ENGINEERING DESIGN SHOWCASE 2016

JUNE 2, 2016
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The UC Davis College of Engineering is pleased to share with the campus community the efforts of the senior design teams and engineering clubs. Together, these students and aspiring professionals have endured hours of drafting, modeling, prototyping, testing, and analysis to complete these projects – on top of an already rigorous curriculum. The senior year coursework is the culmination of years of meticulous and precise study and presents students with the opportunity to apply their skills and knowledge in order to engineer solutions to a variety of problems and needs. The faculty and the administration of the College are proud and thrilled to host this event so that members of the public and our partners in industry can see and experience the quality of a UC Davis engineering degree. We thank our guests for their time and attention, and we appreciate our students for their hard work. Please enjoy the showcase!

A SPECIAL THANK YOU

Thank you for attending the 2016 Engineering Design Showcase at UC Davis. I want to especially thank the judges who have taken time to be here today to evaluate our students’ projects and help celebrate our students’ achievements. The College of Engineering appreciates the close relationships we enjoy with our guests from industry. Your feedback will enable our programs to improve our quality of instruction and experience of students. On behalf of the entire faculty in the College of Engineering, I am grateful you have joined us today.

Sincerely,

Jim Schaaf
Associate Dean, Undergraduate Studies
TEAM #1: 3-AXIS ROBOTIC ASSEMBLY CELL

- Department: Mechanical & Aerospace Engineering
- Team members: Jonathan Fleming, Natalie Hagler, Kyle Keating, Austin Lee, Robert MacFarlane, Andrew Pursifull
- Adviser: Dr. Steven Velinsky

This project was sponsored by Flexible Assembly Systems, Inc., a company based in San Diego, CA. The project task was to design, construct, and automate a three-axis robot that will tighten screws and install solder and glue onto a workpiece with minimal interaction from an operator. Our team’s solution consists of a standard orthogonal Cartesian X-Y-Z axis robot. A gantry design was selected for robustness. Linear motion is achieved by use of four NEMA 23 motors from Oriental Motors: two are synchronized to drive the gantry in the Y axis, one is used for the X axis gantry rail, and the third is used for the Z axis. Belt drives were used to elicit motion on the X and Y axes while a lead screw was used in the Z axis for increased position accuracy. This robot is made to interpret G-code, a machine programming language that is standard throughout the automated manufacturing industry. The operator can input a USB flash drive containing the G-code program into a touchscreen interface powered by a Raspberry Pi. The operator can then select and run a program via a custom graphical user interface (GUI) designed by team members. The motors are controlled by a tinyG motor driver board that is Arduino-compatible; the tinyG is in turn controlled by the Raspberry Pi. The primary programming language used is Python.

TEAM #2: ACCELERATION OF IMAGE RECOGNITION NEURAL NETWORK

- Department: Electrical & Computer Engineering
- Team members: Kevin Dinh, Jacob Ley
- Adviser: Dr. Soheil Ghiasi

The purpose of our design is to create a neural network that works faster, while being just as accurate, as a network running solely on CPU. With the use of an FPGA as well as memory compression, we achieve speed up of this network.

TEAM #3: ACESSARY: LAPAROSCOPIC ULTRASOUND TRANSDUCER SLEEVE

- Department: Biomedical Engineering
- Team members: Azeba Bajwa, Alagu Chidambaram, Bridget Devlin, Nikita Lim
- Adviser: Dr. Anthony Passerini

Fibroids are benign tumors that are commonly found in the lining of the uterus. Almost 70% of women over thirty develop fibroids during their lifetime. Though harmless, fibroids can sometimes grow very large and can cause pain and excessive bleeding. In such cases, treatment is required to restore the patient’s quality of life. Current treatments range from ineffective, with the use of hormonal birth control that targets fibroid symptoms, to invasive and dangerous, with a hysterectomy. Halt Medical, Inc. has created the Acessa Procedure, a laparoscopic procedure that safely and effectively destroys tumorous tissue while leaving the uterus functional and in tact. The Acessa procedure relies on a sleeve to protect the ultrasound transducer used during surgery and interface with the monitor that displays the ultrasound image. Additionally, the sleeve acts as a position sensor to orient the physician and dramatically reduces fibroid location time. The Acessa Procedure was originally designed around the Aloka transducer. Recently, BK has introduced a more ergonomic ultrasound probe that is preferred by physicians. The AcessaRy team has designed a sleeve to fit the BK transducer probe while maintaining all of its ergonomic benefits and increased the user friendliness of the sleeve through a minimalistic design with a single button control.

TEAM #4: ACCELERATION OF NEURAL NETWORK ALGORITHM FOR HANDWRITING RECOGNITION

- Department: Electrical & Computer Engineering
- Team members: Justin Lam, Perry Leong, Andre Miranda
- Course Instructor: Dr. Soheil Ghiasi

This project demonstrates how a trained neural network for identifying a handwritten number can be accelerated by using digital hardware in a field-programmable gate array (FPGA).

TEAM #5: ADAPTIVE TARGET FOR JUMPING STUDIES

- Department: Mechanical & Aerospace Engineering
- Team members: Jacob Alameda, Cyrus Caretto, Joseph Chua
- Course Instructor: Dr. Jason Moore

Our sponsor is Dr. Bryan Conrad from the Nike Sports Research Lab in Portland, OR. He is conducting studies which track the performance of shoes over time by measuring the height of repeated jumps for 30 seconds or more. These tests assume the person being tested is giving his or her best effort with every jump. However, the data collected from such studies shows that this is likely not the case. The team was tasked with designing and building an adaptive target that adjusts to the performance of the subject to encourage maximum effort on every jump. The adaptive target designed by the team is a basketball suspended from the ceiling by pulleys. The height of the basketball is controlled by a stepper motor that indicate the test subject’s jump height. With each
jump, the basketball adjusts to a position such that it will be just out of reach on the next jump.

TEAM #6: AUTOMATED BOARD LOADER

- Department: Mechanical & Aerospace Engineering
- Team members: Adam Barry, Alex Landry, Christopher O’Keefe, Micah Starr
- Adviser: Dr. Jason Moore

Micro-Vu Corporation designs and manufactures optical measurement machines. As a California based manufacturer, automation is critical to keeping costs low. To reduce labor intensive processes, Micro-Vu developed a semi-automatic cut and drill station for 14’ wooden boards in the summer of 2015. The primary purpose of this project is to design, manufacture, assemble and verify an automated board loader and unloader to fully automate the custom cut and drill station. The solution to this challenge includes pneumatics to simplify the movement of materials, brushless DC motors to transfer boards from storage locations to the infeed table, sensors for material location verification, and PLC programming for the interaction of each component. The final product has the capability of running unattended for 2 hours and only requires additional loading of material to continue production.

TEAM #7: AUTONOMOUS VEHICLE DESIGN

- Department: Electrical & Computer Engineering
- Team members: Arash Ansari, Tin Huynh, Nikhil Krishna
- Course Instructor: Lance Halsted

In this project we created a vehicle that is able to drive itself through the use of various sensors and a guided track.

TEAM #8: CHICKEN MONITOR

- Department: Electrical & Computer Engineering
- Team members: Yin Yi Chan, Ryan Marquiss, Benjamin Ryan
- Adviser: Dr. Andre Knoesen

This senior design group created two primary systems to monitor a chicken coop’s ambient environment and the chicken’s movement in and out of the coop. Temperature, humidity, and light levels were recorded and stored on an SD card along with the time each chicken entered and exited the coop. This data is useful for keeping track of each chicken in order to notice patterns of when each chicken enters the coop. This can help the owners of the coop from losing the chickens. The temperature, humidity, and light sensors can allow the owners of the coop to monitor the conditions that the chickens are facing over a given period of time.

TEAM #9: CNC CARDBOARD CUTTER

- Department: Mechanical & Aerospace Engineering
- Team members: Christopher Loos, Angelo Magliola, Jay Nagin, Silas Walker
- Course Instructor: Dr. Jason Moore

The purpose of the CNC Cardboard Cutter is to enable engineering students to engage in low-cost rapid prototyping. At present, 3D printing is the most easily-accessible rapid prototyping method available to engineering students. While 3D printing may be used to construct complex designs, it is often relatively slow, sometimes requiring several hours for larger and more complex parts. This deters many young engineering students from engaging in the engineering design process. The CNC Cardboard Cutter allows students to cut through or create fold lines on sheets of cardboard. These cut and fold lines may be used to construct 3D shapes from cheaper materials more rapidly than traditional 3D printing methods.

TEAM #10: AUTONOMOUS VEHICLE DESIGN PROJECT

- Department: Electrical & Computer Engineering
- Team members: Siu Tsui, Dinglei Xie, Yuexin Yu
- Course Instructor: Lance Halsted

This project is to design and build an autonomous race car that uses optical sensing to follow a preset course in the shortest possible time. Our team uses a small micro-controller board to interface to a servo motor, two DC drive motors and various optical sensors such as linescan and 2D cameras. Our team also builds our own DC motor control PCB for controlling the two drive motors.

TEAM #11: CONCUSSION ASSESSMENT TOOL

- Department: Computer Science
- Team members: Yvone Chau, Kevin Fu, Seanna Vien, Philson Wong
- Adviser: Dr. Xin Liu

An iOS application to allow onsite and immediate assessment by non-professionals to determine if patient has a concussion.

TEAM #12: DIGIT RECOGNITION USING ACCELERATED NEURAL NETWORK

- Department: Electrical & Computer Engineering
- Team members: Samuel Sugimoto, Chen Xie
- Course Instructor: Dr. Soheil Ghiasi

A hardware/software implementation of a neural network capable of recognizing a handwritten number. The number is provided as a 28 pixel by 28 pixel greyscale image. The neural network is accelerated via a combination of parallel processing, efficient data storage, and minimal computations. Provided a valid data set, the program will process one hundred images, each image being processed in less than 100ms while achieving an overall recognition accuracy of over 90%.
TEAM #13: DIGITAL NEURAL NETWORK

- Department: Electrical & Computer Engineering
- Team members: Bill Ma, Elmer Santos
- Course Instructor: Dr. Soheil Ghiasi

For our senior design project, we developed a neural network to detect hand-written numbers very quickly. The speedup comes from using FPGA design as it processes images faster than a single core processor.

TEAM #14: EX-VIVO NORMOTHERMIC PEDIATRIC PERFUSION CASSETTE

- Department: Biomedical Engineering
- Team members: Kyle Christopher, Ryan Dinh, Juzer Munaim, Raphael Nesheiwat, Ivania Palma
- Course Instructor: Dr. Anthony Passerini

A re-usable perfusion cassette that will enable normothermic perfusion for pediatric kidneys, thus allowing for analysis of renal viability prior to transplantation.

TEAM #15: DIGITAL SYSTEMS SENIOR DESIGN PROJECT

- Department: Electrical & Computer Engineering
- Team members: Stanley Chen, Kevin Wang, Yiu Yung Wong
- Course Instructor: Dr. Soheil Ghiasi

Using a DE1-SOC Altera FPGA, our group has implemented and accelerated a numerical handwriting detection algorithm through pipelining, parallelism, and memory management.

TEAM #16: SUBSEA LINEAR ACTUATOR AND GRIPPER

- Department: Mechanical & Aerospace Engineering
- Team members: Mohammad Ali, Martin Barba, Michael Keebler, Brian Lewis, David Myers
- Course Instructor: Dr. Steven Velinsky

Blue Robotics' thrusters use a unique “flooded” motor design in which water is constantly flowing through the motor. This design eliminates pressure cavities and provides for a high depth rating. Leveraging this technology, the design team designed, built and tested the world’s first flooded linear actuator and gripper design to be used in a subsea remotely operated vehicle (ROV). The design team’s objective was to develop an affordable mechanism, marketed for the general consumer, that can extend and grab objects underwater.

TEAM #17: FISH EGG SEPARATION AND COUNTING DEVICE

- Department: Biological & Agricultural Engineering
- Team members: Kary Liang, Sean Tang, Jessica Wilmer
- Adviser: Dr. Ken Giles

The Fish Conservation and Culture Lab of UC Davis hosts populations of Delta Smelt fish eggs. The Delta Smelt are an endangered species of fish that live exclusively in the San Joaquin River Delta. When the eggs die, they have a tendency to grow moldy, which would affect other live eggs in the culture. This device allows for the separation of live fish eggs from the dead ones. The device is also able to count the live eggs. The device uses a rotary pump that is able to draw up the eggs into a tube. Because the live and dead eggs differ in color, the device also utilizes a phototransistor and LED set up for detection of the eggs. When the eggs pass in front of the light, the device is able to sense the difference using varying voltage potentials. Once this difference has been detected, the Arduino software works to move the contact from the live/dead dish. The counting portion of the device is to fill the live egg population up to 750 eggs before starting a new culture.

TEAM #18: FPGA NEURAL NETWORK ACCELERATOR

- Department: Electrical & Computer Engineering
- Team members: Grigor Ambartsumyan, Cameron Amey, Parnya Baradaran
- Course Instructor: Dr. Soheil Ghiasi

This project is an FPGA-based system, which runs an accelerated neural network algorithm on Altera’s DE1-SoC board. Through the recognition of handwritten numbers, we test the accelerated system’s accuracy and speed-up. We compare our FPGA design with our C implementation of the neural network, achieving an accuracy of 90%+ and speed-up of 70.

TEAM #19: HOME-BREW BEER KEG CLEANER

- Department: Mechanical & Aerospace Engineering
- Team members: Russel Bryan, Tyler Chilson, Matthew Escalante, George Herrera, Nicholas Sherman
- Course Instructor: Dr. Steven Velinsky

A device that will autonomously wash and clean home-brew beer kegs at the push of a button. After mounting the keg and starting the machine, the keg will automatically be pressure washed, sanitized, and drained with the use of a nozzle-funnel system.
TEAM #20: GLYCOCUBE: RAPID DETECTION OF GLYCATED PRODUCTS

- Department: Biomedical Engineering
- Team members: Marcelo Khouri, Irena Kislyanka, Curtis Lam, Alla Polyakov, Quan Trinh
- Adviser: Dr. Anthony Passerini

With the significant rise of diabetes in third world countries, the high demand for point-of-care (POC) devices has come to the attention of many doctors. Our client Dr. Tran tasked us with creating a POC device that could rapidly detect glycate products. For those of us who aren’t endocrinologists, a quick definition is glycate products = glucose+products. We focused on the hemoglobin A1c (HbA1c) biomarker because it is well established with-in the medical field. When is HbA1c ‘produced’ within the body? HbA1c occurs when the hemoglobin protein permanently attaches to glucose. This reaction cannot be reversed; therefore, a measurement of HbA1c reflects 2-3 months of average blood glucose in the body (2-3 months = average lifespan of a red blood cell, in which hemoglobin resides). The higher amount of glucose running through the blood, the higher probability that it will attach to a hemoglobin, the higher likelihood of diabetes. From an engineering design perspective, not only did our device need to be able to operate in a low resource settings (lack of electricity outlets, exposure to temperature variation, and so on), the device also needed to come with a reasonable price tag. From these design constraints, the first GlycoCube was born. We use the direct enzymatic method (which entails many chemical processes) which induces a color difference proportional to the amount of HbA1c in a blood sample. The color change is detected by positioning a smartphone into the slot of the GlycoCube. Come check us out for a demonstration!

