. Superpro Designer simulates the batch processing of the vaccine and includes tools to assist in economic analysis. This project lays the groundwork for future investigations into the implementation of this manufacturing at an industrial level.

Methane to Ammonia Gas Process, Lake Kivu in Rwanda

Billy Al-yahyaai, Mazin Alshaqsi, Faham Al Abri, Muayyad Zaind

In this project, we come up with means to extract methane gas in a stipulated time to reduce the risk to native communities living in the suburbs of lake Kivu. We employ the Haber process concept to combine nitrogen from the air and combine it with natural gas (methane) under the influence of a catalyst after initiated fractional distillation to produce ammonia. The process was developed through aspen plus simulator to analyze the model properties.



Synthesis of DME from "Killer" Lake

Tyler Wysocki, Hassan Al Lawati, Yaqoob Al Aamri, Abdallah Soliman

We are designing a process to synthesize DME from methane in the depth of Lake Kivu on the borders of Rwanda and DR of Congo. The DME will be used as a cooking fuel to help reduce the use of wood for cooking which will benefit the environment and public health. Most importantly our project will help avoid the release of the methane into the atmosphere which would cause a natural disaster that could potentially harm 2 million human lives.

CHEMICAL AND BIOLOGICAL ENGINEERING

Ramskeller Brewhouse Design & Automation

Gillian Fahey, Hannah Peters, Cole Harris, Kinsey Flanders, Giuliana Seretti, Jason Kiehlbauch, Willow Cline

Colorado State University's Fermentation Science and Technology Program (FST) has asked a team of undergraduate, interdisciplinary engineering students to continue automating and maintaining the Ramskeller Brewery located in the Lory Student Center basement (LSC). The Ramskeller Brewery is a critical component to the FST program as a hands-on learning tool for their students. This is a multi-year, interdisciplinary team of engineering senior design students who will continue to work on providing the College of Health and Human Sciences and the University a functioning brewery for the FST program. The goal for the 2019-2020 team is to continue automating the brewery, culminating in a multi-phase Clean in Place system design that will focus mainly on the safety of the brewers. There will also be a variety of smaller projects the team will have the opportunity to work on to make the brewery more efficient.

View Project Website

Wind Energy to Ammonia

Loay Al-Bahlani, Al-Waleed Al-Rashdi, Ahmed Al-Sumri, Trent Hanson, Kate Larsen, Jessica Reyes, Andrew Temple

Our project is to create a small scale ammonia production process based on the work of Dr. Edward L. Cussler from the University of Minnesota. His work outlined a system that is different from the Haber-Bosch process, which produces 1% of the global carbon dioxide emissions annually. Our process aims to use curtailed wind energy to power our process along with an electrolysis of water to produce hydrogen gas and an adsorption column to separate the liquid ammonia product. Our goal is produce ammonia to compete with the large-scale production of the Haber-Bosch process. This technology could be the future of storing renewable energy in the form of liquid ammonia.

CHEMICAL AND BIOLOGICAL ENGINEERING

Plant Flu Vaccine: BioPharma Team

Ryan Miller, Chloe Chou, Hyeonjeong Kim, Cooper Zilkenat, Dan Stone

The Plant Flu Vaccine senior design project utilizes N. Benthamiana to produce a virus like particle (VLP) based vaccine via transient expression. Subsequent downstream processes were designed to extract the VLPs and formulate an appropriately dosed vaccine. The process underwent a techno-economic analysis to judge its feasibility and improvement upon traditional flu vaccine production methods.

Oral Plant Based Flu Vaccine

Juman Al-Zadjali, Darcey Burns, Syd Hall, Cooper Schmitz, Grant Kruisselbrink, Ivette Villa

The focus of this project is to create an easily accessible and time efficient flu vaccine without using traditional methods but rather using plant based materials. The vaccine will be modeled in a tablet form using tobacco leaves as its plant source to generate pathogens against the virus. This method elicits an increase in immune response while also being a non-invasive technique.

The Iron Fleet

Rachel Jackson, Sarah Wakumoto, Xandria Amash, Sergei Driga, Christopher Kovacic, Jacob Stewart, Amanda Shick

The end goal is to have a product that can be used in cases of trauma, war zones, and third world countries with less intensive storage requirements than blood. This can be used to stabilize trauma patients and supply an oxygen carrier to temporarily replace blood lost so vital organs continue to receive the necessary amount of oxygen and avoid damage. The goal of this senior design project was to create a synthetic oxygen carrier using a protein crystal scaffold, coupled with a naturally occurring small hemoglobin molecule to act as the oxygen carrier. Scale-up of the production of mini-hemoglobin was conducted in a 2L bioreactor, and further scale-up was modeled using SuperPro. Biocompatibility tests and economic analysis were completed for proof of concept of the feasibility of this product.





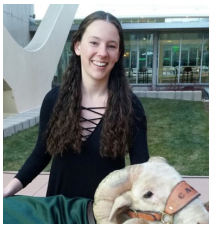


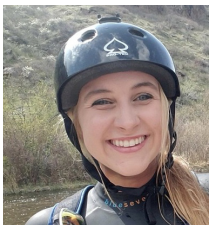
CIVIL AND ENVIRONMENTAL ENGINEERING

Class VII Engineering

Matt Bundren, Allie Huber, Brandon Jensen, Jessica Menconi, Daniel Sanchez, Claire Schreiber, Shayna Underwood, Matt Bundren



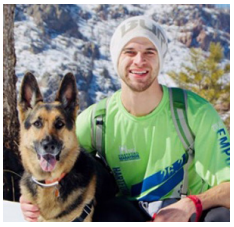
Class VII Engineering, made up of civil, environmental, and hydraulic engineers specializes in projects regarding open channel flow and hydraulic elements. For their senior design project, Class VII was tasked with designing a whitewater park for the City of Danville. The focus of the project is the development of two whitewater features catered to all aspects of community recreation and intended for use by kayakers, stand-up paddleboarders, and tubers. The design has minimal environmental impacts including consideration of fish passage and gradual erosion, while enhancing the quality of life for the people of Danville.

CLP Consulting

Dillon Willet, Chris Lamson, Sara McMahon, Simon Lindley, Matt Doyle, Matt Plante, Connor Sheldon

CLP Consulting's project is to design a new water utility line and two stormwater inlets for Hickory Street. The main purpose is to redevelop the water utility to supply clean water to surrounding businesses and residents. The project also seeks to redesign the stormwater inlets to meet required flood management criteria. This project will go to construction with the City of Fort Collins following the designs.




CIVIL AND ENVIRONMENTAL ENGINEERING

Concrete Canoe

Katie Beardslee, Solvieg Williams, Megan McGuire, Cydney Gray, Thomas Mayer

The Concrete Canoe Project is an annual competition sponsored by the American Society of Civil Engineers. Civil Engineering students at colleges across the globe compete to design, build, and race concrete canoes. The Concrete Canoe project has fantastic opportunities for students at all levels to get involved and apply their civil engineering education. upon traditional flu vaccine production methods.

Too Many Interns Engineering

Abdulrahman Almutairi, Austin Danhoff, Zoe Goreski, Isabella Jackman, Cole Tallman, Janaye Walker

The overall objective of this project is to create a comparative design for Martin/Martin's Translational Medicine Institute. Criteria in phase one will be applied to determine the materials of the building as well as the components of full lateral-and-gravity framing system including columns, beams, and girders. Cost analysis will need to be used to determine the overall cost of not only the tasks, but the construction of the framing as well. By completing all these tasks, a presentation will be compiled and presented to the College of Engineering in May of 2020.