TEAM #21: HANDWRITTEN DIGIT RECOGNITION SYSTEM

- Department: Electrical & Computer Engineering
- Team members: Qianfeng Gao, Samin Mohammadi Kamangar, Stephen Wu
- Course Instructor: Dr. Soheil Ghiasi

In our project, we develop an FPGA based handwritten digit recognition system which is capable of reading, recognizing and displaying handwritten numbers at a fast rate. The typical input to the system is a number written in white over a black background. We implement our algorithm on Altera DE1-SoC board. We use the neural network algorithm in designing the system.

TEAM #22: MUSIC MEMENTO

- Department: Computer Science
- Team members: Alan Chan, Lucas Hom, Ling Pei Li, Qingwei Zeng
- Adviser: Dr. Xin Liu

This is a mobile application created to assist professor Peter Janata’s research on the relationship between music and spiritual relationships. Users schedule certain timeframes during which they will be randomly prompted to have a “musical moment”. During a “musical moment”, users are given the option to record what memory they want to associate with a randomly provided song excerpt.

TEAM #23: HANDWRITTEN DIGIT RECOGNITION USING NEURAL NETWORKS AND FPGA BASED HARDWARE ACCELERATION

- Department: Electrical & Computer Engineering
- Team members: Karthika Pai, Duy Phu, Quy Tran
- Adviser: Dr. Soheil Ghiasi

The goal of this project is to develop an FPGA based handwritten digit recognition system which is capable of reading, recognizing and classifying, the values of the handwritten numbers rapidly. The digit recognition system is entirely implemented on the Altera DE1-SOC board in C and Verilog and uses a complex neural network to classify numbers with a high accuracy.

TEAM #24: INSTRUMENTED BICYCLE FOR CRASH RECONSTRUCTION

- Department: Mechanical & Aerospace Engineering
- Team members: Peter Dailey, Robert Ferris, Austin Pastrnak
- Adviser: Dr. Jason Moore

Our group was tasked with designing and building a sensor array for InSciTech, a company specializing in vehicle accident reconstruction. They are interested in investigating the dynamic riding behavior of a bicycle under normal riding conditions. More specifically, they request data concerning lean & pitch angle, linear & rotational acceleration of the frame, global position & elevation, brake engagement, steering input angle, crank cadence, and wheel speed. We determined that a sensor array with a 9-axis Internal Measuring Unit (IMU), a GPS unit, flex sensors, limit switches, a potentiometer, and Hall-effect sensors can measure each of the aforementioned characteristics. We also detailed the capabilities of the BeagleBone Black and Arduino microcontrollers as data-collection devices. A power system was designed to allow for hour-long test rides along with component housings robust enough to withstand typical riding conditions.

TEAM #25: LASER MICROMACHINING FOR 304 STAINLESS STEEL

- Department: Materials Science & Engineering
- Team members: Katherine Acord, Jose Andrade, Alicia Diebner, Samantha Dris, Holten Joerger, Hannah Kearney, John Kraska, Christopher Mason, Joseph Polese, Lino Romero
- Course Instructor: Dr. Ricardo Castro, Leyla Hashemi

Laser micromachining (LMM) is a subtractive manufacturing
technique used for machining metals, polymers, and ceramics. Advantages such as, no tool and workpiece contact, minimal creation of burrs, programmability, and rapid cutting speeds enable LMM to provide the accuracy, precision and cost-effectiveness sought in the electronics industry. However, disadvantages of LMM, such as surface roughness, heat-affected zones, and scalability, are directly affected by the processing parameters used during the machining process. In collaboration with Keysight Technologies, this study endeavors to optimize the processing parameters of the Hyper Rapid 50 High-Energy laser system in order to establish an effective method for laser machining 304 stainless steel. Our approach considers maximizing feature precision while minimizing surface roughness by altering the laser power, traverse speed, pulse frequency, and pass width. Establishing these parameters allowed for strategic raster pattern layering to achieve minimal surface roughness. Results of this design project enable Keysight Technologies to decrease the preparation time for future projects involving LMM of 304 stainless steel.

**TEAM #26: NEUTROPHIL ISOLATION FROM SMALL BLOOD VOLUMES**
- Department: Biomedical Engineering
- Team members: Hessam Gharaviram, Rui Jiang, Aaron Kho, Htet Ma, Kevin Tran
- Course Instructor: Dr. Anthony Passerini

Current methods of neutrophil isolation consist of various techniques that mark and separate specific cell types from whole blood. These methods include but are not limited to centrifugation, magnetic bead marking, and cell strainers. Regardless, many of the current devices that accomplish neutrophil isolation require a volume of blood that must be obtained through venous blood draw. Venous blood draw is harmful to blood donors, because it can result in pain, bruising, and infection. The objective of this project is to develop a scaled-down method that will isolate neutrophils from a small amount of blood, which can be taken from a simple finger prick, eliminating the need for venous blood draw. Our device is a microfluidic chip that will utilize an enrichment cocktail, which marks unwanted cells with magnetic beads. The microfluidic device uses a magnetic gradient in harmony with other microfluidic interactions to separate the neutrophils from the unwanted cells. Since most of the interactions occur within the chip, it will reduce the amount of handling time that would normally result in loss of precious fluid volume and cells. In doing so, it can accomplish its goal of isolating neutrophils from small blood volumes.

**TEAM #27: PULSE OXIMETRY FEEDING TUBE**
- Department: Biomedical Engineering
- Team members: Joanna Coham, Christine Kalogeras, Aishwarya Pamula, Ryan Wright
- Adviser: Dr. Anthony Passerini

Sensors cannot be placed on the skin of burn patients, and an effective method of measuring vitals is needed during surgery. We have designed a feeding tube for burn patients that will allow accurate monitoring of pulse and oxygen saturation internally, thereby solving the difficulty of finding suitable sites on the skin for sensor placement.

**TEAM #28: PYROTECHNIC ACTUATOR INSTALLATION ROBOT**
- Department: Mechanical & Aerospace Engineering
- Team members: Gladys Abapo, Carissa Chan, Ritu Parekh, Alexander Peimann
- Course Instructor: Dr. Jason Moore

The objective of our design project is to automate, as much as possible, the installation process of a pyrotechnic actuator into a steel block. The motivation for this project stems from Sandia’s commitment in enhancing the safety of its personnel by minimizing the time that they are exposed to explosives. Additionally, the robot we design will enhance the efficiency of the installation process.

**TEAM #29: QUAIL RIDGE MESH NETWORK**
- Department: Computer Science
- Team members: YiYang Bai, Dinesh Jayasankar, Courtney Laux, Charlie Le
- Adviser: Dr. Xin Liu

In realizing Wireless Mesh Network potentials, researchers at UCD deployed QuRiNet (Quail Ridge Natural Reserve Wireless Mesh Network) about ten years ago. It sought not only to assist ecological research at Quail Ridge by providing a communications infrastructure spanning 2,000 acres, but also serve as research on WMN and on its dynamic routing protocols. The network has expanded from six nodes supporting three video cameras and few audio sensors in 2006 to currently about 44 sites with multitude of sensors. While the previous researchers established the low-level devices and some routing functionality, the current expansion of both the usage and additional communication sites demand a more modern solution. Hence, the students will need to research and develop the most proven routing and wireless protocols compatible with the existing infrastructure, perform small-scale testing, and full-scale implementation as well as its performance verification. Moreover, students will only modify the current system’s low level network and link layer with tools and methods that are used in the industry. Any algorithm used should consider infrastructure expansion or higher usage later on. The result of this reconfiguration would give biological researchers a stable wireless communication infrastructure for studying flora and fauna in the region. Furthermore, it would give future networking researchers a standard system to experimentally augment on top. While this interference-free test-bed facilitates protocol design, tuning, and easy diagnostic gathering, the students expect to encounter challenges in both real-world testing and deployment.
TEAM #30: REMOTE CROP WATER STRESS MONITOR
- Department: Biological & Agricultural Engineering
- Team members: Kelley Drechsler, Channing Ko-Madden, Alex Schramm
- Adviser: Dr. Ken Giles

Many advanced crop cultivation systems are beginning to incorporate plant water stress measurements into irrigation decision-making in order to save water by irrigating only the areas with the greatest need. We have adapted an existing perennial crop water stress sensor suite for use in annual field crops such as tomatoes. Our system has great potential for improving water use efficiency in one of California’s highest production crops, cutting the costs for food production, and increasing agricultural sustainability. Our design uses a digital camera to differentiate between leaf and soil, and a thermal IR sensor to determine the leaf surface temperature remotely. The system is integrated with a suite of other sensors, measuring wind speed, air temperature, relative humidity, and light radiation, in order to form a field-ready unit capable of uploading data to the internet in real-time. Mounted at the edge of a tomato field, this device will allow farmers to remotely monitor crop response to irrigation, in order to manage water use.

TEAM #31: SIMILAR TO GOOGLE’S DRIVERLESS CARS
- Department: Electrical & Computer Engineering
- Team members: Ian Frazier, Samuel Price, Sudharsan Sundara
- Adviser: Lance Halsted

Our task was to program an autonomous car that could traverse two different kinds of tracks in as short of an amount of time as possible.

TEAM #32: SIMULIVER: A TRAUMATIC LIVER INJURY SIMULATOR
- Department: Biomedical Engineering
- Team members: Michael Chavez, Katherine Macway, Ryan Morgan, Brijesh Patel, Chaithra Sathisan
- Adviser: Dr. Anthony Passerini

General surgery residents receive little to no opportunity to practice hemorrhage control of traumatic liver injury during their residency, often performing these procedures for the first time in an emergency setting. Modern standard procedures utilize pigs to practice these surgical techniques, but this is both expensive and does not provide an anatomically accurate training experience. Additionally, artificial models have not been well adopted since they are neither economically feasible nor provide a well-rounded training experience. Hence, this necessitates an alternative method for resident surgeons to practice traumatic liver surgeries as open surgical simulators have proven to increase residents’ skills in surgery. Learning and practicing lifesaving interventions prior to performing them on patients would give resident trainees the needed expertise to deal with these injuries in their upcoming careers as practicing general surgeons. Our objective is to develop an open, hemodynamic simulator for liver surgery that is affordable, reusable, anatomically similar, and accurate in recreating liver hemorrhaging. SimuLiver creates a holistic environment for a resident to experience traumatic liver surgical interventions through a pre-injured, diagnosable synthetic liver simulator. The device will bleed through the incision in the liver and internal vessels, simulating an injury that would be seen in an operating room. Overall, SimuLiver will provide the resident with the unique experience of practicing these vital techniques before they are to be used on a live patient in an emergency situation.

TEAM #33: SMALL-SCALE VELVET-ROLL DODDER SEPARATOR
- Department: Biological & Agricultural Engineering
- Team members: Malia Collins, Jackson Gardner, Mitchel McCarthy, Kacie Powell
- Adviser: Dr. Ken Giles

In 2000, Alfalfa was valued worldwide at $8 billion, and its value has only grown since then. Due to alfalfa being such an economically important crop, preventing any loss of yield is a concern for many. Dodder, a parasitic weed that infests fields across the country, is currently the greatest threat to alfalfa. Dodder derives all its nutrients from the alfalfa plants which causes a decrease in crop yield and an increase in harvesting costs. The key to reducing these dodder infestations is to remove dodder seed from alfalfa seed. The problem is that dodder and alfalfa seeds are virtually identical in size (3 mm diameter) and physical properties, except for the texture of their exterior; alfalfa has a smooth exterior whereas dodder has a rough exterior. This difference is exploited and used to separate the dodder seed from the alfalfa seed using velvet rolls. Due to their rough exterior, the dodder seeds get caught on the velvet and pulled away from the alfalfa seeds. While large-scale seed separators are available, they are too large for the small-scale sorting that occurs in labs; instead they have to visually sort through the seeds with poor results. This project solves this problem by designing a small-scale, cost-effective seed separator, as well as a working prototype. This will allow the small seed labs to build their own seed separator and more effectively sort out the alfalfa seed from the dodder.

TEAM #34: SPORTING EQUIPMENT INERTIA MEASUREMENT DEVICE
- Department: Mechanical & Aerospace Engineering
- Team members: Sky Lau, Roger Monroy, Allan Perotti
- Course Instructor: Dr. Jason Moore

Traditional methods of measuring the inertia tensor require fixturing an object multiple times relative to a fixed rotation axis. A technician must be present to perform this tedious
This device offers a new method to measure the inertia tensor. Instead of repositioning the object relative to a fixed axis, the device keeps the object stationary and repeatedly changes the rotation axis. An operator loads objects onto a testing platform and reconfigures the machine to prescribed settings. In each configuration, the object performs oscillatory rotation about a single axis. The oscillation frequencies are measured and input to a program developed to calculate the inertia tensor.

TEAM #35: STEBBINS PHOTO MONITORING WEB APP

- Department: Computer Science
- Team members: Ibrahim Ahmed, Haoyao Chen, Edward Kim, Farzin Shargh
- Course Instructor: Dr. Xin Liu

Stebbins Cold Canyon Natural Reserve is a UC Davis research and teaching site in the mountains approximately 30 minutes from campus. It is also the most popular hiking destination in the region, with more than 60,000 hikers per year. Last summer, a fire burned most of the reserve. The reserve would like to set up a citizen science-based project to document fire recovery through the collection of photos at specific “photo stations.” This project is a web-based interface to upload photos to database that is created. Photos are categorized by location and date. Our Client uses these photos to create animations of changes over time.

TEAM #36: SUBSEA LINEAR ACTUATOR AND GRIPPER

- Department: Mechanical & Aerospace Engineering
- Team members: Mistrano Bui, Joshua Horn, Dai Nguyen, Adam Simko, Khoa Truong
- Course Instructor: Dr. Steven Velinsky

Due to growing interest from smaller research teams as well as hobbyists, there has been a demand for versatile, cheap and efficient subsea components to be used for remotely operated vehicles (ROVs). This project aims to develop a low-cost and durable subsea linear actuator and gripper attachment with ease of manufacturing in mind. The linear actuator is a component which is capable of exerting a linear force in order to perform a specific task such as opening and closing a gripper, locking or unlocking a cargo skid, etc, allowing the ROV a means of interacting with its environment beyond passive observation. The device is designed to operate without corrosion or binding in a range of different aqueous environments including freshwater, saltwater and chlorinated water which may contain sediment and organic matter. Following the requirements set forth by the sponsor, Blue Robotics, the actuator possesses absolute position encoding and the capability of being configured for a range of linear motion varying from 2” to 8”. Additionally the device makes use of a fully flooded design with no pressure differential and is capable of exerting at least 10 lbf with a gripping strength averaging 5 lbf using a 12V, 10W nominal power supply.

TEAM #37: TILTING TABLE

- Department: Mechanical & Aerospace Engineering
- Team members: Kiarash Haydari Shayesteh, Veronica Hing, Gabrielle Yu
- Adviser: Dr. Jason Moore

This project will involve design, construction, and validation of a device to automatically rotate a cutting tool to be perpendicular to the surface of a test specimen. There shall be minimal operator action required for alignment. The system shall operate in any orientation (i.e., mounted at up to 180-deg from horizontal) and shall be rigid and capable of holding up to 40 lbs in any orientation. When mounted, the system shall have the capability to rotate up to +/- 10- deg and should be capable of resolving 0.1-deg of rotation over a length of 12 mm. Additionally, the system should be capable of at least 75 mm of translation parallel to the cutting tool axis. After adjustment, the system must stay locked in place +/- 5 μm. The system shall fit within a volume of 300 mm (L) x 300 mm (W) x 200 mm (H), shall have sufficient open space to fit a cutting tool (details to be provided) and shall weigh less than 20 lbs. A software interface is required to operate the alignment system. The software should allow for automatic alignment as well as manual control of the system.

TEAM #38: TRAUMATIC BRAIN INJURY DATA ASSESSMENT TOOL

- Department: Biomedical Engineering
- Team members: Austin Dunn, Michaela Gobron, Lydia Lui, Jin Matsumoto, Mandeep Sandhu
- Course Instructor: Dr. Anthony Passerini

Currently monitors in Neurosurgical Intensive Care Unit (NSICU) lack in displaying the immediate status of the variables crucial to the overall health of patients suffering from Traumatic Brain Injury (TBI). Clinicians need to always be mindful of all the prescribed ranges, and our novel device aims to assist all the healthcare providers by displaying the data in a new innovative format. Our device will display data from TBI variables on a separate monitor utilizing a graphical user interface (GUI) with a green-yellow-red color scheme to display every change-of-state from the ideal, marginal, and critical regions. This way healthcare providers can easily determine if and for how long the variables deviate from their prescribed ranges. The device will serve as a data assessment tool allowing clinicians to find trends in the progression in each of the parameters. Furthermore the next most novel component of our device is the modularity. Right now the focus is on variables for TBI patients; however, other Intensive Care Units have parameters equally important to their own patients. Our technology will assist doctors and nurses throughout the hospital in analyzing patient data.
TEAM #39: WEST VILLAGE ENERGY FEEDBACK

- Department: Computer Science
- Team members: Kyle Calica, Bradley Singer, Anmol Singh, Tuan Vu
- Adviser: Dr. Xin Liu

Consumer Energy Interfaces Lab is now looking to expand the feedback project to all research offices at West Village and create a digital energy feedback dashboard. The data will be collected using a hardware called HOBOloggers. We will need to create a back-end system, via HOBOlink, that will support the data needs of the dashboard design. Lastly, program the front-end of an energy feedback dashboard, a website, which will deliver frequently updating energy feedback to office occupants at four research centers.

TEAM #40: SKY BISON - DISTRIBUTED ELECTRIC PROPULSION COMMUTER AIRLINER

- Department: Mechanical & Aerospace Engineering
- Team members: Peter Chen, Chungho Cheng, Bryce Fong, Wai Lam Ho, Holly Kim, Julio Tang Hon
- Course Instructor: Dr. C.P. van Dam

The Sky Bison is a 19-passenger, hybrid-electric distributed propulsion aircraft designed in response to the NASA LARC DEP Design Challenge 2015. The Sky Bison, uses a unique propulsor configuration made possible by the advent of a distributed electric propulsion system: (1) ten 3.5 ft-diameter propellers are distributed along the span of the wing and (2) a 5.8 ft-diameter ducted fan located at the aft end of the fuselage. The span-wise distributed propellers are used in conjunction with plain flaps to achieve high lift coefficients during takeoff and landing, drastically improving short takeoff and landing performance compared to conventional high-lift systems. The aft-mounted ducted propeller ingests the boundary layer of the fuselage, re-energizing the slow-moving air and reducing wake drag. The drag reduction benefits of boundary layer ingestion manifests in a 7% increase in propulsive efficiency during cruise. The Sky Bison’s two turboshaft engines are sized to maintain maximum continuous power over the entire flight envelope, optimizing fuel efficiency. The wing has a high aspect ratio of 15, made possible by the strengths of composite materials. The Sky Bison carries a maximum payload weight of 4,275 pounds. The maximum range exceeds 3000 miles due to the Sky Bison’s highly cruise efficient propulsion system design. The Sky Bison is designed to significantly outcompete conventional turboprop commuter aircraft when it enters commercial service in 2025.

TEAM #41: THE PHOENIX

- Department: Mechanical & Aerospace Engineering
- Team members: Manuel Felix, Erick Galeano, Victor Macias, Gregory Shelton, Lea Spongberg, Hanna Tears
- Course Instructor: Dr. C.P. van Dam

This design is a submission for the 2015/16 AIAA Foundation Student Design Competition. It is an undergraduate team effort to design an aerobatic light sport aircraft (LSA) family of two members for the sport aircraft market. Major design decisions and analysis took place during Winter and Spring Quarters to create the Phoenix I, a single seat aircraft, and Phoenix II, a tandem configuration trainer version. Each version meets FAA and ASTM standards. Both aircraft use a low wing, fixed taildragger configuration with a twin vertical tail and Rotax 912 iS engine. The incorporation of a cruise flap is an advanced technology which sets the Phoenix design apart from the competition. The cruise flap adjusts the camber in the airfoil, allowing the aircraft to perform aerobatics, including inverted flight for a minimum of 5 minutes. The unique cambered airfoil is chosen to maximize lift at zero angle of attack. The Phoenix designs aim to beat the competition in rate of climb performance of 1500 feet per second. These LSA aerobatic airplanes are designed for the re-use of at least 75% of the airframe structure and systems by weight.

TEAM #42: DISTRIBUTED ELECTRIC PROPULSION COMMUTER AIRLINER DESIGN CHALLENGE BY NASA

- Department: Mechanical & Aerospace Engineering
- Team members: Sahir Alokozai, Matthew Gabel, James MacLeod, Kuang-Ying Ting, Steven Vasquez, Omar Vega
- Course Instructor: Dr. C.P. van Dam

Mission Requirements:
- Passenger capacity: 19 passengers with a 31-inch seat pitch. Assume a passenger with baggage weighs 225 lb.
- All-weather capability, including the ability to fly in icing conditions.
- Cruise Speed: 250 mph
- Service Ceiling: 28,000 ft.
- Range Requirement: The design concept should be capable of capturing at least 90% of the 19 passenger commercial commuter aircraft market. The design range should be compatible with that goal.
- Takeoff & Landing Field Length: No greater than 3000 ft. at maximum takeoff weight at sea level standard atmospheric conditions
- Reserve requirement: FAR fuel requirements for flight in IFR conditions
- Structural design criteria are +2.5/-1.0 g with a factor of safety of 1.5.

TEAM #43: AIRSPARC - SMALL PASSENGER AEROBATIC RECREATIONAL CRAFT

- Department: Mechanical & Aerospace Engineering
- Team members: Niklas Braun, Jonathan Gonzalez, Kevin Perez, Gregory Philip, Tyler Robert, Cheyenne Steele
- Course Instructor: Dr. C.P. van Dam
Agile and lightweight, the Light Sport Aircraft (LSA) category ushered into the skies a new market of sport aircraft, inspiring a range of versatile aircraft, some inherently capable of doing aerobatic maneuvers. The objective of this study was to design an aircraft that fits within the numerous design requirements while also being original, inspiring and thus unconventional. This was achieved by studying the present market of light sport aircraft followed by identifying key requirements that would be needed to make an aircraft very capable of performing in the aerobatic competition set forth by the AIAA. That set the blueprint for the various design choices that had to be made such as the forward swept wings coupled with the pusher configuration. With the CAD model aid of a preliminary design, every component of the aircraft was carefully studied, analyzed so as to understand the consequence of the choices made. The study was further deepened by conducting a weight, aerodynamics, stability and performance analysis, the results of which helped the team AirSPARC (Small Passenger Aerobatic Recreational Craft) make informed decisions.

**TEAM #44: DISTRIBUTED ELECTRIC PROPULSION COMMUTER AIRLINE DESIGN CHALLENGE: TEAM LEVIATHAN**

- Department: Mechanical & Aerospace Engineering
- Team members: Kel De La Trinidad, Sonia Gonzalez, Chin Yang Lui, Russell Manalo, Kevin Saddi, Christopher Stevens
- Course Instructor: Dr. C.P. van Dam

Distributed electric propulsion (DEP) is an emerging concept that has the potential to increase aircraft performance. The Leviathan aircraft is a 19 passenger aircraft that uses DEP to reduce operational costs and remain competitive with aircraft available in today’s market. DEP allows the aircraft to use the blown-wing effect of multiple electric propellers along the span of the wing. Increased dynamic pressure over the wing, reduced downwash, and reduced wing tip vortices increase the performance of the aircraft. The aircraft has a max take-off weight of 18,600 lbs. and max take-off power of 1995 hp. The DEP reduces emissions compared to conventional fossil-fuel propulsion systems. Fuel reduction from DEP eliminates over 680,000 lbs. of CO2 emissions annually. Leviathan’s hybrid propulsion system consists of two turboshafts and six electric-driven propellers. Noise reduction is also an advantage of DEP. Lower propeller tip speeds and synchronous rotation decrease ambient noise pollution. The Leviathan exceeds 90% of the effective operational market range with a range of 544 nmi. The Leviathan will revitalize the market for small regional propeller-driven aircraft.

**TEAM #45: BEE SCALE**

- Department: Electrical & Computer Engineering
- Team members: Jeff Luu, Anthony Troxell, Wael Yehdego
- Adviser: Dr. Andre Knoesen

Entomologists require behavioral data from bees to understand the recent decline in their numbers nationwide. A weight scale with milligram precision will aid in better understanding the bees’ foraging patterns and, potentially, in identifying some of the underlying issues related to the decline in bee populations. The bee scale will provide time stamped weight data for individual bees upon entry to and exit from a monitored hive.

**TEAM #46: WEIGHING BEES**

- Department: Mechanical & Aerospace Engineering
- Team members: Lillian Gibbons, Laurel Salinas, Ryan Tucci
- Adviser: Dr. Jason Moore

In order to better understand the behavior of bee colonies, UC Davis Entomologists want to track the weights of bees and their pollen loads as they enter and exit the hive. In order to accomplish this, we have used a load cell sensitive enough to register these very small weights and incorporated the load cell into the preexisting hive. Bees are equipped with sensors that are read by RFID readers as they come and go through PVC tubes. We have accommodated this design feature by attaching a floating segment of pipe to our load cell; the bees must pass through this section, where they are weighed, in order to leave or return to their hive. The load cell integrates with an electronics system designed by UC Davis Electrical Engineering students to interpret, record, and store the collected data. Our design consists of an enclosure that houses the load cell, necessary electronics, and RFID readers. These components will be secured to a bee colony and kept inside a cooler to ensure modularity and temperature control. The final design allows entomologists to track how much pollen each individual bee contributes to the colony.

**TEAM #47: BOWEL PREP APP**

- Department: Computer Science
- Team members: Ela Amatya, Kevin Huang, Kevin Lee, Keith Lo, Guangsha Mou
- Adviser: Dr. Xin Liu

This application is designed to guide patients in preparation for a colonoscopy and will replace the current method of paper instruction distribution. It includes instructions for the five days leading up to the procedure. After an appointment date, location and current medications are inputted, the user will be alerted of any conflicts with the preparation if one exists. The user will then receive reminder notifications starting five days prior to the appointment date until the day of the appointment. The user can consult the application for FAQs (equipped with a search tool), instructions for any of the five days, and colonoscopy related videos. Additionally, the appointment date can be added to your phone calendar and directions to your appointment location may also be accessed via the application. A successful preparation is vital for a successful colonoscopy and this application’s purpose is to enforce the preparation instructions in the most effective way.
TEAM #48: LOW-COST TENSION METER
- Department: Mechanical & Aerospace Engineering
- Team members: Chris Brislawn, QingQiao Liu, Nataniel Jacobson, Nicolas Marinkovich
- Course Instructor: Dr. Steven Velinsky

Trinity Highway Products manufactures and installs various road safety systems including guardrails, crash cushions, and wire rope barriers. Currently, Trinity uses the Dillon AWT15-500844 Quick Balance Tension Meter to ensure the safety and reliability of their cable barrier systems. To measure the tension, this product uses a load cell which provides the user with a precise digital readout. While the Dillon instrument is quite accurate, it is also incredibly expensive, costing customers roughly $2000 for a device. Our task was to design a purely mechanical tension meter. The tension meter we designed uses the mechanical advantage supplied by pistons, incompressible fluids, and levers to circumvent the need for expensive electronics. It maintains the simplicity, user-friendliness, and performance standards of Dillon’s tension meter while decreasing the cost of production.

TEAM #49: MEDIASTINAL ACCESS DEVICE
- Department: Biomedical Engineering
- Team members: Thomas Brodt, Patrick Govea, Melanie Klich, Robert Weiner, Ryan Wong
- Course Instructor: Dr. Anthony Passerini

The objective of Mediastinal Access Device (MAD) is to replace the devices currently used for mediastinal access with a device that is safe, disposable, easy to use, and specialized for the mediastinal cavity. MAD will create access through the sternum, allowing for interventional radiologists of varying experience levels to pass a standard biopsy needle into the mediastinal cavity and retrieve pathologically usable lymph biopsies. Currently, access to the mediastinal cavity is only possible using dated methodologies or by placing a guiding needle parasternally. These procedures are highly invasive, difficult to perform for interventional radiologists, and most importantly, do not consistently result in useable biopsies. Current methods lack the proper safety and specialization interventional radiologists require for a mediastinal access device, leading to small biopsy samples and posing a significant risk to the patient. Using a handheld bone drill and variable depth guard, MAD will give IR’s direct access to the mediastinum in an easy to use, safe, and affordable manner.