GDH Inc: Shambhala Center Energy Master Plan

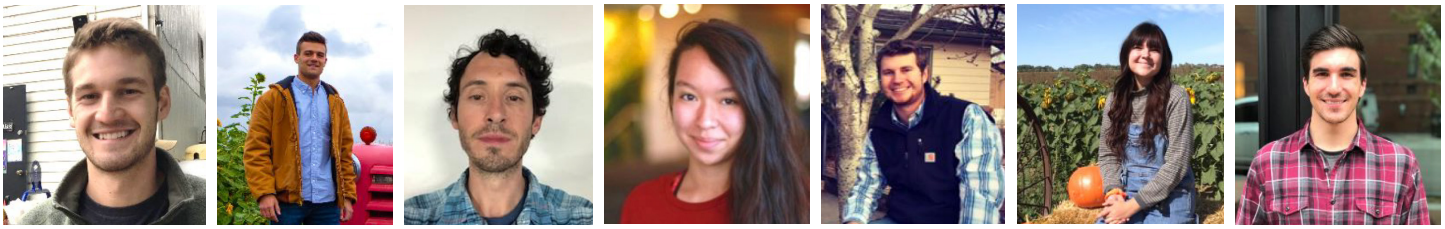
Kylie Rasmussen, Theresa O'Donnell- Sloan, Jana McKinney, Majed Alqatari, Karl Comstedt

GDH inc. has produced an energy master plan for the Shambhala Mountain Center that will aid the center's goal of achieving net-zero by 2050 through the design of a renewable energy source hub for future buildings, and increasing the efficiency of three of the main existing buildings: Shambhala Lodge, Rigden Lodge and Sacred Studies.

CIVIL AND ENVIRONMENTAL ENGINEERING

Grasshopper Engineering

Keoni Frampton, Parker Maddocks, Gene Halsey, Kaori Keyser, Caleb Maxey, Madison Jara, Wyatt Young



Grasshopper engineering is a part of the Green Sun Storage Hydro Power (GRSSHPR) Project which is the largest privately financed renewable energy, water delivery, and storage project in the western U.S. The project goal is to permit, engineer, and build several hundred miles of new staged pipeline infrastructure, providing renewable energy, hydro power, water storage, and new water supplies. Grasshopper engineering's objective is to divert 55,000-acre-feet of water annually from the Green River in Browns Park, Utah, while avoiding the use of a 404 permit (Section 404 of the Clean Water Act). Water will be delivered to existing pipeline infrastructure running from Browns Park, Utah to the I-80 energy corridor in Wyoming and finally arriving in Colorado's Front Range. The Projects' water supplies will create benefits for environmental in-stream flows, wildlife conservation, agricultural expansion, and municipal use.

Northern Colorado Civil Associates (NCCA), Structure G-21-A Replacement over Agate Creek, Elbert County

Trey Scism, Hannah Rockwell, Erik Oles, Michelle Ondrejka, Jordan Stennis, Peter Shaw

Developing a replacement structure for G-21-A over Agate creek is the objective of this project. Improvement of hydraulic performance by optimizing flood conveyance is the main requirement for the replacement structure. This design will implement a 2D model detailing the current hydraulics of the site. Once developed, the model will be used to design three potential replacement structures. Criteria will then be developed evaluating feasibility and functionality to select the optimal design.

CIVIL AND ENVIRONMENTAL ENGINEERING

MoveSmol (Micro-mobility Design Concept Study)

Danielle Koch, Josie Maher, Sophie Slade, Josh Sperry, Adji Witjaksono, Olivia Wylie, Maddy Cieciorka

MoveSmol has conducted research on current micro-mobility systems in place, and has established recommendations in hopes to increase efficiency, safety and accessibility of these devices. Improvements will be in the form of policy, management, and design changes. All research and suggestions will be summarized in a tool-box user guide, with Fort Collins as the primary example for design changes. Even though the design aspects will focus in Fort Collins, this manual is to be applicable to all cities, and help to achieve a safer environment for micro-mobility users in different communities.

Green Peak Engineering, Railroad Bridge Replacement

Alison Brown, Chaz Hogenauer, Kyle Kvietkus, Andrea Lau, Colton O'Gara, Anthony Kidd

The objective of this project was to replace an existing railroad bridge with a new expanded bridge, to allow space for additional residential and freeway lanes. Our team was tasked with designing a temporary shoring system to aid construction and specific structural elements necessary for the bridge replacement and expansion.

Trailblazing Engineering

Michael Del Pape, Ben Weiss, Natalie Robinson, Chereen Zahner, Amanda Landrum, Nathan Dunning

The Bike Roundabout and Trail Expansion Lory Trail Vietnam Bridge and Campus Loop project is aimed to design a safe, accessible, and sustainable bike path by redesigning the 4-way intersections adjacent to the Vietnam Memorial Bridge and surrounding bike paths from University Avenue to Plum and Meridian.

CIVIL AND ENVIRONMENTAL ENGINEERING

Outdoor Design Solutions

Sierra Trout, Matt Barr, Joe Johnson, Jameson Lumpkin, Jason Wooldridge, Sheridyn Randolph, Christian Peterson

Outdoor Design Solutions was tasked by the Northern Colorado Water Conservancy District to create an ADA compliant fishing pier and access path for the shores of Glade Reservoir. Two main challenges of this project were making the pier accessible by navigating the steep banks of the reservoir and allowing the pier to be utilized during peak fishing season even as the water level fluctuates. In this project, the Outdoor Design Solutions team focused on providing accessible outdoor fishing access for people of all abilities by creating a fishing pier and access path to overcome these obstacles.

Ram Air Engineering

Natalie Caves, Ryan Fenske, Clay Shaver, Brandon Headrick, Jake Harrold

Ram Air Engineering has used Christman Airfield to develop a drone research and testing facility. The "RAD Research Center" will be a hub for drone development, to include; beyond line of sight flying, aerial mapping, search and rescue and drone construction.

Poudre Protectors

Allen Lentz, Callie McAdoo, Caroline VanHorn, Joe Keaveny, Reilly Miller, Shannon Harney

The Poudre Protectors conducted an in-stream study and designed a diversion structure to assist in remediating the predicted water supply stress of the Colorado Front Range in the coming decades. A proposed pipeline meant to bring water from Utah to the Colorado Front Range will discharge water into a stream in Wyoming which later connects to the Poudre River. The Poudre Protectors determined how much water can be discharged into the stream in the effort to maximize benefits and minimize impacts, and designed a structure to safely convey and control this flow. This additional flow will provide additional environmental, societal, and recreational improvements to the region.

CIVIL AND ENVIRONMENTAL ENGINEERING

SNEGG Engineering

Taylor Ellis, Tony Gauer, Mariah Northcott, Sawyer Snode, Bryston Gartner

Our project is to redesign Meridian Avenue while also implementing a roundabout at the intersection between Hughes Way and Meridian Avenue as well as redesigning the intersection on University Avenue. The goal of the project is to adjust the intersections/street to the increase of traffic, both pedestrian/bike and automotive, on CSU's campus as safely and efficiently as possible. All while considering the aesthetics and functionality to match CSU's ever changing main campus.

Seniors Without Borders

Stephen Rencher, Chris Zabalaga, Luke Stark, Sonia Bame, Daniel Pohlen, Jackson Lines, Talia Knapp

Seniors Without Borders endeavours to provide potable water to homes in El Pital and Las Tablas, two neighboring hillside communities in El Salvador. The existing system is an obsolete and deteriorating spring that is only able to provide water to the closest of homes leaving the majority of the community with no reliable access to local water. The team has completely overhauled the current system, designing a well, disinfectant system, pump, storage tank, transmission line, and gravity-fed distribution system. Additionally, each component has been provided with an operations, maintenance, and control manual. The project has seen the close partnership of the senior design team with CSU's Rams Without Borders, as well the students and faculty of the University of El Salvador, all with the goal of helping the communities' residents to live happier and healthier lives.

PCI Big Beam Competition

Charlie Davis, Javon Anderson, Juan Soltero-Enriquez, Hugo Lezama, Kenny Bui, Sydney Schwartz

RAM Strand engineering has entered the Big Beam competition against several teams from across the nation. Tasked with the design of a beam adhering to the competition's stringent conditions, the team has designed and constructed an I-Beam that each member is proud to present.

CIVIL AND ENVIRONMENTAL ENGINEERING

RAM BTC Office Building Design

Andy Kotwica, Brandon Johnson, Taher Jamel, Conner Lindholm, Ryan Videtich, Michael Morrison, Andy Kotwica

RAM BTC team is tasked with providing the structural design for a spacious three-story, multi-use office building in Fort Collins. The project includes analyzing and comparing multiple material types and member configurations to arrive at the most economic, dependable, and constructible design for a pre-set basic floor plan. Final design is communicated via a construction drawing set. This building project will provide general office space and provide for retail stores and restaurants.