TEAM #50: STETHOSCOPE SOLUTION FOR HEARING IMPAIRED PHYSICIANS
- Department: Mechanical & Aerospace Engineering
- Team members: Kenneth Chang, Janak Jobanputra, Anthony Leung, Shannon Tee, Victoria Ung
- Adviser: Dr. Anthony Passerini

The objective of our project is to create a solution for hearing impaired physicians to use a stethoscope while wearing Behind the Ear hearing aids together. Currently, physicians with hearing loss use amplified electronic stethoscopes to produce louder sound or visual readouts of patient’s bodily sounds. In general, stethoscopes are uncomfortable to wear due to the hard and concentrated force the ear tips push into the ear. Our device aims to mitigate both of these issues by working with the stethoscope and Behind the Ear hearing aid to make a comfortable and portable device that produces optimal sound quality for the user.

TEAM #51: WHEELCHAIR ADAPTATION FOR PHYSICAL EDUCATION PARTICIPATION
- Department: Mechanical & Aerospace Engineering
- Team members: Daniel Bender, Daniele Panganiban, Marilyn Vergara
- Adviser: Dr. Jason Moore

The purpose of this project is to develop an adaptive device that will enable a power wheelchair user to participate in physical education activities with his peers. Taking into account both the user’s limited capabilities and strong desire to play sports, our team has developed a soccer bumper frame along with a throwing arm and kicking leg combination to be activated by the user. The soccer bumper frame can be easily attached and secured to the user’s powerchair, and can be used independently of the kick/throw device if desired. When set for either the throwing or kicking position, the user can launch or kick a projectile, such as a baseball or a soccer ball, by a simple push of a button. Our design features an extending telescoping arm base that allows for further traveling distance when throwing a projectile, and can be shortened for the kicking mode. Both the kicker and the steel bumper frame are wrapped by a rubber foam material to reduce possible injuries and increase safety when in play. This device has been designed to be efficient and durable, so as to be used by the user for years to come.

TEAM #52: MITIGATING SAPROLEGNIA DAMAGE ON DELTA SMELT EGGS
- Department: Biological & Agricultural Engineering
- Team members: Brett Fergusson, Mathew Mathai, Calvin Yee
- Course Instructor: Dr. Ken Giles

Delta Smelt are fish that reside in the Sacramento-San Joaquin estuary and are currently in risk of extinction due to poor water management from the lack of incoming freshwater,
require protection from light, heat and oxygen to retain their instability, nutraceuticals are vulnerable to oxidation and reduce symptoms of diabetes, cardiovascular disease, compounds, and have been shown to improve digestion include polyphenols, antioxidants and other bioactive market for health beneficial compounds. Nutraceutical compounds represent a large and growing

development of an improved method of providing consumers with health-beneficial food additives at a lower cost.

TEAM #55: DEATH STAR PATHFINDING

• Department: Computer Science
• Team members: Mazar Farran, Justin Perona, Michael Rea, Paul Salessi
• Course Instructor: Dr. Xin Liu

The Social Sciences and Humanities Building at UC Davis, informally known as the “Death Star,” is notorious for its unique and confusing architecture. Visitors often have trouble navigating the complex structure. In response, using SVG floor plans of the building, software was developed and kiosks were installed throughout the area to help people navigate. The existing pathfinding algorithm is a recursive version of Dijkstra’s graph-distance algorithm. Due to the complexity of the maps, the application takes up to 30 seconds to generate a path. In order to improve the scalability of the pathfinding plugin being used, the team decided to write a non-recursive form of Dijkstra’s in C++ that was compiled using Emscripten to a low-level, efficient subset of JavaScript known as asm. js. The updated algorithm was integrated into the existing application and achieves run times of under a second. In addition to updating the Department of Social Sciences’ application, the team integrated their new algorithm into a general pathfinding jQuery plugin that can be used with any set of SVG maps that have the correct format. The team also wrote a program to verify the correctness of any set of SVG maps, in order to notify the user of data errors and improper syntax.
**TEAM #56: OPTIMIZED MOUNTAIN BIKE RIM DESIGN**
- Department: Mechanical & Aerospace Engineering
- Team members: Christian Lonsky, Nicholas Palomo, Daniel Reid, Wei Yan
- Course Instructor: Dr. Jason Moore

The focus of our project was to design a mountain bike rim optimized for lateral stiffness – the resistance of the wheel to sideways bending – for Felt Bicycle’s Decree mountain bike. Lateral stiffness is extremely important for bicycle wheels, especially in professional mountain biking where the wheels are subject to heavy lateral loads during sprints. The first phase of our project involved modeling our own unique rim designs in SolidWorks. Next, we performed finite element computer simulations in order to find optimal shapes for our rims and compared the performance of these rims to a baseline rim model provided by Felt. We focused on how to limit the rim thickness in non-critical regions while optimizing the thickness in high stress regions of the rim, particularly at the spoke connections, with the goal of maintaining high stiffness while decreasing the overall weight. Finally, following the technical advice on general composites design from Professor La Saponara in the MAE Department and from Felt Bicycles’ experience designing carbon fiber bike frames, we transitioned from using aluminum to carbon fiber – which is lighter and stronger than aluminum - to find the most laterally stiff layup combination. Our final optimized rim design exhibits a higher stiffness-to-weight ratio than traditional high end aluminum mountain bike rims.

**TEAM #57: MODIFICATION OF A MUSSEL-DERIVED ADHESIVE WITH A MONOSACCHARIDE AT A MACROSCOPIC SCALE**
- Department: Biological & Agricultural Engineering
- Team members: Nick Weiner, Shannel Williamson
- Adviser: Dr. Ken Giles

What can mussels and bacteria do for you? Our project aims to see if together mussel and bacterial properties can help stop bleeding after surgery by creating a waterproof surgical adhesive. Based on the plasmids created and provided by the Synthetic Biology Group at MIT and the testing techniques of Eun Young Jeon et al of South Korea, we sought to obtain macroscale measurements of a mussel foot protein-based adhesive, which works well on wet surfaces, such as bloody skin/tissue. Our project aims to ascertain whether the addition of a monosaccharide, found in a bacterial holdfast and known to have adhesive properties, would make the existing adhesive more effective.

**TEAM #58: REMOTE SOLAR-POWERED DATA COLLECTION USING UAVS**
- Department: Electrical & Computer Engineering
- Team members: Ivan Hebrio, Jonathan Marrs, Kim-Thu Pham, Justin Yau
- Adviser: Dr. Andre Knoesen

A system using a UAV that receives data from a solar-powered beacon located in a remote or agricultural area. Data collection in these areas are costly, hard to reach, and power consuming. The system design minimizes cost, easily reaches remote locations, and consumes less power compared to a data collecting antenna tower. The beacon has a power management system that switches between solar and battery power. The solar cells power the beacon and recharge the battery during daytime. The battery is used as a backup and nighttime power source. The beacon periodically collects and stores data that will be transmitted, via Bluetooth Low Energy, into a UAV’s data receiver when a connection is established. The receiver then formats and writes the data into an SD card to easily view the information.

**TEAM #59: SECOND ENDOSCOPIC ARM**
- Department: Mechanical & Aerospace Engineering
- Team members: Justin Cho, Isabella Hildalgo, Melvin Mallari
- Adviser: Dr. Jason Moore

Our sponsor, Dr. Shiro Urayama, is a gastroenterologist who utilizes an instrument called an endoscope to navigate and examine the interior of a hollow organ or cavity within the human body. Endoscopic Mucosal Resection is a procedure that utilizes this instrument along with accessories that extend from ports located on the instrument tip to remove cancerous or other abnormal tissues called lesions from the mucous membrane that lines the digestive tract. However often during this procedure flaps of meat overlap the lesions, rendering them inaccessible. With current forms of endoscopic accessory technology, uncovering this overlapping meat while performing the resection is difficult, which in turn decreases the utility and viability of the procedure. This project involves creating endoscopic forceps which move independently from the endoscope itself. The forceps must have 3-dimensional maneuverability and capable of grasping tissue and move it away from the endoscopic field for easier completion of treatment.

**TEAM #60: CHROMEBOOK FAILURE ANALYSIS**
- Department: Computer Science
- Team members: Weidong Guo, Arman Kapbasov, Zhang Liu, Jonathan Luu, Declan Zhang
- Course Instructor: Dr. Xin Liu

Failure Analysis Chrome Team One modified the embedded controller firmware of the Chromebook Pixel so upon a special sequence of angular displacement of the lid, the Chromebook will output console messages using the LED strip on the back side of the laptop screen.
TEAM #61: IMMERSIVE CALL CENTER SIMULATION

- Department: Computer Science
- Team members: Thomas Bui, Stanton Ho, Andrew Kwon, Alexander Parella
- Adviser: Dr. Xin Liu

Web application that allows for accurate and realistic simulation of a call center environment for new employee training, in addition to grading performance using multiple metrics, analyzing both speech and how accurately the trainee responds to the call.

TEAM #62: SENSORE: PRESSURE ULCER PREVENTION

- Department: Biomedical Engineering
- Team members: Vinoj Govinhasamy, Erica Ling, Jennifer Nguyen, Nazia Podana, Mary Sedarous
- Course Instructor: Dr. Anthony Passerini

Pressure ulcers are an ongoing clinical problem that have been addressed for over 75 years. These injuries predominantly occur in immobilized patients and can range from redness and blistering to the complete breakdown of the skin. The resulting injury significantly increases the duration of a patient’s hospital stay and can result in both physical and emotional suffering. Current widely-used therapies address the magnitude of pressure or the duration in which pressure is applied; these factors are indirectly related to the onset of tissue damage and, therefore, are not reliable deterministic factors of pressure ulcer formation. Thus, there is a need for a device that senses for physiological factors directly related to the onset of tissue damage caused by pressure ulcer formation and alerts nurses when immobilized patients need to be repositioned. Our device monitors for the condition of tissue as a method of prevention. When pressure is applied to an area on the body, the pressure causes blood vessel occlusion. This inadequate blood supply results in tissue oxygen deprivation, since oxygen normally diffuses into tissue from hemoglobin that is present in blood cells. Our device implements near-infrared spectroscopy, which relies on the principle of light absorbance and reflectance, to monitor tissue oxygen saturation and determine the onset of pressure ulcer formation at the sacrum. When a low oxygen saturation level is detected, our device audibly and visually notifies caretakers that the immobilized patient must be repositioned.

TEAM #63: FAST SERIES-EXPANSION FOR SYMENGINE

- Department: Computer Science
- Team members: Charles Chen, Iris Lui, Matthew Luszczak, James Stojic
- Adviser: Dr. Xin Liu

SymEngine is an open-source C++ symbolic manipulation library. While SymEngine can be used as a standalone library, it is intended to provide faster backend support for computer algebra systems written in other languages such as C, Python, Ruby, Julia and Haskell. The goal of this project is to implement computationally fast symbolic mathematical series expansions in SymEngine. Series are sums of infinite sequences. Series expansion is widely used in many fields such as physics, biology, computer science, and finances for calculating approximations of functions that cannot easily be expressed with elementary operations like addition and subtraction. Since many applications require expanding several functions into series many times for critical measurements, the speed of the implementation is particularly important.

TEAM #64: NATCAR - AUTONOMOUS VEHICLE PROJECT

- Department: Electrical & Computer Engineering
- Team members: Eliseo Campos, Surender Singh, Zacher Tiburzi
- Adviser: Lance Halsted

For the project we created a autonomously driving car. We programed micro-controllers to interface with the car motor, servo, and camera and made it follow the track.

TEAM #65: O2 AND CO2 SENSOR INTEGRATED MASK FOR AIDING CARDIOTHORACIC SURGEONS IN ASSESSMENT OF PATIENT RISK AND RECOVERY

- Department: Electrical & Computer Engineering
- Team members: Jaskaran Atwal, Brianna Myers, Chai Yang
- Adviser: Dr. Andre Knoesen

Current VO2 Max testing requires the ill patients to maximally exercise and entails testing at a certain location. Therefore, current testing is often very cumbersome for patients and doctors. Since VO2 Max testing procedures are very demanding, doctors often do not perform this test as often as they would like for their patients; doctors often estimate the risk when assessing patients without VO2 Max testing. Therefore, a less vigorous solution to pulmonary function testing for lung resection patients needs to be developed. The system (OOCOOO Mask) allows for doctors to more precisely assess patients on their pre-operative risk before lung resection surgery and their recovery after.
and corrosion and the ease of maintenance, updating, and reconfiguration provided by the utility bay. To reduce noise pollution, the SkyRunner insulates turbine noise within the fuselage, uses blended flaps, and treats the landing gear with aerodynamic fairings. Overall, the SkyRunner is a leap forward in the commuter aircraft market.

**TEAM #69: JOHNNY DEP: DISTRIBUTED ELECTRIC PROPULSION 19 PASSENGER AIRCRAFT**

- Department: Mechanical & Aerospace Engineering
- Team members: Irving Chang, Maxwell Drolet, Milani Lyman, Andrew Renwick, Patricia Revolinsky, Chinmay Trivedi
- Course Instructor: Dr. C.P. van Dam

In an effort to further push the boundaries of sustainable and innovative aviation, NASA is promoting a new design concept in aviation: Distributed Electric Propulsion (DEP). DEP breaks the paradigm by considering aircraft designs where electrically powered propulsors and the energy source are mounted independently, enabling new and exciting possibilities for improving aircraft performance parameters using innovative propulsion integration combinations and energy storage solutions, for example in the areas of emissions, cruise efficiency, and fuel consumption. This paper introduces the “Johnny DEP” conceptual design for an aircraft that utilizes NASA’s new concept of Distributed Electric Propulsion for the NASA University Challenge 2016. In particular, this 19 passenger commuter aircraft—slated for a 2025 rollout—relies on turboelectric generators that generate power to drive eight propeller motors on the wing. That enables it to cruise at 21,000 feet, with a cruising speed of 250 mph, and a range of 1300 miles, making it a clear competitor against current aircraft in the 19 passenger commuter market. This preliminary aircraft conceptual design attempts to investigate how DEP would enhance and affect this aircraft class by considering its aerodynamics, propulsion, competition, and more.

**TEAM #70: UC DAVIS AEROBATIC DESIGN**

- Department: Mechanical & Aerospace Engineering
- Team members: Aleczander Briley, Jeffrey Camerino, Trevor Davison, Thomas Graham, Kimberly Jenks, David Taylor
- Course Instructor: Dr. C.P. van Dam

The UC Davis “Space Cowboys” team developed a two-member family of aerobatic light-sport aircraft, as part of the 2015-2016 AIAA Undergraduate Team Aircraft Design Competition. The team designed the aircraft based on high-performance standards used for aerobatic competition involving extensive inverted flight and negative-g maneuvers. One of the aircraft family members is a single-seat aircraft that meets the Federal Aviation Administration regulations for Light-Sport Aircraft, and is capable of competing in the International Aerobatic Club Intermediate Category. The second family member is a two-seater aircraft that can serve as both a general sport plane and an aerobatic trainer.
Latias and Latioes are lightweight sport aircraft designed for the AIAA Undergraduate Team Aircraft Design competition. The competition’s RFP calls for a family of propeller-driven aircraft that consists of one seat and two seat models. These aircraft must have a structure commonality of 75%, low production costs, visually appealing features, and comparable maintainability and reliability to other LSA aircraft. Latias, the one seat aircraft, is designed for recreational flight and training. Both aircraft incorporate lightweight carbon composite rectangular wings, a Rotax 912 ULS piston engine modified for inverted flight, and an aesthetically pleasing V-tail configuration for reduced parasitic and induced drag. These attributes allow for loads of +6/-5 G and +6/-3 G loads, respectively, minimum ferry ranges of 300 nmi and 250 nmi, respectively, and inverted flight for a minimum of 5 minutes. In addition to the RFP’s requirements, both airplanes are designed for low drag and high aerobatic maneuverability.

The following presents the comprehensive design of a 19-passenger transport airplane that employs Distributed Electric Propulsion (DEP) to outperform conventional regional turboprop aircraft in at least one key performance area. Effective use of modern composites throughout the airframe and a 418 square foot wing leads to a takeoff weight of 14450 lbs. In order to achieve long range and short takeoff and landing performance to challenge comparable aircraft, the airplane features small leading edge propellers for takeoff in addition to the cruise propeller on each wing. The distributed electrical system powers these propellers in addition to other aircraft systems such as avionics and the Thermawing deicing strip. The 1924 horsepower necessary to power all of this is provided by a pair of turbogenerators located at the wing tips. Aside from the benefits to vehicle performance and integration that arise with the implementation of DEP, it also gives rise to several environmental considerations including vastly reduced fuel consumption and therefore CO2 emissions.

PocketLab is an Android application that will allow technologists to use an Android phone as a universal laboratory instrument. The application will utilize available on-phone sensors, as well as a blue-tooth interface board (IOIOTG) connected to readily-available low-cost analog and digital sensors that can determine a wide range of quality and environmental parameters. The primary target audience is postharvest technologists, but the PocketLab will be useful to a much wider audience, since the interface board can monitor almost any digital or analog signal. PocketLab will use the phone’s display to provide instantaneous readings from on-phone and connected sensors. It will also provide the capability of monitoring readings of selected sensors, providing on-phone graphical output, as well as writing the values to a .csv file that can be downloaded for further analysis.
analysis on a computer. The IOIOTG board is an input/output device, and can be used to control instrumentation and other devices. The PocketLab application will also include a control module to provide the opportunity to switch relays connected to the interface board (to control temperature, instrumentation or alarms). The board will be mounted in a small enclosure providing onboard battery power as well as an input for a standard 5V power supply.

TEAM #77: NEXT GENERATION SEANET CONNECTOR

- Department: Mechanical & Aerospace Engineering
- Team members: Justin Duhow, Daniel Goldin, Ryan Lorenz, Victor Quintero, Brett Stark
- Adviser: Dr. Steven Velinsky

FMC Technologies Schilling Robotics manufactures subsurface remotely operated vehicles (ROVs) and manipulator arms. The ROVs operate at ocean depths of up to 4 km and perform a variety of inspection and maintenance tasks. A proprietary multi-purpose connector called the Seanet is used to transfer power, data, video, and low pressure hydraulic oil between components and control devices. The current Seanet connector model is compact and connects to a circular mating receptacle that can be rotated freely prior to locking to allow for flexibility in the orientation of the attached cables. Schilling has requested a new Seanet connector design to address reliability issues with the current connection mechanism which does not always engage. This lack of engagement can allow the connector to flood with seawater causing damage to the ROV systems. The new connector will be simple and easy to use, with direct feedback to the user that a complete connection has been made. Additionally, a new system for bleeding air while filling the connector with hydraulic oil via a rapid fill and drain system is desired. This air bleeding system must be able to accommodate the various orientations the connector may be installed in. Finally, the new connector housing must be able to accommodate increased power and data requirements, as well as circuitry for LED status lights for operational feedback.

TEAM #78: CHEMOTHERAPY PATIENT SCHEDULING APPLICATION

- Department: Computer Science
- Team members: Rachel Church, Carl Glahn, Jett Lewis, Alex Peng
- Adviser: Dr. Xin Liu

Scheduling appointments for chemotherapy treatment can be extremely difficult due to variety of patients needs. We have been working with James Thum, the local director of oncology at Kaiser Permanente, to develop a web application that creates an optimal schedule of varying length appointments. By creating an optimal schedule, we maximize productivity of nurses and increase quality of care to the patients.

TEAM #79: VEXIMA

- Department: Biomedical Engineering
- Team members: Michael Fickenscher, Daniel Ngo, Michael Nguyen, Matthew Parish, John Sienkiewicz
- Adviser: Dr. Anthony Passerini

A portable blood sampling collection device. ICU patient’s blood are sampled continuously while in hospital care. Traditional blood sampling systems are not only slow, but they discard some of the patient’s blood before sampling. With this device, not only is the process faster, but the device completely eliminates blood waste. This device is also so light and portable that it could be used in almost any situation.

TEAM #80: MONITORING PARTICIPANT COMPLIANCE IN DAILY DIARY STUDIES

- Department: Computer Science
- Team members: Michael Dai, Alysa McCall, Aman Mishra, Surti Sundaresan
- Adviser: Dr. Xin Liu

Daily diary design, which requires participants to fill out a survey every day, is often used in social sciences to study daily variations in activity, mood, stress, etc. The Human Development Department of UC Davis has an on-going daily diary research project in which they collect data from about 200 participants for 100 consecutive days. To help them monitor their compliance, they hope to be able to send them daily email reminders containing a link to the survey, as well as summary statistics at various stages of the project (e.g., a summary of how many surveys they have completed in the middle of the study). One challenge is that participants have different start dates, and sometimes participants will miss a survey despite the daily reminders. Hence, they hope to develop a system to help monitor their compliance. For example, if a participant misses the survey 3 days in a row, the system will send an alert and we can then follow up with them. Our goal is to develop a mobile app that allows study participants to take daily surveys, and for their moderators to monitor their results and compliance.

TEAM #81: PARKING ENFORCEMENT VIA DRONES

- Department: Computer Science
- Team members: Kelvin Lu, Mark Machado, Baotuan Nguyen, Alexander Sergian
- Course Instructor: Dr. Xin Liu

Gone are the days of chalky tires. Our project explores the possibility of revolutionizing city parking enforcement with the help of quadcopters! Combining the DJI Phantom 3’s imaging capabilities with computer vision software, our drones will fly through predetermined locations to keep track of how long vehicles have been parked. Any violations are flagged in our system, and a web interface allows authorities to verify these results and send out citations.
TEAM #82: SOLAR CAR - REGENERATIVE BRAKING AND ANTI-LOCK BRAKING SYSTEM

- Department: Computer Science
- Team members: Sebastian Bloem, Christopher Ellis, Francois Demoullin, Nile Mittow
- Adviser: Dr. Xin Liu

This cross-disciplinary project focused on designing and implementing regenerative braking and an anti-lock braking system (ABS) for the UC Davis Solar Car Team. Over the course of two quarters, our team developed an electrical system to recapture braking energy as electricity to recharge a solar vehicle through a process known as regenerative braking. Furthermore, our team also developed an ABS system which prevents the wheels from locking up during braking by monitoring the state of the wheels. These systems will be utilized in the solar car being developed by the UC Davis Solar Car Team to compete in the American Solar Challenge and Formula Sun Grand Prix. These systems will extend the operational range of the solar car and increase its overall safety.

TEAM #83: SOLFLOW

- Department: Mechanical & Aerospace Engineering
- Team members: Justin Delarge, Mohammad Khan, Areeb Mehmood
- Course Instructor: Dr. Jason Moore

Our project is a battery enclosure made specifically for the UC Davis Solar car team in preparation for the American Solar Challenge and Formula Sun Grand Prix. The enclosure will be sealed from the interior of the car and house 420 Panasonic 18650 battery cells. The goal of this project is to have optimal cooling distribution for the cells so that the solar vehicle can run for a great amount of time without having to stop to cool. The choice of material for the enclosure frame is Aluminum Honeycomb panel, as this material is lightweight and satisfies the constraints given by the competitions. Within the enclosure will be the PLA 3D printed modules carrying the cells. As for how we want to achieve maximum cooling, our design will incorporate intake and exhaust manifolds which create an equal pressure distribution so that every cell within the enclosure receives the same amount of air flow, and even heat transfer. Lastly, the enclosure itself will be mounted on the chassis of the vehicle via supports on its edges. These supports ensure stability so as to prevent possible damages from driving the vehicle itself, coming across slight bumps or hurdles along the road, and any form of vibration.

TEAM #84: SOLAR CAR DUAL ANALOG BRAKING SYSTEM WITH INTEGRATED ABS

- Department: Mechanical & Aerospace Engineering
- Team members: Wilhelmena Figueiredo, Calvin Lam, Daniel Reif
- Adviser: Dr. Steven Velinsky

The UC Davis Solar Car team requires a brake system for a car that will compete in the American Solar Challenge (ASC) and the Formula Sun Grand Prix (FSGP). The car will be driven by two electric motors in the rear and this allows for energy to be recovered using regenerative braking. However, the brake force produced during regeneration is limited and cannot be relied on to stop the car. This project will focus on the design and manufacturing of an analog braking system for a solar-powered electric vehicle. In order to recover as much energy as possible and produce the necessary braking force, the system has been designed to blend the regenerative and mechanical braking. An anti-lock braking system will be integrated into the system and will prevent the brakes from remaining locked up after hard braking. The transitions between mechanical and regenerative braking should be invisible to the driver, always producing the total stopping power the driver expects. The software implementation component of the project is a Computer Science senior design project. The two teams have been working in tandem over the past six months.

TEAM #85: 3D PRINTED MICRO UAV

- Department: Mechanical & Aerospace Engineering
- Team members: Kyle Hossli, Michael Liszka, Mark Wong
- Adviser: Dr. Jason Moore

The goal of this project is to design and prototype a micro sized (less than 12 in) unmanned aerial vehicle capable of vertical takeoff and landing utilizing 3D printing technology. The final design is a 10cm x 10cm quadcopter with a 3D printed frame and all of the necessary electrical components.

TEAM #86: ACESSORI-UTERINE MANIPULATOR COMPANION TO THE ACESSA PROCEDURE

- Department: Biomedical Engineering
- Team members: Jonathan Chen, Dayna Pettit, Tanya Senna, Shahin Shams
- Adviser: Dr. Anthony Passerini

AcessORi is a uterine manipulation device designed to support the Acessa procedure, a revolutionary treatment option for uterine fibroids or tumors. AcessORi utilizes suction force to stabilize and manipulate the position of the uterus, giving physicians greater access to fibroids and greater ability to treat them, allowing afflicted women to get back to their lives without total uterus removal. AcessORi is designed to fit through a small laparoscopic port and deploy once inside the body, allowing for fast and easy patient recovery. AcessORi is an intuitive, mechanical device with a simple mission of improving treatment of a serious women’s health issue.
TEAM #87: CHROME FAILURE ANALYSIS APPLICATION

- Department: Computer Science
- Team members: Vijay Kumar, Aaron Salazar, Vincent Trinh, Jason Wong
- Adviser: Dr. Xin Liu

Android Application to detect and decode an LED signal on failure of a chrome device using computer vision techniques and the OpenCV API.

TEAM #88: CLEANING AND WEIGHING SYSTEM FOR A 1940S BEAN THRESHER

- Department: Mechanical & Aerospace Engineering
- Team members: Chun Yin Au, Nicholas DeMella, Kelvin Garcia
- Adviser: Dr. Jason Moore

The Paul Gepts Lab of the UC Davis Plant Sciences Department wants to make usability improvements to their 1940s bean thresher. After discussing the importance of their needs, our team decided to design an air-blower system that cleans out stranded beans and chaff in the interior of the thresher, and a weighing system that has the ability to organize and store data using a Raspberry Pi. A lot of beans and chaff gets stranded in the concave plate underneath the two set of drum knives in the thresher. Currently there are two air nozzles which the operators can use to manually reach into the machine and blow out the stranded biomass, but they need to disengage the drivetrain of the machine from the engine due to safety reasons, and this introduces inefficiency and wear on the clutch. The air-blower system uses the current air compressor to blow the stranded biomass back to the hopper. The system can be operated from the exterior of the thresher, eliminating the safety need to disengage the drivetrain from the engine every time they need to clean. The weighing system will help with the efficiency of the harvesting process, for which the operators can immediately find out the weight of their harvested beans, without needing to transport them to a facility to weigh them then redistribute them to clients. The weighing system will also allow data to be recorded digitally, eliminating the need for papers which have a potential to get lost.

TEAM #89: CPWEAR

- Department: Computer Science
- Team members: Alton Fong, Kevin Nguyen, Saravan Pantham, Christopher Vu
- Adviser: Dr. Xin Liu

Wearable device paired with a mobile device for CPR treatment. Allows for individuals to track their progress and monitor quality of their CPR performance. Also provides valuable historical data for individuals to gauge and improve their CPR performance in the future.

TEAM #90: DEATHSTAR PATHFINDING

- Department: Computer Science
- Team members: Andrea Brenner-Billet, Dean Lukes, Dustin Mai
- Adviser: Dr. Xin Liu

Enable visitors to the Davis Social Sciences complex to navigate using their smartphones by scanning QR codes located on walls.

TEAM #91: DEEP-SUBMERSIBLE PAN AND TILT DEVICE (SPAT)

- Department: Mechanical & Aerospace Engineering
- Team members: Yangdy Chen, Abdul Hamid, Gurpreet Kaur, Nathaniel Szumowski
- Adviser: Dr. Jason Moore

FMC Technologies Schilling Robotics is a manufacturer of work-class remotely operated vehicles (ROVs) and manipulator arms that are capable of deep sea operations. Their custom submersible pan and tilt device (SPAT) allows movement of a mounted camera and light. This provides the user of the ROV with a clear view of the manipulator arm. Our team’s project was to rethink and improve the design of the deep-submersible pan and tilt device by addressing problems faced with the current design. These include a limited field of view that consists of a conical blind spot, restrictive exterior wiring layout, and an overall design that requires extensive deck space to operate effectively. To combat these problems, our SPAT model introduces a design utilizing internal wire routing to improve cable management, and an on-axis camera alignment to improve overall field of view. Our design also has the ability to be mounted in different directions and reduces the required operational volume.