That Dam Team

Andy Volt, Jess Walker, Kassandra Krohn, Kendall LaBonde, Charlie Krejsa, Andrew Snead

That Dam Team is designing a tailings dam meant to hold back mine waste in the mountains of South America. The dam is designed to withstand an ever increasing load of mine waste, rainfall, and potentially earthquakes. That Dam Team has performed research on past failures and come up with a suitable design that will meet the needs of the mine and safely hold back the mine waste for decades into the future.

Steel Bridge Team

Matt Koenig, Kyle Simpson, Preston Quaschnick, Derek Egbert, Khaled AlSumait, Wes Walthall

The Student Steel Bridge Competition is a nationwide event sponsored by AISC to encourage civil engineering students to use their classwork in a real-world scenario by building a 1:10 model bridge that must comply with specifications set by AISC annually. Traditionally, Colorado State competes every year with the representing team led by a group of seniors working on their senior design project.

CIVIL AND ENVIRONMENTAL ENGINEERING

Waste-aholics Inc.

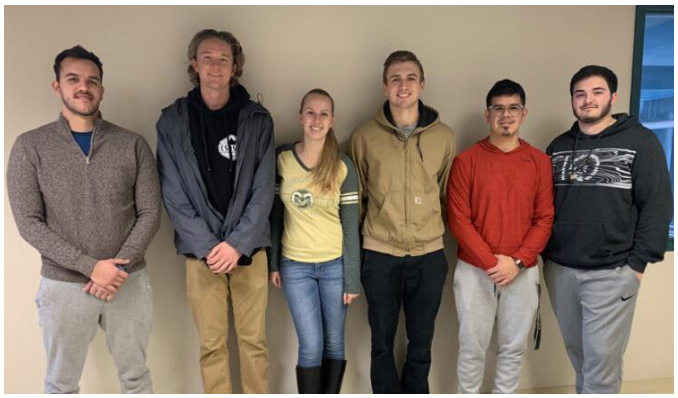
Mariah Wang, Enci Han, Saktah Alazmi, Matthew Douple, Madeline Bartell, Irena Hix

Waste-aholic INC's main goal is to meet Regulation 31 in the Las Vegas Street Water Resource Recovery Facility in Colorado Springs. BioWin, a wastewater treatment process simulator, was used to meet Regulation 31 which includes the annual averages of two nutrient limits. Primary, secondary, and tertiary treatment systems were considered for modification to reach an annual average for Total Nitrogen of 2.10 mg/L and an annual average for Total Phosphorus of 0.17 mg/L. Based on Work-aholic INC's simulations, the most effective designs were extrapolated and built upon.

JAAWS Engineering

Joesph Coleson, Aaron Marshall, Alexa Pappas, Sam Welsh, Wyatt Thomas

JAAWS Engineering has been given the opportunity to design a reservoir expansion for Milton-Seaman Reservoir. The reservoir is located 15 miles northwest of Fort Collins up the Poudre Canyon and is owned by the City of Greeley. Colorado's front range has been experiencing a large population increase, and cities such as Greeley need more available water to meet the demands of their increasing population. Creating or expanding a reservoir can allow a city to meet the rising water demands. The project objective is to increase the capacity of Milton-Seaman Reservoir from 5,000 acre-ft to 53,000 acre-ft.



CSU Lab Rats

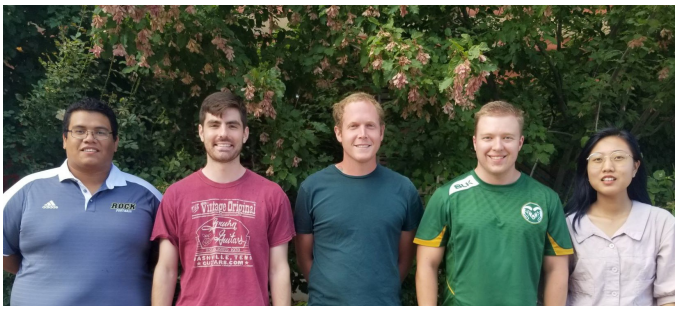
Elizabeth Dominic, Ivan Rodon Pino, Harrison Dunn, Kaleb Mora, Spencer Perry, Zach Thompson

Our task is to create complete construction drawing for a new building at the ERC Foothills campus that will house a spacious, state of the art hydraulics lab. The objective is to improve hydraulic research capabilities for CSU to remain competitive.

ELECTRICAL ENGINEERING

Active Electronic Control & Stabilization of Efficient High Power Lasers

Angel Sanchez Morales, William Delbrueck, Tong He, Michael Farrell, Peter Rhodes



Professors Jorge Rocca and Professor Mario Marconi's group is developing state-of-the-art cryogenically cooled solid-state lasers which generate kilowatts of average power. Laser prototypes and solutions to obtain high peak output will be developed. These lasers are optically pumped by laser diode arrays that produce between 6 and 8 kilowatts of average power. Due to the large amount of heat generated, the mechanical components expand causing the mirrors to misaligned. As the laser passes through successively larger amplification stages, maintaining precise alignment of the beam becomes ever more important.

5G Downlink

Bryan Hird, Matt Oliveira, Jacob Miszczak

The 5G Downlink project revolves around the RF system design flow of a n3 Band Receiver and complex transmitter. The teams objective is build upon RF Microwave courseware provided by Keysight Technologies. This courseware utilizes RF engineering techniques in tackling design challenges regarding the Receiver/Transmitter in both hardware and software.

Antenna Test Range

Kyle Oliveira, Thomas Wilkinson, Jimmy Freeman

The Antenna Test Range (ATR) is an automated antenna characterization system that provides both measurement and modeling capabilities for near and far fields between 4 - 24 GHz. The Range, constructed as a farady cage and anechoic chamber, is located inside the Electromagnetics Lab ENGR B110.

ELECTRICAL ENGINEERING

Canine Exoskeleton for Rehabilitation

Danielle Kubicek, Brendan Greenberg, Caity Costanzo, David Bieber, Elizabeth Stienike, Nick Rizzo, Mikayla Novak

The Canine Exoskeleton for Rehabilitation is an electro-mechanical orthopedic brace system built to assist with the recovery of injured or partially paralyzed dogs. Collaborating with OrthoPets and the Veterinary Teaching Hospital, our team of biomedical, computer, electrical, and mechanical engineers hope to refine and improve a prototype made by previous design teams. The project focuses on rehabilitating medium to large sized dogs with hind limb impairments due to physical injuries or neurodegenerative disorders. This year's team is creating an easy to use, variable device that minimizes the need for human assistance. Our end goal is to develop a device that will be marketable to veterinary hospitals.

ECE Student Projects Lab

Samantha Godinez, Matthew Miller, Cody Marvin

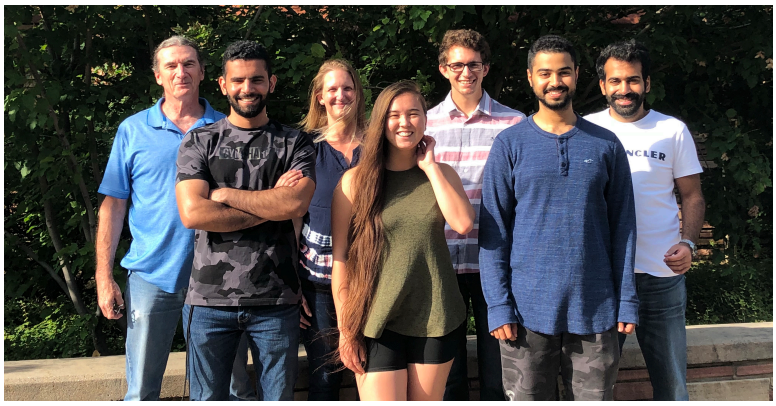
The senior design lab is a lab designated for use by engineering students working on projects for their senior design class or independent studies. This lab needs to be monitored, managed, and continuously improved by a team. This team is responsible for maintaining equipment, setting up new equipment, teaching students to use this equipment, making manuals for the existing equipment, and making overall improvements to the lab wherever possible. Our team is also responsible for addressing issues with any equipment that may be giving students problems and communicate with students about possible issues and future improvements.

Radar Calibration Using Drones

Ben Kuppinger, Eric Sprackling, Elijah J. Atchley

A research initiative to prove the feasibility of End-to-End calibration of RADARs using commercially available drones.

ELECTRICAL ENGINEERING



Energy Suitcase

Abdul Almahrooqi, Mazin Almamari, Oren Vance, Hamad Al-Foudari, Matthew Terres, Anna Grier, Sarah DeLaet

There is a need for cost-effective renewable energy options for people across the world in remote and poverty stricken areas, including Oglala Lakota County, South Dakota, home to the Pine Ridge Reservation, where over 40% of residents live without access to electricity. This can quickly become life threatening in extreme weather events with residents having no way to contact help, power medical equipment or keep critical medications refrigerated. The Energy Suitcase Team is a multidisciplinary group of Mechanical and Electrical Engineering students working in collaboration with Trees, Water, & People, a local non-profit organization, to expand upon the preexisting We Share Solar Suitcase® from We Care Solar to create a solution to supplement daily home energy needs, reduce fuel costs, and provide an emergency source of electricity.This year the team is focused on the system design and function, as well as incorporating a small insulin refrigerator for emergency use for the high percentage of diabetic residents at Pine Ridge.

Electric Plant Hardware-in-the-loop Simulator (HIL)

Dustin Rerko, Matthew Channell, Kojo Otoo

The goal of the Electric Plant Hardware-in-the-Loop Simulator team is to develop a Hardware in the Loop (HIL) simulator that can be used on future Woodward electric plant projects. The HIL simulator will be a piece of hardware that will run a software model of a simple conceptual electric plant. The model will be a physics based model of the electrical properties and dynamics of a fictional shipboard electric plant. Those electrical properties will then be transformed into real physical inputs/outputs (I/O) within the HIL Hardware. The team will be utilizing a Woodward team developed control system for the conceptual plant and Typhoon HIL devices. The goal of the Woodward control system is to observe no difference/special configuration in order to control the HIL versus a real plant.

ELECTRICAL ENGINEERING

EUV Laser Ablation Mass Spectrometer

Dr. Carmen Menoni, Chris West, Hasan Althuwaini, Tim Roberts, Sam Carlson

Mass spectrometry is an analytical technique that is used to measure the mass-to-charge (m/z) ratio of ions generated from a liquid, gas or solid sample. There are a variety of ionization techniques (laser ionization, sputtering, thermal emission, electron impact, etc.) that can be used for mass spectrometry, but our work focuses specifically on ions generated from a solid surface using laser ablation and ionization. Our project uses mass spectrometry in conjunction with an extreme ultraviolet (EUV) laser, operating at a wavelength of 46.9 nm and a photon energy of 26.4 eV, to ablate solid samples and ionize the gaseous species in the laser-created plasma with high spatial resolution. The laser breaks down the sample's surface into a gaseous plume of ions and free electrons, i.e. plasma. The ionized atoms and molecules are then directed into a mass spectrometer for discrimination and analysis. We developed components and an analysis program for two different types of mass spectrometers.

Exercise Bike

Tekoa Williams, Tyler Nobles

The Exercise Bike team seeks to teach underserved counties of Colorado with the use of a fun interactive learning experience, using an exercise bike generator that displays the process of power and how it could be used. This includes how this energy can be used to grow plants. Numerous systems and sensors will calculate and report power output, health metrics, and physical aspects of the bike, such as wattage generated (W), heart beats per minute (BPM), and revolutions per minute (RPM). Ultimately, this project will be used to teach students, young and old, science ideas covering numerous fields and inspire them to pursue math, science, and engineering. This bike will also help power a "BIOBUS", similar to an RV or trailer, which could also include solar power as a future generating source.

ELECTRICAL ENGINEERING

Novel MRI Technologies

Jeremiah Corrado, Sammie Eisenhauer, Maxine Smith

This was a research project that was focused on ultra high field strength MRI's. We designed and researched multiple geometries for RF coils and got the chance to build some of these designs. We also compared experimental MRI data to computer simulated MRI data and used that to optimize the field uniformity.

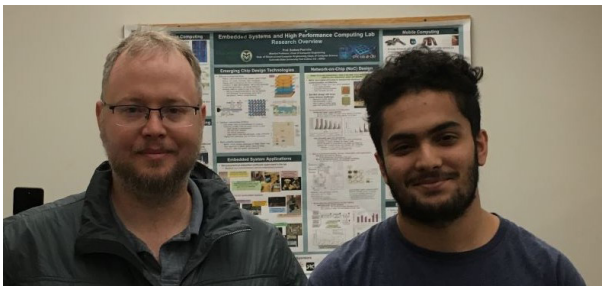
Eye of Horus

Gi Hong, Eric Lyu, Aly Ammar

The project, "Eye of Horus (EoH): A Real-Time Automated Surveillance System to Protect Citizens" aims at improving conventional surveillance systems, making them smarter and more efficient. In particular, in this project, we would like to automate the surveillance process and identify threats in real-time, while involving various parameters to identify potential threats. The project aims at improving the underlying surveillance systems to provide more targeted real- time information in a reliable and refined form down to the level of required corrective action.

Games and Assistive Technologies fOr Rehabilitation (GATOR)

Yousef Al-Foudari, Bryan Sullivan, Joshua Weiser



GATOR, Games and Assistive Technologies fOr Rehabilitation, is a cutting edge rehabilitation program that utilizes the HTC Vive, Occulus Rift, and other VR platforms for stroke rehabilitation. This is a multidisciplinary project, with Computer Engineering student Yousef Al-Foudari, and Electrical Engineering students Joshua Weiser, and ViP student Bryan Sullivan. GATOR is an entertaining and immersive alternative to more mundane forms of physical therapy, set in a virtual environment. GATOR is headed by Dr Sudeep Pasricha, who is also the Chair of Computer Engineering and Director of the Embedded Systems and High Performance Computing (EPiC) Lab. GATOR is also a collaboration project with Dr Neha Lodha, occupational therapist and Assistant Professor and Director for the Laboratory for Movement Neuroscience and Rehabilitation Health and Exercise Science at the CSU Human Performance Clinical Research Laboratory.

ELECTRICAL ENGINEERING

F/25 Beamline

Jeff May, Ryan Nedbailo

The team at Colorado State University's Advanced Beam Lab has developed a petawatt class laser with a high repetition rate. This laser is used to irradiate deuterated nanostructures at extremely high intensities (>10^21 W/cm^2), creating high energy density plasmas that can drive D-D fusion reactions for the production of bright, picosecond bursts of neutron radiation useful for imaging or calibration of detectors. Currently they use an f/2 off axis parabola with a very short focal length of 370mm, which allows them to focus down to micron spot sizes. The goal of this project is to develop a separate beamline using a f/25 off axis parabolic mirror. This will allow for the beam to focus down to a larger spot size, which is proportional to the f# in order to create a larger plasma and thus hopefully creating neutron bursts an order of magnitude greater than with the previous beamline.

Wireless playground assistant

Alvaro Molina, Jake Foster

Our project is designed to assist visually impaired children navigate their local playground while simultaneously developing their confidence and independence. The project acts as a series of wireless speakers that can be placed around the playground that, when activated will emit a sound to guide the user to its location.

Multispectral Change Detection

James Bryce

This design project involves development and implementation of an automated multispectral change detection algorithm to perform analysis on pairs of new and old images taken by a drone system. The purpose is to detect and classify any subtle change occurred between the pairs of terrain images e.g., buried objects such as IED's, vehicles tracks, and other human-made activities. Multispectral imaging was chosen so that the algorithm can detect features that are not able to be seen with a normal optical sensor, such as thermal radiation. The current application is geared towards detecting metal objects buried just beneath the surface. The procedure to accomplish these tasks includes generating a relevant data set of before and after image pairs without and with buried objects, co-registering to the images and performing canonical correlation analysis (CCA) on the data set to detect and classify any potential disturbances caused by human activities.