TEAM #92: AUTONOMOUS CAR PROJECT

- Department: Electrical & Computer Engineering
- Team members: Harjas Singh, Benjamin Truong
- Adviser: Lance Halsted

This project involved designing all aspects of an autonomous car including both the hardware and the software for it. This utilizes path-tracking of either a thin white line on a dark surface or a thick white line enveloped by two thin black lines on both edges.

TEAM #93: DESIGN OF A GRAPE “ROOMBA”: A ROBOTIC DEVICE FOR REDUCING WINERY WATER USE

- Department: Mechanical & Aerospace Engineering
- Team members: Erick Campos, Kyle Cubba, Jerry Li, Dai Tran
- Adviser: Dr. Jason Moore

Wineries typically use 4 to 6 volumes of water to produce one volume of wine and this only includes winery water use. Nearly all of this water is used in cleaning. With water
After the technician has located the fistula, he or she will use technology to locate the patient's fistula with high resolution. Our device, designed the Sonojector, uses Doppler ultrasound infiltration. To make the injection process more accurate, we reduce the probability of inaccurate injection, which can lead to vascular stenosis or surgical intervention. Ultimately, this improves the lifespan of fistulas, thereby reducing the need for further surgical intervention.

**TEAM #94: DEXPRO: FINGER DEXTERITY ASSIST DEVICE**

- Department: Biomedical Engineering
- Team members: Ingrid Chu, Matt Galang, Nathan Galicia, Jonathan Poon, Ahmad Saleh
- Course Instructor: Dr. Anthony Passerini

The DexPro is a纯粹机械地powered finger dexterity assist device, aiming to restore hand and finger mobility to users afflicted with C6-C7 tetraplegic spinal injury. It allows for a variety of hand and finger configurations to assist in activities of daily living that would otherwise be impossible for the user, including opening doors, carrying bags, lifting weights at the gym, etc. DexPro is based upon novel modifications of the tenodesis splint, utilizing wrist flexion to execute user-controlled contraction of their 4 fingers, while stabilizing the thumb.

**TEAM #95: DIALYSIS ACCESS NEEDLE**

- Department: Biomedical Engineering
- Team members: Philip Dorin, Elizabeth Mock, Sara Quero, Thuy Tran, Dejie Zhou
- Course Instructor: Dr. Anthony Passerini

Hemodialysis, a medical treatment for individuals who suffer from stage III or IV Chronic Kidney Disease (CKD), is used to remove toxic waste from the blood. The primary access site used by patients in the United States is an Arterio-Venous Fistula (AVF), which is the surgical connection of an artery and vein to create an area of increased blood velocity. Unfortunately, 20% of fistulas fail within the first six months of formation, while a healthy fistula only functions for three to five years. Fistula failure results primarily from inaccurate injections, which can lead to vascular stenosis or infiltration. To make the injection process more accurate, we designed the Sonojector. Our device uses Doppler ultrasound technology to locate the patient’s fistula with high resolution. After the technician has located the fistula, he or she will use the automatic injector to cannulate the fistula. The injection mechanism is optimized to insert the needle 8 mm below the surface of the skin, at a 45 degree angle. By minimizing the probability of inaccurate injection, our device reduces the need for recannulization. Ultimately, this improves the lifespan of fistulas, thereby reducing the need for further surgical intervention.

**TEAM #96: DRIVEWAY**

- Department: Computer Science
- Team members: Shai Bruhis, Christopher Chan, Gabriel Chan, Corey Ching
- Adviser: Dr. Xin Liu

Driveway is an on-demand mobile service that helps you find parking spaces. Driveway differentiates itself from the competition by creating a marketplace for users to rent their private driveways to parkers for a designated amount of time. We currently have an iPhone app, and have plans to expand to other platforms.

**TEAM #97: DRIVING SIMULATOR FOR ELECTRIC POWER STEERING RESEARCH**

- Department: Mechanical & Aerospace Engineering
- Team members: Trevor Halsted, Juan Jara, Zhanzhan Liu, Yufei Wu, Kou Xiong
- Course Instructor: Dr. Steven Velinsky

This project consisted of designing and constructing a test mount for an Electric Power Steering (EPS) system. The test mount will be used in future research conducted by the Hyundai Center of Excellence. Considerations in the design of the test mount included mimicking the ergonomics of a real vehicle, incorporating flexibility to accommodate different EPS systems, and ensuring strength and rigidity for accurate testing. In addition, the team created a dynamic model for a vehicle with EPS undergoing driving maneuvers. Simulations of the model provided estimations for the forces that the device and mount would experience during testing. Future uses of this mount will incorporate additional hardware to create a full hardware-in-the-loop driving simulator.

**TEAM #98: EDU-SCOPE: A COST-EFFICIENT SPECTROPHOTOMETER ALTERNATIVE**

- Department: Biomedical Engineering
- Team members: Jesus Aguirre, Nick Dao, Philip Manuilov, Emmanuel Silva
- Adviser: Dr. Anthony Passerini

Current-market spectrophotometers and fluorometers range in cost from hundreds to thousands of dollars. Low-budget institutions in the U.S and in developing nations utilize these types of devices for point-of-care diagnosis and treatment. The high cost of modern spectrophotometers and fluorometers makes them economically unfeasible to obtain and incentivizes the use of outdated, inaccurate devices.
We aim to construct an affordable, durable, and mobile device that is able to measure absorbance and fluorescence of toxicological substances and Green Fluorescent Protein (GFP), respectively. We aim to create an affordable spectrophotometer / fluorometer alternative that exhibits modern data accuracy standards for implementation in educational and low-budget institutions. The data obtained from absorbance measurements would permit our device to exhibit toxicological detection capabilities necessary for quality control and field-testing of mediums important to human health. Additionally, fluorescent measurements taken by our device would permit for necessary point-of-care analysis and research of GFP-tagged viral infections (Herpes Simplex, Influenza, and Adeno-Associated Viruses).

TEAM #99: ERGONOMIC FRUIT PICKING AND TRANSPORTING SYSTEM

- Department: Mechanical & Aerospace Engineering
- Team members: Cassandra Hampton, Thomas Rubio, Raeita Teymouri
- Adviser: Dr. Jason Moore

The “Ergonomic Fruit Picking and Transporting System” aims to provide a more efficient, less time-consuming, and less labor-intensive system of harvesting sensitive fruits for Cloverleaf Farm. The major products of the Cloverleaf Farm are nectarines, figs, and fruits, such as peaches and apricots, that bruise easily. The system consists of two major parts: an ergonomic tray to carry the fruits down from the trees and release them into larger containers, and a cart to transport the full containers to their barn. The tray’s floor retracts and extends to empty the fruits into containers without disturbing them. In addition, the tray has an ergonomic handle to allow the user to have a comfortable and stable grip while climbing up and down the ladder. Major features of the cart are: a sunshade, an ergonomic push handle, and a hitch to tow the cart by truck or ATV. The sides of the cart are foldable to allow the farmers to load and unload containers from all sides. With this, The Peachineers hope the “Ergonomic Fruit Picking and Transporting System” improves Cloverleaf Farm’s harvesting operation of sensitive fruits by reducing overall time and labor.

TEAM #100: SPO2 SENSOR FOR ARTERIAL LINE

- Department: Biomedical Engineering
- Team members: Victor Cruz, Paldin Bet Eivaz, Brajesh Gongal, Henry Luk, Kexun Wu
- Adviser: Dr. Anthony Passerini

Our objective is to design an SpO2 sensor that can be applied in conjunction with an arterial catheter for critical care monitoring of blood oxygen levels in burn patients. We aim to create a device that will provide real-time SpO2 measurements of blood collected in the catheter. With this information, clinicians can better determine the status of patient health, prompted by changes in pathology or treatment, in a timely manner. The sensor will be customized specifically for use with the arterial line pressure tubing, allowing for an efficient and simple application and removal process. With these design considerations, our device will address the current limitations associated with the direct blood gas sampling approach, and will provide accurate and reliable measurements of patient blood oxygen saturation levels.

TEAM #101: FORLOOPS, CHASSIS TEAM FOR THE HYPERLOOP POD DESIGN TEAM AT UC DAVIS

- Department: Mechanical & Aerospace Engineering
- Team members: Drew Ferguson, Justin Hong, Andrew Knowles, Nicole Tsugawa, Jason Yu
- Adviser: Dr. Jason Moore

Hyperloop is a state-of-the-art mass transportation concept proposed by Elon Musk and SpaceX. The proposed system will feature modular pods which travel through a circular vacuum tube at roughly 700 mph. One pod will hypothetically make the trip from San Francisco to Los Angeles in half an hour. In order to generate student interest and develop ideas, SpaceX is hosting a Hyperloop Competition at Hawthorne, California during Summer 2016. The objective of the ForLoops Senior Design team is to design and fabricate a chassis for a half-scale transport pod contracted by One Loop, the Hyperloop Pod Design Team at UC Davis which intends to operate on the track late this summer. The structure must be rigid enough to resist torsion at speed and must be robust enough to withstand intense acceleration and deceleration forces.

TEAM #102: HEAT TRANSFER SYSTEM FOR CLOUD POINT PREVENTION

- Department: Mechanical & Aerospace Engineering
- Team members: David Harizal, Anthony Mayberry, Nicholas Pichotta
- Adviser: Dr. Jason Moore

The purpose of our design project is to prevent cloud point of pure biodiesel fuel in a fuel tank of a compression ignition (diesel) engine. Cloud point induced precipitates are believed to be responsible for clogging fuel filters and other fuel components. Our design project is aimed to keep sedentary B100 biodiesel fuel above the cloud point temperature in order to prevent the issue from occurring. The objective is to develop a serviceable solution that will allow regular use of biodiesel fuels in diesel engine vehicles.

TEAM #103: MVD – METRONOME VENTILATION DEVICE

- Department: Biomedical Engineering
- Team members: Peter Burkard, Yimeng Dou, Richard Perez, Sartaj Sangha, Lingyu Zhang
- Course Instructor: Dr. Anthony Passerini

Device used to give physician greater control in delivering an accurate breath rate with a manual resuscitator. Includes three modes of sensual feedback through which to notify the user when to bag the patient.
TEAM #104: IMPROVING SANITATION IN CAMBODIA BY REFINING WETLANDS WORKS! HANDYPOD SYSTEM

- Department: Mechanical & Aerospace Engineering
- Team members: Yao Guan, Rachel Muradian, Joanne Wu
- Course Instructor: Dr. Jason Moore

The Tonle Sap Lake in Cambodia is home to around 1.5 million people. During the low water dry season, many experience poor health as the local ambient water becomes contaminated and often septic. Wetlands Works!, a social enterprise based in Cambodia, has designed a sanitation system for use with houses that float on the lake: the HandyPod. Pilot studies indicate that the HandyPod has the potential to improve sanitation conditions significantly, however there are three main obstacles to its widespread implementation: its high cost, short product life span, and slow assembly process. Team Floating Toilets is partnering with Wetlands Works to refine the HandyPod system and assembly process to increase its uptake among residents. Our two-pronged approach consists of (a) designing a support structure that reinforces weak points of the current design, thereby improving product lifespan and reducing maintenance costs and (b) developing an assembly tool kit to increase installation speed.

TEAM #105: JACK CADDY

- Department: Mechanical & Aerospace Engineering
- Team members: Paul Corcoran, Billy Gong, Tom Phong
- Course Instructor: Dr. Jason Moore

The Bus Jack Caddy was constructed to aid in the mounting and removal of a Stertil Koni JB-160 rolling jack onto a Stertil Koni Skylift. The customer, Unitrans, has installed a Skylift at their maintenance facility as of late March, 2016. The purpose of the caddy is to eliminate the need for an additional recess in the ground that would have housed the jack if it were to be kept mounted onto the Skylift thus preventing a potential safety hazard. The identified sub-problems that must be addressed for ideal caddy performance are maneuverability, lifting mechanism, and stability. The caddy must be able to withstand a heavy load while lifting the jack up to mount onto the Skylift as well as traverse various terrain such as gravel and cracks in the ground. Some features of the caddy are: carrying weight capacity of 550 lb, a strong steel construction, and a stable base size of about twelve square feet. The proposed solution is a fairly modular design comprising of a steel base with four polyurethane casters, a hydraulic jack, four telescoping support columns, and a steel platform.

TEAM #106: LINE LAUNCHER

- Department: Mechanical & Aerospace Engineering
- Team members: Matthew Cummings, Maxwell Garrow, Richard Orta
- Adviser: Dr. Jason Moore

This project is dedicated to the line launcher project with B. Dillon Engineering. The goal is for the team to take an existing handheld projectile launcher and modify it to shoot a line and payload a minimum of 100 feet, consecutively without tangling.

TEAM #107: LINKED DATA SCANNER

- Department: Computer Science
- Team members: Amanda Brindle, Kamran Jadoon, Deividas Kirsonis, Sylvia Lam, Colin Lee
- Adviser: Dr. Xin Liu

An Android application that allows users to scan a barcode rather than enter an ISBN by hand to display a rich set of bibliographic, scholarly, and contextual information. The mobile application will interact with the campus library’s current cataloguing system.

TEAM #108: MIXIT

- Department: Computer Science
- Team members: Qianhui Fan, Andrew Kaufman, Kwanil Kim, Michael Li
- Adviser: Dr. Xin Liu

Split a multi-channels AAC (Advanced Audio Coding) file into multi mono channels, and adjust the volume of different channels separately and merge selected mono channel AAC files into one AAC file.

TEAM #109: MOBILE APP FOR PROSTATE CANCER CARE

- Department: Computer Science
- Team members: XiaoLin Li, Kathy Nguyen, Kiet Quach, Andrew Tran
- Adviser: Dr. Xin Liu

This mobile app is developed in Android and is used to gather data from men on active surveillance for prostate cancer and to monitor their progress. The app aims to be patient centric and user friendly in order to facilitate ease of use and to make user data more consistent. The goal is to foster better communication between physicians and patients.
Without thromboelastography, medical personnel must resort to blind ratios when treating patients with freeze-dried plasma, blood transfusions, and administering pro-coagulant TXA. Blind ratios impart critical medical risks to patients and may result in non-therapeutic dosing, as well as life-threatening thromboembolism if excess TXA is administered. In order to expand the access of thromboelastography, we developed a point-of-care device which provides physicians with the time-based parameters of the blood coagulation cascade. Our device relies on real-time monitoring of bioimpedimetric changes which are imparted by blood plasma as blood undergoes coagulation and fibrinolysis processes. This prototype eliminates long calibration times and allows this technology to be transportable and robust enough for point-of-care applications.