ELECTRICAL ENGINEERING

EcoCar CAV

Huanjia Liu, Andrew Rackow, Anisha Aswani, Wesley Taylor, Kevin Alamo-Perez, JT Bovee, Mason Cheshier, Abhishek Balasubramaniam, Joydeep Dey, Wes Taylor

The Connected and Autonomous Vehicles (CAV) portion of the EcoCar Mobility Challenge is responsible for adding autonomous features to our Chevrolet Blazer. For this year, we integrated our computing system into the vehicle, implemented forward object tracking, and rudimentary Vehicle-to-"X"(V2X) functionality.

View Project Website

Wireless Signal Characterization

Ben Fox, Matthew Clark, Jordan Leonard, Riley Ancona

The Wireless Signal Characterization project under Dr.Branislav Notaros is a pioneering electromagnetic simulation software project. This project is a continuation project and focuses on developing an accurate simulation of electromagnetic signals through the fast method of ray tracing. Verified through real world data collection, this software facilitates the deployment of wireless signal nodes and can reduce deployment times and costs significantly.

Indoor Localization For Android Smartphone

Hussain Ahmed, Tyler Engle

Our project focuses on bringing localization and navigational abilities to Android smartphones for use with indoor environments such as malls, schools and hospitals. The project utilizes the intelligent combination of lightweight inertial sensing, machine learning, and WiFi fingerprinting to determine the user's location.

ELECTRICAL ENGINEERING

Next Gen Snowflake Camera & Snowflake Sensing System

Collin Orr, Hein Thant, Blake Danis

The Next Gen Snowflake Camera and Snowflake Sensing System (SSS) Senior Design team is working to optimize the Multi-Angle Snowflake Camera (MASC) that many Senior Design teams have worked on in previous years. We hope to improve the quality of the photos that the MASC captures and refine the system's interface for simple operation. The System will then generate 3D models of the precipitate, calculate fall speed, and categorize the precipitate into six different subspecies to improve computational electromagnetic scattering analysis, all in real time.

RF Car Radar

Austin Specht

This project will involve a car radar that will be a sensor for autonomous vehicles. The board will be able to map objects using a phased array and will inform the user if there is an obstacle in the road. The radar will be able to map distance and the angle of an object using 2D array mapping and electromagnetic reflection. Research in beam forming will be done in order to optimize the radar.

On Device ML for Smartphones

Amanda Merkley, Nicholas McMahon

As classroom sizes continue to grow, the time it takes for teachers to grade assignments increases. This project's mission is to make grading easier, faster, and more streamlined.

ELECTRICAL ENGINEERING

Smart Glasses

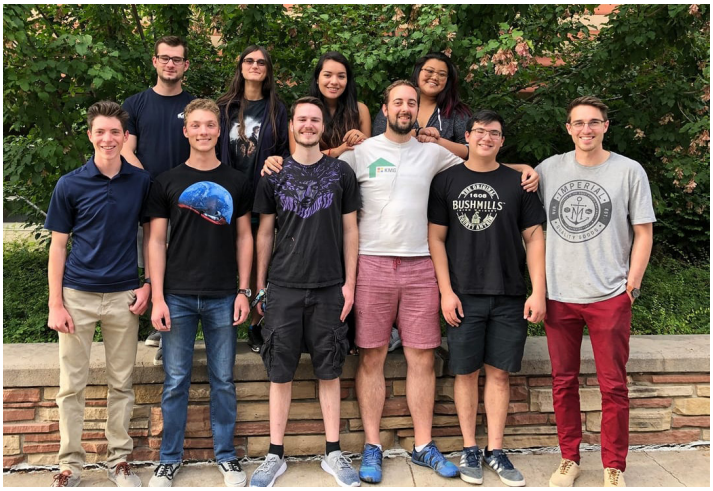
Connor Haden, Tyler Feist

The Smart Glasses project aims to relieve the symptoms of macular degeneration by using augmented reality glasses. We aim to leverage the ability of augmented reality glasses to capture real-time video and manipulate it. The video transformations include movement of problem areas to other sections of vision and magnification of problem areas. The Smart Glasses project serves as is an exciting new venture as there are no current vision assistance products on that market that utilizes augmented reality technology!

Solar Grid Integration

Abdullah Al-Ajmi, Brendon Stanley, Logan Wood, Eric Morgan, Wes Longshore

In today's society, a standard has been set to start taking an initiative in producing renewable energy as a means of providing carbon-free distributed resources to the electrical grid. Fort Collins currently has 3% power generation by solar but has plans in motion to drastically increase renewable grid penetration to 100% by as early as 2030. Given the addition of distributed resources becoming available to the grid, concerns regarding integration to the grid must be addressed. The team will look to take steps to address these concerns by designing a solar sensor network, developing data ingestion software, and completing power inverter analysis.



ECE Outreach

Jameson Richard, Ryan Barnes, Blake Danis, Kendra Ott, Jonathan Emig

ECE Outreach is a educational program designed to get high school and middle school students excited about Electrical and Computer Engineering. Our goal is to bring engaging lesson plans, demos, and workshops to young students around the CSU area to peak their interested in ECE and more generally STEM.

MECHANICAL ENGINEERING

Advanced Energy Smart Manifold

Calvin Lippert, Musaab Al-Maqbali, Kevin Hewson, Tyler Noirot

The Advanced Energy Smart Manifold project focuses on designing and manufacturing a device that is capable of measuring the properties of coolant and ambient air such as humidity, static pressure, and volumetric flow rate. The Smart Manifold will connect to Advanced Energy power supplies to monitor these properties and optimize power supply performance. The manifold is intended for commercial use and requires accurate measurement capabilities, along with a compact and inexpensive design.

Advanced Extruder Head System & User Environment

Isaac Morris, Tyler Walker, Tanner Gettel, Matt Kovacich, Kate Tarkenton, Brandon Alvarado

The goal of this team was to design and test advanced extruders on a cartesian 3D printer that can be scaled up to the dual 6-axis robot system that was installed at The Factory. The extruders are 'advanced' because of the use of feedback control and instrumentation to improve the quality and repeatability of 3D printed parts. The advanced extruder systems are capable of 3D printing typical filaments, as well as continuous fiber reinforced composites with improved consolidation and properties when compared to similar systems. A safety system and user environment was also created to fully integrate the robotic system into The Factory.

AeXonis Smart Irrigation System

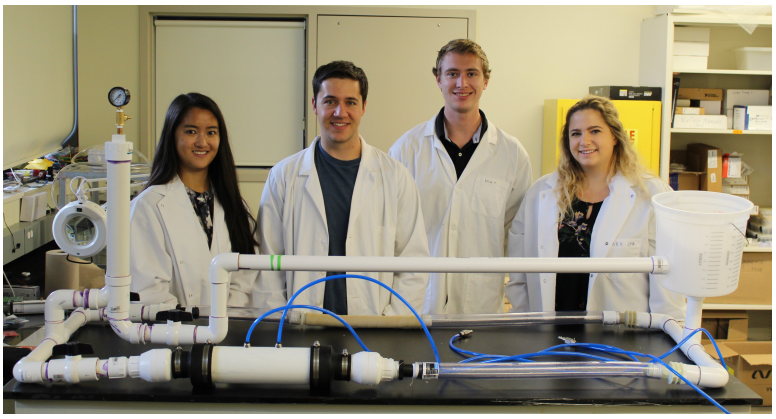
Alex Smith, Faisal Albluwi, Husam Al Habsi, Brent Setar

The agriculture industry has been unnecessarily wasting water, money, and resources for years due to the use of outdated methods of irrigation. The goal is to create a fully automated irrigation system that will be the future of agriculture and can be implemented on large scales, such as golf courses or orchards. This will provide massive economic benefits for the agriculture industry such as increased crop yield and significantly lower labor costs, as well as environmental impacts from the conservation of water.

MECHANICAL ENGINEERING

Alternative Ventricular Assist Device (AVAD)

Maddie Yarbrough, Grayson Riott, Copeland Green, Ava Ruppert



The Alternative Ventricular Assist Device (AVAD) is a nontraditional implantable heart pump prototype. Current Left Ventricular Assist Devices (LVAD) are centrifugal-flow or axial-flow pumps and have several issues including tearing of blood cells, high rates of blood clots, and high infection rates. To combat these complications, the AVAD has been designed to pump blood by constricting and expanding a flexible tube while also incorporating trileaflet artificial heart valves at the inlet and outlet areas.

ASME HPVC

Connor Tynan, Muayad Al-Marhoobi, Andy Davis, Amelia Harvey, Azam Al-Alawi, Jedidiah John

The American Society of Mechanical Engineers sponsors the annual Human Powered Vehicle challenge to encourage the development of HPVC technology. The primary focus of the project is to create a vehicle viable for third world and emission free transportation.

Audio Fireplace

Keely Morton, Nicole Duca, Violeta Flores, Jordan Miller

Our project is focused upon the research and development of audio amplified fireplaces: fireplaces of which the flames dance to music. Our prototypes are very user-friendly; a user can connect their phone or other audio device with Bluetooth or aux and the flames will react dynamically to the audio input. The focus of our project has been to demonstrate prototypes on a fire table and as an outdoor fireplace in a demo trailer.

MECHANICAL ENGINEERING

Boeing Hi Temp Composite Material System

Derek Hanson, Alex Bragg, Gryphon Nayman, Conner Piko

This project compares the manufacturability of a conventional carbon fiber/epoxy prepreg material to a higher temperature capable carbon fiber/polyimide prepreg material. The target application involves the acoustic inner wall (AIW) of a commercial aircraft engine, where the conventional composite material structural sandwich panel is shielded from high temperatures through the use of a thermal protection system. As an approach to reducing the complexity of this system, one potential option is to replace the conventional composite sandwich panel with a higher temperature capable one that can carry the required structural loads and resist the temperatures of operation. In attempting to determine the viability of such a material's replacement, an improved understanding of the relative costs of manufacturing is critical. Thus, this project compares the manufacturing processes and handling ability of the current and proposed composite materials along with evaluating the performance of different sandwich panel configurations.

LAPS V3

Mahmood Al Hadhrami, Majeed Al Wahaibi, Olivia Torres

This project aims to design, model, and build a mobile stand for a Low Atmospheric Pressure Stunning testing chamber. The stand must be mobile and have room for all components needed to test the chamber such as a pump, a control box, as-well as room for future equipment.

Solar Powered Refrigeration 3.0

Zach Gebhardt, Jason Pazmino, Cody Griffin

The Solar Powered Refrigeration Project has a goal of creating a robust, stand-alone refrigeration unit to minimize post harvest losses for farmers in least developed countries. This year's team is expanding on the previous two years by increasing measurement accuracy, efficiency of electrical components, and accuracy of modeled predictions.

MECHANICAL ENGINEERING

Caterpillar RCM

Clayton Eisenach, Daniel Kalfas, Tess Hubbeling, Victoria Mondy

The Caterpillar sponsored Rapid Compression Machine (RCM) project is a never before done high pressure injection of micron sized oil droplets into a newly designed combustion chamber. This project was created because Caterpillar experienced auto-ignition of lube oil droplets and now wants to study the effects of such ignition on combustion.

View Project Report **View Presentation**

Doc Schaeffer Enterprises Foundry Furnace

Koby Peters, Jake Edwards, Sawyer Carlton, Will Schrader

DSE will have a self manufactured gas fired furnace that will melt 50lbs of aluminum. We intend to demonstrate the melting process and talk about major components. The team will discuss components such as the combustion process, manufacturing, cost, and safety control systems. Anyone interested in learning about metal casting, control systems, and manufacturing is encouraged to come.

Terraforma Biobox

Dustin Ethridge, Riggin Bippus, Jeffrey Malik

Terraforma Biobox is a shelf size controlled environment terrarium being produced for Prof. Vamsi Nalam, Prof. Angela Bosco-Lauth and the Bioagricultural Sciences and Pest Management lab. The Terraforma Biobox is focused on making an environmentally controlled enclosure capable of maintaining an ideal climate for plant and pest cultivation in addition to providing a compact footprint and diminished pest cross contamination. The 2019-2020 Senior Design team have produced the third iteration of the project with the help of Dr. Samuel Bechara as advisor and Dr. John Petro as course instructor.

MECHANICAL ENGINEERING

Ergonomic Solutions to Custodial Services

Kameron Jones, Muath Al-Rasbi, Saud Al-Shezawi, Grayson Remington

The Ergonomic Solutions to Custodial Services team has designed a mobile trash receptacle equipped with a hydraulic lift system. Once the trash can has been filled, the unit is attached to the dumpster and raised to the height of the dumpster by a hydraulic cylinder. At the appropriate height, the trash in dispensed of in the dumpster with gravity assistance. This greatly reduces the physical impact on the human body compared to conventional methods.

Cummins Turbocharger Oil Seal Test Rig Development

Jack MacDonald, Deven Shields, Cinta Varghese, Felipe Prado

The Cummins Turbocharger senior design team was responsible developing a robust test rig that identified the minimum speed required to prevent oil from leaking without the use of combustion on a turbocharger for an ISX15 engine. The team designed, manufactured, and conducted various tests in order to deliver accurate results and data. The team created an oil supply circuit that maintained operating conditions of 40psi and 100 degrees Celsius. Additionally, the team designed a drive method that controls the speed at which the turbocharger is spun. Main drive system components include a 3hp AC Motor, a Variable Frequency Drive, and a planetary gear box.

Swing for the Stars: Special Needs Swing Set

Renee Farnes, Paige Floyd, Nick Krekeler

This project involves designing and building a custom swing set for a client who is on the autism spectrum, weighing 310 pounds, and 6'1" tall. Current public swings are not designed for an adult, making it difficult for this client to swing without painful sores and bruises resulting from the seat and chains pressing into their hips. The custom swing set will be installed at the client's home and will be built to enhance their overall experience. This custom swing will allow for both rotational and linear motion as well as be safe, comfortable, portable, and easy to use. At the end of this project, the client will be able to enjoy doing the activity they love to do everyday without consequences, and successfully swing for the stars.

MECHANICAL ENGINEERING

EcoCAR Mobility Challenge: Powertrain Systems Integration

Cole Zarinelli, Jack Cavallaro, Logan Ash, Ben Habert, Clayton Rozman, Jacob Calvert, Rj Ramcharansingh, Andris Delins, Joshua Moore

The Powertrain Systems Integration (PSI) subteam of the CSU Vehicle Innovation Team is responsible for all the components that make a vehicle move. The EcoCAR Mobility Challenge provides the team with a stock 2019 Chevrolet Blazer RS, which the PSI Team converts into a fully functional, hybrid-electric vehicle. From architecture research, to teardown, to custom designing, manufacturing, installation, and optimization, the PSI Team is very hands-on in the vehicle development process. This is year two in a four-year project prototyping the Chevy as an alternative energy vehicle designed for Mobility as a Service (MaaS). The year two goal is to have the propulsion system 65% complete with respect to full vehicle functionality; at the end of the year the team will compete with other teams in categories such as acceleration, ride quality, and fuel mileage.

EcoCAR Mobility Challenge: Propulsion Controls & Modeling

Chon Chia Ang, Elijah Sandoval, Sam White, Tommy Kirscher, Zhiyue Lu, Ethan Fonteix, Devon Fossceco, Jackson Krebill

Onboard control systems are an essential component to modern vehicles; these systems command, regulate and monitor the behavior of all automotive devices. An especially sophisticated controller network is required to ensure safety and functionality of hybrid-electric vehicles (HEVs). As CSU's EcoCAR team has converted a 2019 Chevrolet Blazer into a hybrid vehicle, the PCM team is responsible for developing a Hybrid Supervisory Controller (HSC); the HSC acts as an interface to guarantee that current systems and newly installed hybrid systems communicate and work as a coherent unit. Controller development consists of conceptual modeling, software development, and verification testing. Verification testing includes computational testing, hardware testing, and physical experiments which are performed by bench or in-vehicle.

MECHANICAL ENGINEERING

Fluid Power Vehical Challenge

Blake Franklin, Brady Patrias, Donavan Daniel, Lingqi Tang, Ross Millard, Riley Abbott

The Fluid Power Vehical Challenge is a competition based senior design project. The goal is to replace the typical chain method of power transfer on a bike to a hydraulic circuit. This completion involves three different races against teams across the nation and is put on by the National Fluid Power Association.