TEAM #113: POND ALGAE REMOVAL
- Department: Mechanical & Aerospace Engineering
- Team members: Grace Chen, Ping Hwang, Daniel Kosykh, Zhaochun Liu
- Adviser: Dr. Jason Moore

The algae removal project has the objective of removing and/or algae and duckweed from the UC Davis arboretum to give the waterway better aesthetics. This project will work in conjunction with another project that will create a weir system in the arboretum, which will create flowing water. Our project will be applied in locations where eddies will occur due to the flow. A portable sprinkler system will be applied to push algae and duckweed into the main flow from the eddies, as these areas will be the primary problematic locations.

TEAM #114: PRODUCE FACTS MOBILE APPLICATION
- Department: Computer Science
- Team members: Helen Chac, Evan Soohoo, Nathan Truong, Edmond Wang
- Course Instructor: Dr. Xin Liu

The Produce Facts mobile app brings the UC Davis Post Harvest Produce Sheet to a new platform that makes searching for information easier. The key features of this application are online capabilities and multiple language options.

TEAM #115: RICE SILO EASY LET DOWN SYSTEM
- Department: Mechanical & Aerospace Engineering
- Team members: Pedro Carillo, Nicholas Gazinsky-Irwin, Chris Kelly, Jonathan Kornachuk, Bryant Sin
- Adviser: Dr. Steven Velinsky

In the rice industry, there are USDA standards that have to be met when selling rice to customers. Farmer’s Rice Cooperative produces USDA #1 rice, which has the highest quality standards. One of those standards is the amount of broken rice has to be less than 4% in the finished product. Broken rice is defined as any kernel that is 75% or less the size of a
TEAM #116: ROBOTIC SCARECROW
- Department: Mechanical & Aerospace Engineering
- Team members: Jeremiah Blackburn, Paul Narrea, Amit Harel, Aaron Schneider
- Adviser: Dr. Jason Moore

Pestering birds are a common problem that strawberry farmers must deal with. Today’s bird deterrents such as scarecrows or shiny tape are not very effective in scaring birds away. We have addressed this problem by developing a unique bird detection software that works together with a loudspeaker to scare birds and stop them from eating crops. The sensor consists of two cameras linked together and controlled by a raspberry pi computer. The sensor sits inside of a weather-resistant box with two openings for the cameras and the loudspeaker sits outside of this box. The Raspberry Pi runs a three-part software that detects motion, distinguishes between birds and non-birds, and measures the distance that the birds are from the cameras. The distance output can be used in further developing deterrents that use distance to more effectively scare birds. Our current deterrent is a loudspeaker attached to the bird sensor which will activate anytime a bird is detected in range. The autonomy of this system makes it unpredictable, efficient, and effective in achieving our goal: to scare away birds so that they will stop eating a farm’s crops.

TEAM #117: ROLLING TRANSFER STOOL
- Department: Biomedical Engineering
- Team members: Nicole Bonilla, Tina Li, Gabriella Orteza, Paris Tucker, Sydney Wong
- Course Instructor: Dr. Anthony Passerini

Current devices for transferring bariatric spinal cord injury patients across short distances, or transfer points, can be hazardous, unreliable, uncomfortable, and limited. These patients are unable to move independently, putting medical personnel at risk for musculoskeletal injuries due to excessive load bearing when using current transfer assist devices. These problems make it difficult for both the patient and assistant to safely and efficiently complete these transfers. Our objective is to design a safer and more user-friendly transfer assist device for bariatric patients with spinal cord injuries to use between a bed and wheelchair for long term use. More specifically, our focus is on patients with spinal cord injuries of the sixth thoracic vertebra or below, who are considered overweight or class I obese, having a BMI of 25 to 35. Our design solution is a rolling transfer stool, consisting of a modified scissor cart with wing extenders to allow for easier transfer onto and off the device and handles which fit into holes along the cart platform for therapeutic purposes and patient independence. This device creates a bridge between transfer points. This provides support for level and more stable transfers, allowing patients to feel secure to participate at their own pace. In addition, the full support and elimination of unwanted slopes due to uneven transfers reduces the required manual labor of assistants, aiming to create a better transfer solution for both the patient and the assistant.

TEAM #118: GRAFT SHEAR SENTINEL
- Department: Biomedical Engineering
- Team members: Michael DePass, Kyle Juchau, Shalin Patel, Gary Root
- Course Instructor: Dr. Anthony Passerini

Patients who experience serious burns on their bodies may require a skin graft procedure in order to introduce healthy tissue to these damaged areas. However, nearly a third of skin grafts fail to take, potentially due to the presence of high shear stress arising from various sources such as patient readjustment in a hospital bed. Currently there is no device on the market to quantify shear forces on the skin in a clinical setting. The Graft Shear Sentinel is a flexible sensor that is designed to measure and output the magnitude of shear stress and pressure experienced on the skin graft in real time. The sensor uses square copper pads etched directly into the flexible circuit board to create a novel arrangement of capacitors whose values change in response to shear stress. After accurate calibration using known forces, the Graft Shear Sentinel will provide a heatmap of shear stress for easy visualization. Physicians will use this visual data by the Graft Shear Sentinel to optimize burn patient care, increase the chance of a successful skin graft procedure, and perform additional research in the relationship between shear stress and skin graft failure.

TEAM #119: THE EFFECT OF EMBEDDED SENSORS ON STRAIN MEASUREMENTS IN 3D PRINTED PARTS
- Department: Mechanical & Aerospace Engineering
- Team members: Scott Kresie, Jeronimo Mora, Dominique True
- Adviser: Dr. Jason Moore

Lawrence Livermore National Laboratory (LLNL) has tasked us with investigating the effects of embedding a strain gauge into a 3D printed part. Strain gauges are conventionally used on the surface of structures to measure strain. Embedding these sensors requires special internal geometry for their seamless placement. Our goal is to determine an embedding process as well as experimental evidence to show that an embedded strain gauge can accurately sense strain within a structure.
Due to the nature of the embedding process, embedded sensors may not provide an accurate depiction of strain within a 3D printed part. By comparing our experimental results to a computer model we can determine the validity of the data received from the embedded strain gauges. We are also providing the groundwork for future research LLNL plans to do in the area of embedded sensors.

**TEAM #120: THORAFIT - A CUSTOM CHEST WALL RECONSTRUCTION IMPLANT**

- Department: Biomedical Engineering
- Team members: Mason Becker, Lauren Damian, Hailey Hinkle, Matthew Kennedy
- Adviser: Dr. Anthony Passerini

Our objective for this project is to design an individualized thoracic prosthesis for mature adults that can provide long term patient viability. The implant is customized in accordance to the patient’s defect by processing the patient’s raw CT scan data and converting it into a 3D printed prosthetic. The custom 3D implant is produced by the aforementioned process and integrates a novel sternum to rib interface to reduce physical stress and maximize chest wall flexibility.

**TEAM #121: BLACK SOLDIER FLY LARVAE CULTIVATOR TO SUPPLEMENT CHICKEN FEED**

- Department: Biological & Agricultural Engineering
- Team members: David Barraza, Marianelly Lopez, Emily Quan, Sara Wat, Lisa Wolbert
- Course Instructor: Dr. Jean VanderGheynst, Dr. Deb Niemeier

The cost of specialized feed is a significant burden for farmers maintaining small poultry farms. One alternative is to redirect organic waste through a system that can produce nutritious poultry feedstocks. Hermetia illucens, commonly known as the black soldier fly, could provide a cost-effective and nutritional solution for small farms. Black soldier fly larvae (BSFL) feed on organic waste and are a high source of protein. This project designed and built a containment vessel in which the BSFL can be cultivated and harvested at a constant rate year-round to provide low-cost, pathogen-free food source for pasture-raised chickens. An alternative feed production system that utilizes on-farm material for the cultivation of BSFL can reduce cost to the farmer. The project team optimized feed compositions using farm crop residue, chicken manure, and rice hulls to yield the highest larval biomass growth. Using these data, the team designed and built a vessel that provides a controlled environment for growing the BSFL. The results of this project provide the foundation for a BSFL integrated biosystem, offering an economical and low-maintenance alternative for chicken feed.

**TEAM #122: UC DAVIS SOLAR REGATTA**

- Department: Mechanical & Aerospace Engineering
- Team members: Kevin Choy, Alexis Dorman, Nathan Sistek
- Course Instructor: Dr. Jason Moore

The UC Davis Solar Regatta team designed, built, and raced a solar-powered catamaran in the Sacramento Municipal Utility District’s Northern California Solar Regatta collegiate competition on May 14, 2016. The first team of its kind from UC Davis, they entered a boat that functioned competitively and represented the university with pride.

**TEAM #123: WHIM WHEELCHAIR - A DIY ELECTRIC POWERED WHEELCHAIR**

- Department: Mechanical & Aerospace Engineering
- Team members: Iliia Potanin, Simon Quan, Josh Taggard
- Course Instructor: Dr. Jason Moore

The purpose of this project is to provide plans for a low cost, easily maintainable, do-it-yourself wheelchair. This chair will give people with disabilities a way to avoid long wait times for repair, expensive replacement parts, and other issues associated with currently available chairs. The wheelchair plans are to be easy to follow and can be adapted and modular to accommodate those with unique disabilities. Ultimately, the hope is that these plans help make it easy for wheelchair users start to think like makers and take control of their personal mobility needs. The primary market is the do-it-yourself consumer who requires a wheelchair for personal mobility. This assumption implies the builder of the chair won’t have access to a complicated machine shop, order expensive or specialty parts, and will have to make quick repairs to avoid down time. The main points of focus for the project are the wheelchair frame, the drivetrain, and the motor.

**TEAM #124: TRANSPORTATION OF CLINICAL SAMPLES**

- Department: Biomedical Engineering
- Team members: Shane Hoang, Samantha Kennedy, Joseph Pham, Betty Tan, Jacob Vargas
- Adviser: Dr. Anthony Passerini

Within the practice of medicine, blood tests and clinical sampling are crucial to the industry’s ability to effectively diagnose patients. The UC Davis Medical Center (UCDMC) conducts millions of these tests each year with the help of an automated system, requiring the aliquot test sample tubes to be fitted with an easy-to-remove cap. While convenient for machine operation, this can be extremely hazardous to the clinicians and scientists handling the samples. In addition to being tested in-house, the samples are frequently sent to an offsite location for specialized testing. During this short timeframe of transportation, the test tube samples are consistently becoming compromised due to the tubes tipping over and the caps popping off, causing the samples to leak.
and create a biohazard. This leads to sample disposal and a large delay of essential data, preventing doctors from quickly assessing a patient’s condition. Furthermore, samples have been found to be mixed together while being transported, subsequently causing false results and emotional trauma for the patient. Fortunately, the UCDMC has been vigilant about this matter and continues to automatically dispose of samples that are suspected to be compromised. However, there is still a lack of efficiency in transporting these samples in a safe and timely manner. Our device addresses this problem by maintaining a safe and secure environment for both the samples and the people handling them.

**TEAM #125: TERCERO RESIDENCE HALLS: REDESIGN OF WATER SYSTEMS IN COMPLIANCE WITH THE LIVING BUILDING CHALLENGE**

- **Department:** Civil & Environmental Engineering
- **Team members:** Stefan Flynn-Garcia, Kathryn Laudeman, Adam Mansour, Rafael Molina-Cornejo
- **Course Instructor:** Dr. Jeannie Darby

Our team has examined the Tercero Residence Hall Area as a model for residence halls and using information about the area have designed a water treatment system for a residence hall area located in Birmingham, Alabama. The system is in compliance with the water petal of the Living Building Challenge meaning that all water used, both potable and nonpotable, was collected on site or recycled from greywater. Additionally, the treatment processes outlined are done without the use of chemicals while still treating the water to a level deemed safe by governmental standards.

**TEAM #126: SUSTAINABLE WATER TREATMENT SYSTEM OF THE TERCERO DORMS**

- **Department:** Civil & Environmental Engineering
- **Team members:** Samantha Duran, Brian Gee, Brittany Leung, Mariza Sibal, Stephanie Wong
- **Adviser:** Dr. Jeannie Darby

The overall design goal of the Tercero water treatment system is to reduce potable water demands and to treat wastewater to meet this demand through the Water Petal of the Living Building Challenge. This design will establish an onsite sustainable water system that will accommodate potable and non-potable supplies through the collection of rainfall, treating wastewater directly and recycling the treated water back into the system.

**TEAM #127: LIVING BUILDING CHALLENGE: NET ZERO WATER STUDENT HOUSING**

- **Department:** Civil & Environmental Engineering
- **Team members:** Christopher Cameron, Joshua Cho, Kathleen Stone, Alexander Sweat, Ryan Yamamoto
- **Adviser:** Dr. Jeannie Darby

Our team’s ECI 148B design project involves redesigning UC Davis’ Tercero dormitory complex in the weather climate of the city of Portland, Oregon to make it a net zero water facility. To achieve this, water conservation tactics like low-flow showerheads, faucets, and washing machines are used in the dormitory area and dining commons to conserve water supply. Along with that, two separate treatment trains are utilized to maximize water efficiency – one for potable water and the other for non-potable water. Rainwater is collected from the ground and the rooftops in the dormitory area and put through a treatment process to be used for the potable water supply. The volume of water gathered for this potable supply was calculated using average precipitation data for Portland, Oregon combined with the rooftop surface area of Tercero’s dormitory buildings. For non-potable use, greywater is collected from bathroom sinks, kitchen sinks, washing machines, and showers and treated to be recycled back into the system. This project brought tremendous insight to water conservation/treatment strategies that can be utilized in buildings to combat future drought or water shortages around the world.

**TEAM #128: DESIGNING OF THE TERCERO DORM COMPLEX IN LINCOLN NEBRASKA WITH NET POSITIVE WATER USAGE**

- **Department:** Civil & Environmental Engineering
- **Team members:** Jessica Chander, Bradley Howard, Israel Sanchez Mejia, Camila Rodriguez, Stephanie Saiz
- **Course Instructor:** Dr. Jeannie Darby

The aim of our project is to create a design of the Tercero Dorm complex that is operated within the Water Petal guidelines of the Living Building Challenge. This requires that all water used in the dorms be from captured precipitation and treated onsite. This design will be done with water saving techniques such as composting toilets, effective on site capture, and a closed graywater loop.