Baja SAE

Katie Paradis, Adam Glauvitz, James Schneider, Ryan Jones, Parker Wisma, Tanner Vaughn, Ford Rundel, Dan Hun, Drayton Browning, Wyatt Campling

Baja SAE® is a national competition that tests a team's ability to design and build a vehicle able to survive rough terrain. Projects are evaluated on design phases, manufacturing and business management. The BSAE competition brings thousands of spectators from industry and schools across the nation.

FSAE

Connor Anderson, Brandon Hellem, Austin Laurel, Chris Meduna, Kristen Yexley, Nick Domagala, Nick Penrose, Saul Arce, Trevor Stern, Vincent DeCarlo, Tyler Wilkinson

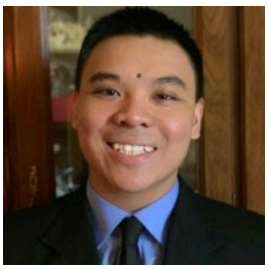
Ram Racing competes in the largest intercollegiate design competition in the world, under the governing body of Formula SAE (FSAE). We design and manufacture a single seat race car from the ground up every single year to compete against teams from across the globe. The competition consists of five dynamic events (acceleration, skidpad, autocross, endurance and fuel economy) as well as three static events (design, cost and presentation). This year the project is divided into five subsystems; Aerodynamics, Chassis, Drivetrain, Driver Interface and Suspension.

MECHANICAL ENGINEERING

Heated Sidewalk

Brooke Levine, Kilyn Reed, Robert Wagner, Henry Chhor

The Heated Sidewalk project aimed to create a cheap, sustainable way to provide heated sidewalks for society. Compared to existing heated sidewalks which cost thousands of dollars and took months to install, ours hoped to cost less than $5 per square foot and be installed in under three days. Furthermore, the system would be autonomous for all users and be targeted for the elderly and disabled that find icy sidewalks or shoveling extremely difficult. While the current system is not as attractive as consumers would like, this team is very optimistic that with enough time and dedication over the next few years, this innovation could be something everyone sees in the future!




NASA RMC: Lunabotics

Brooks Classick, Mason Deal, Nikita Khlopotin, Jade Lee, Zach Scott, Jacob Sheradin, Rick Stansbury, Kyle Vorreiter, Nathan Wallace

The NASA Robotic Mining Competition is hosted at the Kennedy Space Center every year. Collegiate teams from all states are invited to design and build robots that will be showcased and put head to head against each other to see which design performs best. This year, the competition has shifted to reflect the objectives and constraints of the exciting Artemis Program that NASA is undertaking. The robot's purpose will be to mine ice from just below the surface of the moon and deposit it where it can be used to support a permanent moon base. MAY THE BEST BOT WIN!

MECHANICAL ENGINEERING

Heavy Lift Multi-Copter

Alex Aurand, Doug Baker, Zachary Bibik, William Brown, Robert DePaoli, Jared Watkins, Jared Weber

Drone technology is currently limited by payload capacity and flight time. The objective of this project is to design and manufacture a drone capable of supporting heavy payloads. The propulsion system will be the focus of optimization. The device would benefit the package delivery, infrastructure, and public safety industries.

Thermal Management System for Li-ion Batteries for John Deere

Sam Penner, Thomas Bridges, Joel Doesken

Our team was tasked with making a mobile plug and play battery management system for John Deere (JD) which will be used for testing hybridized powertrains. The objectives of the project are to maintain a battery temperature of 25 degrees C through a wide range of operating and environmental conditions, contain the battery in the event of failure, and to easily interface with JD's existing testing equipment.

Multimedia Field Solutions

Bryce Florschuetz, Ryan Staab, Yaseen Al Lawati, Blaze Johnson

The Multimedia Field Solutions team was driven to create an innovative solution to media transportation needs. Our cart has been designed to effectively transport media equipment from a car to a site while integrating designs such as collapsibility and a mobile workstation. This cart has been designed to traverse across varying terrains allowing for more accessibility and media coverage.

MECHANICAL ENGINEERING

Remote Livestock Monitoring Project

Connor Craddock, Ryan Thamert, Emerson Davis, Brendan Abel

The Remote Livestock Monitoring project is a proof of concept project looking into how to track cattle on large ranches using drones. This project is a joint project with the Mechanical Engineering Department and the College of Agricultural Sciences. The project began with the need to easily and frequently track cattle for research purposes. The current methods of doing so are either expensive or take more than a day to get results. With our drone system we hope to have less expensive operation and quicker results.

Riff Raff Brewing Team

Warren St. George, Tyler Mellinger, Ben Platt, Kaitlyn Baker

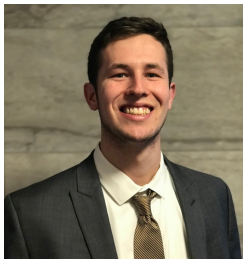
Riff Raff Brewing Company located in Pagosa Springs is committed to making and selling "Earth Powered Beer". Its original location utilizes the city's geothermal grid to heat their water and is the second brewery in the United States to do so. Two months ago their second location down the street began operation. The goal of this project is to use solar energy to heat up the water that is used in the brewing process and cleaning of the brewing equipment. This system will be used to offset the natural gas system that is currently in place.

MECHANICAL ENGINEERING

Spaceport America Cup Rocket Team

Mason Mill, Dylan Newell, Susan Ossareh, Caitlin Robinson, Patrick Stauffer, Katie Thorne, Matt Willman, Brye Windell, Nicole Kindred, James Edward Fisher, Danelle Lazcano, Hannah Zimmerman, Rob Bescheinen-Hajdas

Colorado State University has participated in the Spaceport America Cup competition for the last five years and has given seniors in engineering the opportunity to demonstrate their knowledge in rocket design. The competition is hosted in Las Cruces New Mexico and has more than 125 competing teams from all around the world. Universities and clubs enter the 10,000ft or 30,000ft altitude category by using liquid, hybrid or solid propellants. Our mission is to beat our previous record of 10,000ft altitude using a custom built nitrous oxide and ethanol liquid motor rocket to a new height of 30,000ft while carrying a muon detection payload. As a diverse and highly technical team of 13 senior design students, we are confident and dedicated to reaching our goal of 30,000ft altitude to break records at the Spaceport America Cup competition.



STP Array Team

Matthew Hoefler, Linden Howard, Tanner Foreman, Levi Nicholson

The STP Array Senior Design Team has researched, designed, and prototyped a fully functional solar array for use on small satellite spacecraft. Solar arrays are used extensively on almost all satellites on orbit around the Earth and on orbits of other terrestrial bodies throughout our solar system. The STP array is unique in that every single component used in this array is made of high strain composite parts that allow the array to self deploy without the need for heavy mechanical components such as motors or gear trains. The information presented to the public about this array is limited due to ITAR restrictions.

MECHANICAL ENGINEERING

Titan Robotics: Robotic Additive Manufacturing

Dan Moody, Nick Siler, Jon Wempe, Gabe Baranovsky

The purpose of this project is to create a 5-axis 3-D printer using an ABB robotic arm and an extruder head provided by Titan Robotics. 5-axis 3-D printers have advantages over traditional 3-axis printers. The additional mobility of the extruder head allows it to print more complex curves and because the extruder head can always print normal to the part's surface, the prints are stronger with less need for support which can result in faster prints.




CSU Woodward Fire Team

Haley Lang, Bryan Wenzel, Jacob Stier, Riley Fantasia

The CSU Woodward Fire Shield team was tasked with redesigning the fire shield used on Woodward's Active Clearance Control Valves. The ACCV are aluminum valves used for directing air inside an aircraft engine and require protection in the event of an engine fire. This project comes in light of the problems created by the incumbent design which include manufacturing difficulties, subjectivity to handling damage, and galvanic corrosion of the valve. The CSU team obtained samples from advanced material suppliers and evaluated each sample's feasibility to be incorporated in a new shield design.

Woodward Fuel Flow Control Valve

Jared Ham

The Woodward Fuel Flow Control Valve team is creating a mass flow control valve for use in industrial power plants. The team was tasked with creating a valve with an integrated shutoff system that could operate at up to 3,000 PSI and flow rates up to 165 GPM while maintaining a pressure drop of less than 150 PSI.

A/F Ratio Dithering & Three Way Catalyst Performance on Stoichiometric Engines

Andrew Jones

Engine emissions are a growing concern in the 21st century, and stationary spark-ignited natural gas engines are currently faced with strict emissions limits. Exhaust after-treatment systems, such as the three-way catalyst, can be used to drastically reduce emissions of regulated pollutants at a relatively low cost. This project aims to investigate advanced air-fuel ratio control strategies and their effects on three-way catalyst effectiveness.

Bioaerosol Fluorescence Characterization with the Portable Optical Particle Spectrometer

Scott Parmelee

Bioaerosols are a small but potentially dangerous segment of the atmosphere. The propensity for bioaerosols to carry dangerous viruses, bacteria and environmental toxins has led to intense research on tracking and quantifying particle location and composition. Current technologies identifying bioaerosols are either cost prohibitive or limited to use by skilled individuals with specialized laboratory equipment. The development of a low cost and portable bioaerosol detection and quantification sensor permits for wide scale, real time, bioaerosol data collection and analysis. The objective of the research was to design and produce a prototype bioaerosol sensor, utilizing the Portable Optical Particle Spectrometer (POPS) platform and additional optics, to make real time measurements of bioaerosol fluorescence.

Blast Mitigation Analysis & Barrier Design

Kellan Sullivan

The use of explosives as a form of terrorism, specifically improvised explosive devices (IEDs), has grown in popularity over the last few decades for its effectiveness in ensuring mass casualties and damage to communities. Most of the existing research focuses on how to design and protect structures from blast loading through the use of large, robust and immobile barriers. However, little research has been done on developing methods for protecting people in large open spaces from blast loading. The purpose of this research is to develop a blast wall that's sole purpose is to protect people within public settings that could be the site of a potential terrorist attack such as airports, concerts or marathons. Through computational modeling and finite element analysis the blast wave and the reaction of the wall is analyzed to determine the best characteristics for a blast wall that is intended to protect people while being community friendly.

Effect of Exosome Source on Tenocyte Bioactivity

Lauren Berens

Current research has demonstrated that extracellular vesicles (e.g. exosomes) have substantial potential to improve wound healing. Additionally, there has been a push for the use of cellular therapies to improve wound healing. Therefore, the purpose of this study is to analyze exosome production of different cell types and exosomal uptake of primary tendon cells given different exosomal sources. This is of clinical importance because current tendon repair strategies have up to a 95% failure rate due to poor tendon regeneration.

Measurement of Trace Atmospheric Gases

Anthony Puga

The background concentration of atmospheric methane has been steadily rising over the past decade. Anthropogenic sources such as agriculture and the oil and gas industry account for 60% of Methane emissions into Earth's atmosphere. Our project works on the development of a mobile methane sensor that uses open-path cavity ring-down spectroscopy in order to accurately measure methane plumes caused by anthropogenic sources.

Variable Power Generation With Carbon Capture & Thermal Energy Storage

Ethan Markey

Wind and solar energy production technologies are contributing more and more to the electricity grid in the United States. However, wind and solar technologies alone are not sufficient to cover all of our electricity needs because they only produce energy when the wind blows and the sun shines. In order to assist the implementation a low carbon energy economy, this project has analyzed the economic potential of retrofitting a natural gas combined cycle fossil fuel power plant with CO 2 absorption technology, and thermal energy storage. These retrofits allow the plant to sequester most of the exhausted carbon dioxide, while enabling it to operate at variable loads, at high capacities, to mirror the power output from the renewable sources.

Measuring Fine Particle Emissions using Unmanned Aerial Vehicles

Zach Lustig

In the past decade, airborne particle matter (PM) pollution has become an increasingly dangerous health hazard. In 2015, PM was responsible for 4.2 million premature deaths, making it the 5th ranked mortality risk in the world. This warrants frequent and thorough monitoring of air quality in areas at risk, such as those near wildfires, exhaust plumes from industrial processes and power generation, landfills, construction sites, and other similar PM sources. This study utilized a portable optical particle spectrometer (POPS) mounted to a DJI Matrice 600 Pro drone to determine PM emission rates in the plumes of a coal power plant and prescribed burns. The drone-POPS apparatus provides PM data with high spatiotemporal resolution, can be rapidly deployed, is safe to operate in hazardous conditions, and is relatively low cost, but requires more extensive research if it is to be implemented as a federally approved air quality sampling method.

Evaluation & Development a of Rapidly Deployable Ozone Measurement System

Dylan Giardina

Urbanization, industrialization, and natural events such as wildfires contribute to the ozone pollution problem in the Colorado Front Range. Short term exposure to ozone can cause respiratory irritation, while chronic ozone exposure can increase mortality risk, cause permanent respiratory damage, and increase the likelihood of respiratory cancers. Evaluating ozone pollution trends and health impacts is difficult in rural areas due to lack of infrastructure. In order to support ozone monitoring efforts in rural areas, I worked to develop and evaluate a deployable low-cost ozone sensor system.

Mechanobiology of Platelet Tethers Under Flow

Jake Null

Blood clots in vessels lead to the majority of heart attack and stroke cases. Platelet adhesion and aggregation are central to clot formation, a crucial component of which is the platelet's ability to tether to vessel walls. This research investigates the mechanics of platelet tethers and their reactions to varying flow conditions.

Plasma Diagnostic Measurements of a High-Voltage Laser Triggered Switch by Optical Emission Spectroscopy

Blake Duff

The purpose of this project is to better understand and contribute to the knowledge of high-voltage laser triggered switches (HV-LTS). A HV-LTS is a key component in pulsed powered technology systems such as those seen at Sandia National Laboratories. Diagnostic measurements are performed on the switch to understand switch closure and the plasma channel formation that follows. Optical emission spectroscopy is one form of a diagnostic measurement on plasma characteristics, which is thoroughly discussed in the results of the project presentation.

Rapid Photothermal Frontal Polymerization of Thermoset Composites

Sean Smith

Frontal polymerization (FP) is a promising curing method for the production of fiber reinforced polymer composites where the heat for curing is provided by the material itself rather than from external energy sources. FP has been previously triggered by contact thermal sources, which is not ideal in many cases. This project aims to address this shortcoming by investigating rapid, remote, photothermal initiation of FP (PTFP) using a high-power laser source. Specifically, the project has demonstrated activation times two orders of magnitude faster than reported in the literature and has shown that PTFP can be easily integrated into the traditional vacuum-assisted resin transfer molding (VARTM) process for composite manufacturing. This work presents a significant improvement in the activation of FP reaction and lays the foundation for utilizing PTFP in composite manufacturing.

The Erosion of Carbon Rocket Nozzles in a Non-Metalized Hybrid Rocket Motor

Matt Kronwall

Rocket nozzle erosion has devastating effects on engine performance and thrust. Using graphite, or carbon based, nozzles has become a simple and cost-effective solution to withstanding the harsh environment inside the combustion chamber as well as maintaining structural stability and shape. However, the erosion of graphite nozzles is greatly dependent on both fuel chemistry and combustion chamber pressure. This project aims to address how non-metalized hydrocarbon fuels as well as low combustion chamber pressure effect graphite nozzle erosion.

Thermal Management SWaP Analysis for Generic HEV Platforms

Justin Hollis

The purpose of this research is to perform a size, weight, and performance (SWaP) analysis of Hybrid Electric Vehicle (HEV) thermal management systems and to quantify the impact of adding phase change materials into the power electronics packaging to deal with the transient conditions of a typical drive cycle.

Utilization of Waste Heat for On-Site Treatment of Produced Water Using Membrane Distillation

Brandi Grauberger

The outdated produced water management method of deep well injection in the Denver-Julesburg Basin is a rising concern for the Oil and Natural Gas industry. Deep well injection requires large shipping expenses and removes water from current water cycles. The research conducted in this project considers a produced water treatment system that uses waste heat that is available at the production site. With an improved produced water management method of treatment, there will be a rise in the amount of clean water available for use, specifically in agriculture, without the need for a large energy investment. This project considers the opportunities available within the Oil and Natural Gas Industry to improve the Food-Energy-Water Nexus.

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