**TEAM #129: NET ZERO WATER SYSTEM FOR TERCERO RESIDENCE COMPLEX**

- **Department:** Civil & Environmental Engineering
- **Team members:** Alijan Mohammad Arif, Nathaniel Bautista, Michael McEvoy, Harris Popal, Christopher Quevedo
- **Course Instructor:** Dr. Jeannie Darby

Our team of graduating civil engineers has designed a Net Zero Water (NZW) system for a residential hall complex modeled after the UC Davis Tercero residential halls. The source of water for this system will be modeled by precipitation data from the climate of Honolulu, Hawaii, which will supplement our designed treated water recycle process. Our design aims to manage the water onsite by constraining the proposed systems to the physical footprint of the existing site. The system is optimized to account for overall cost and greenhouse gas emissions.
TEAM #130: DECENTRALIZED WASTE WATER TREATMENT DESIGN

- Department: Civil & Environmental Engineering
- Team members: Pedro Do Vale, Saagar Ghai, Alvin Kim, Ken Xu, Rong Zhao
- Course Instructor: Dr. Jeannie Darby

Our project team has designed a water system for a 12 building dorm complex in Madison, Wisconsin. This system meets 100% of its potable and non-potable water needs from precipitation or recycled flows. The system also treats the water back to potable and non-potable water quality in order to be reused onsite. The use of chemicals treatment or offsite services have been avoided in order to keep the entire system onsite. This design uses UC Davis’s Tercero Halls as a model. Calculations for energy use, nutrient loading, rainfall, and other parameters have been made to determine which water system will be the most efficient for our region’s climate.

TEAM #131: SAN DIEGO, CA LIVING BUILDING CHALLENGE

- Department: Civil & Environmental Engineering
- Team members: Pilar Araujo, Justin Darr, Grace Hoang, Bryan LoCoco, Gloria Vo
- Adviser: Dr. Jeannie Darby

The project’s goal is to demonstrate the feasibility of transforming a site, modeled after the Tercero Complex in UC Davis, to be water net positive if it existed in San Diego, CA. The specifications of the project must abide by the parameters established in the Living Building Challenge (LBC) Water Petal documentation as well as California laws regarding water and wastewater management. The Living Building Challenge goes beyond the basic design and functions of the site. It aims to make a self-sustainable site with a closed loop system that can treat what is normally considered as “waste” to a form that can be used as an asset. By applying techniques such as anaerobic digestion and organic composting, the San Diego site could potentially produce assets such as additional energy, clean water for potable and non-potable reuse, and fertilizer for agricultural purposes. Through rooftop rainwater collection and treatment of greywater and blackwater effluent using a variety of techniques, even a city like San Diego that receives little rainfall and is far from other freshwater supplies can be net positive in terms of water use.

TEAM #132: TECERO NET ZERO WATER TREATMENT SYSTEM

- Department: Civil & Environmental Engineering
- Team members: Titus Garrett, Carmen Liu, Kevin Nguyen, Thiri Yu
- Adviser: Dr. Jeannie Darby

Our design requirement is to design a new construction of a water system for the Tecero residence hall complex. The complex is chosen to be located in Seattle, Washington. Based on the rainfall and the demand for water, three different design scenarios were developed. Our design meets the following specifications: 100% of water needs is supplied by precipitation or recycled, all sanitary wastes managed on site, excess precipitation is used to beneficially, chemical use is minimized or avoided, energy use is a consideration, physical footprint constrained to existing site and lastly, the life cycle cost is computed. Our goal is to reduce the water usage by the residents in the dorms as well as the usage in the Dinning Commons.

TEAM #133: NET ZERO WATER UNIVERSITY LIVING COMPLEX; LOS ANGELES

- Department: Civil & Environmental Engineering
- Team members: Victoria Liang, Gabriela Trujillo, Yunting Yu, Xingyang Zhang
- Adviser: Dr. Jeannie Darby

The goal of the project is to design a water and wastewater treatment system for the Tercero residence dorms that meets the water petal of the Living Building Challenge (LBC) while being based in Los Angeles, CA. The LBC is a standard that is based on net-positive water where 100% of the project’s water will be supplied by captured precipitation or other natural closed loop water systems, or recycled water.

TEAM #134: DESIGN OF WATER AND WASTEWATER TREATMENT SYSTEMS FOR TECERO RESIDENTIAL COMPLEX

- Department: Civil & Environmental Engineering
- Team members: Sophavy Sung, Janie Tran, Monica Vazquez, Jiongcheng Xu, Wenjia Yan
- Adviser: Dr. Jeannie Darby

We will design both water and wastewater treatment systems for Tecero Residential Complex by using sustainable strategies. Our goal is to maximize the utilization of onsite water reuse and capture the rain harvesting water so as to achieve an environmental friendly requirement.

TEAM #135: SUSTAINABLE FERTILIZER RECOVERY FROM URINE

- Department: Civil & Environmental Engineering
- Team member: Jessica Hazard
- Adviser: Dr. Jeannie Darby

Urine is rich in nutrients like nitrogen, phosphorus, potassium and other elements. These nutrients are very hard to remove from wastewater and end up in our rivers, lakes, and bays. The nutrients encourage algae growth that can cause severe environmental consequences that kill fish and leaves the water unfit for human consumption. This research project is developing and optimizing a small scale technology that recovers ammonium, phosphate and potassium from urine by precipitation and distillation. Specifically, the distillation of concentrated Ammonium Bicarbonate and the crystallization of struvite.
TEAM #136: ISOOCTANE PRODUCTION PLANT
- Department: Chemical Engineering & Materials Science
- Team members: Grace Chan, Daniella Holm, Kathleen Paccapo, Alison Pinto
- Course Instructor: Dr. Nael El Farra

Designed an ‘existing’ MTBE plant and retrofit the plant utilizing as much equipment from the ‘existing’ plant as possible to create an optimized isooctane production plant.

TEAM #137: MTBE TO ISOOCTANE PLANT RETROFIT/DESIGN PROJECT
- Department: Chemical Engineering & Materials Science
- Team members: Adam Entizne, Leila Abdoul Hady, Wanmei (Cassandra) Kuang, Jenny Zhou
- Course Instructor: Dr. Nael El Farra

This design project involves retrofitting an existing MTBE (methyl-tert butyl ether) plant to produce isooctane. This potential retrofit is being examined due to changing environmental regulations and the increased environmental concern MTBE poses on groundwater. The existing MTBE production scheme was modeled using Aspen Plus. In order to maximize the profit achieved from the retrofit, an effort was made to reuse the existing equipment in the production of isooctane. The kinetics of the formation of isooctane was determined from experimental data. Using Aspen Plus to simulate the isooctane production, a conversion of 99% was achieved for di-isobutylene using two catalytic, adiabatic fixed-bed reactors. Following the production of di-isobutylene, isooctane was produced downstream using a series of three catalytic beds achieving 99% conversion. A plant capacity of 2,630 BPSD of 99.8 wt.% C8+ was achieved. An economic evaluation was performed in order to determine the feasibility of the proposed retrofit. The capital costs, operating costs, and the process were examined and presented to make the determination if the proposed retrofit is economically feasible.

TEAM #138: PROCESS INTENSIVE RETROFIT OF AN MTBE PLANT
- Department: Chemical Engineering & Materials Science
- Team members: Gary Banh, Un Fai Chan, Sam Ghafari-Saravi, Tony Zhang
- Course Instructor: Dr. Nael El Farra

The Clean Air act of 1990 has pressured fuel companies to reformulate their product. The going solution at that time was MTBE, an oxygenate that helps gasoline burn more thoroughly. MTBE’s affects on environmental water resources has motivated a call for environmentally sound alternatives. Alternative oxygenates such as TAME and ETBE are costly due their high cost of transport. A viable solution is to produce a higher quality fuel. Isooctane is a higher quality fuel that complies with the Clean Air Act as well as shown great economic promise to companies currently producing MTBE because isooctane’s process similarities to MTBE provides a great opportunity to retrofit existing plants. Our conceptual retrofit has shown a higher profit margin than the existing MTBE plant we studied.

TEAM #139: MTBE RETROFIT TO ISOOCTANE PRODUCTION
- Department: Chemical Engineering & Materials Science
- Team members: Karen Chiang, Yue Deng, Van Huynh, Faustine Wang
- Course Instructor: Dr. Nael El Farra

Methyl tert-butyl ether (MTBE) was widely used as oxygenate to increase the octane number in gasoline, which reduces the emission of hazardous pollutants by burning more cleanly. However, MTBE was later banned due to its environmental and health concern, and one possible solution for the refineries is to retrofit the existing plants as isooctane production plants. ASPEN Plus was used to design and simulate the production of isooctane for the Texas plant. In the retrofit, there is a shell-and-tube fixed bed reactor (FBR) and an adiabatic FBR, followed by four hydrogenation reactors in series to produce isooctane. The downstream units are used to separate out the impurities. As a result, isooctane capacity produced is 1790 barrels per stream day at a purity greater than 99.9%. After conducting a detailed economic evaluation, the result of the fixed capital investment is $9.6 million. Electricity, high pressure steam, cooling water, and chilled water are the utilities used to run the plant. Among the all, high pressure steam is reported to have the highest utility cost. With the current design, it is deduced that the plant will be in $10 million deficits after 15 years. Therefore, the recommendation is to search for other alternatives or to study methods to increase the selectivity of diisobutylene (DIB) and adjust the conditions of the flash to reduce the waste of C8 in the separations.

TEAM #140: MTBE PLANT RETROFIT TO ISOOCTANE PRODUCTION
- Department: Chemical Engineering & Materials Science
- Team members: Nicholas Cabrena, Malinda Cheung, Ethan Jensen, Dawn Leung
- Course Instructor: Dr. Nael El Farra

Methyl tertiary butyl ether (MTBE) is a common fuel additive for gasoline engines. Environmental concerns over MTBE, however, have led to increased production of higher quality gasoline alternatives such as isooctane. The goal of this project was to retrofit an existing MTBE plant to produce isooctane. A base case simulation was first developed for the MTBE plant using Aspen Plus process optimization software. In order to convert this MTBE facility to produce isooctane, kinetic data for isooctane was analyzed and a new process
simulation was developed. To reduce capital costs, care was taken to use as much existing MTBE equipment as possible. An overall economic analysis including utility costs and fixed capital investment was performed.

TEAM #141: METHYL TERT-BUTYL ETHER PLANT RETROFIT FOR THE PRODUCTION OF ISOOCTANE IN OYSTER CREEK, TEXAS

- Department: Chemical Engineering & Materials Science
- Team members: Sarah Chow, Kelly Hudiono, Muhaymin Khalid, Allison Lo
- Course Instructor: Dr. Nael El Farra

Yuba Fuel Additives Corporation is examining the retrofit of its existing Oyster Creek, Texas, methyl t-butyl ether (MTBE) production facility to produce isoctane. Our objective is to determine if this retrofit is economically feasible. Isooctane is a viable replacement for MTBE because isoctane production will utilize the available isobutylene feedstock. An isoctane plant simulation developed using Aspen Plus V8.4 yielded product of 99.9 wt% C8+ with 1.0 vol% olefin. A preliminary economic evaluation indicates that this venture is profitable. Future considerations include finding the optimum throughput to maximize profitability, increasing the number of hydrogenation reactors, and utilizing the available fuel-gas credit.

TEAM #142: AN ISOOCTANE PRODUCTION PLANT DESIGN

- Department: Chemical Engineering & Materials Science
- Team members: Vanessa Garcia, Shawn Mattathil, Bentley Ou, Joseph Williams
- Course Instructor: Dr. Nael El Farra

MTBE, an octane additive, is often used to improve gasoline qualities. Due to heavy government regulations of MTBE products, a careful economic and feasibility assessment have been made to convert an existing MTBE production plant into an isoctane production plant. Isooctane was highly recommended as the substitute for MTBE due to their similarities in industrial processes and functionalities. To retrofit an existing MTBE plant, we generated a basis MTBE plant simulated by Aspen Plus to guide the construction of a new isoctane plant. The final product will include a retrofitted flow sheet for the isoctane production as well as a full economic evaluation and profitability assessment.

TEAM #143: RETROFIT OF AN MTBE PLANT TO PRODUCE ISOOCTANE

- Department: Chemical Engineering & Materials Science
- Team members: Abeer Alsharif, Jillian Doherty, Rachel Doolittle, Niko Kingli
- Course Instructor: Dr. Nael El Farra

Methyl t-butyl ether, MTBE, is a chemical compound synthesized via an acid-catalyzed etherification reaction between methanol and isobutylene. MTBE is best known for replacing lead as an octane enhancer and helping gasoline burn more completely. Unfortunately, MTBE's high volatility and water-solubility result in easy transportation into, and consequent contamination of, soil and groundwater. US regulations have since been imposed on MTBE's production and storage and as a result, MTBE plants are sought for retrofit to produce more marketable chemical alternatives. This project focuses on the retrofit of an MTBE plant based in Bar Nunn, Wyoming to produce isoctane, a more favorable octane enhancer than MTBE. AspenPlus is used to construct a base case simulation of the MTBE plant as well as perform the retrofit to produce isoctane at >99.5 wt% purity. Isooctane is synthesized via an acid-catalyzed dimerization of isobutylene to form di-isobutylene, followed by a hydrogenation reaction to form isoctane. A retrofit is possible due to the dimerization reaction in isoctane production utilizing the same ion-exchange catalyst as used in the etherification reaction in MTBE production, allowing for the same reactors to be used. The process is configured so that the purchase of new equipment is minimized. Economic analyses are performed to detail the capital and operating costs, and the potential profit associated with the proposed retrofit.

TEAM #144: MTBE PLANT RETROFIT

- Department: Chemical Engineering & Materials Science
- Team members: Daniel Kriozere, James Makel, Bradley Petkus, Belinda To
- Adviser: Dr. Nael El Farra

Methyl tert-butylether (MTBE) historically has been used as an octane booster in fuel. In the early 2000s MTBE has been shown to have harmful environmental impacts especially on groundwater. This has led to its ban in many states. As such there is a need for chemical plants that previously produced MTBE to be retrofit to produce alternate chemicals. This project involves the retrofit of an MTBE plant in Oyster Creek, Texas to produce isoctane. Plants simulations and economics analysis were carried out using ASPEN Plus.
TEAM #145: MACE RANCH INNOVATION CENTER SUSTAINABILITY PLAN
- Department: Civil & Environmental Engineering
- Team members: Kelly Andrews, Negine Malboubi, Aaron O’Hearn, Usman Raheel
- Adviser: Tom Kear

Our project analyzes the Mace Ranch Innovation Center development proposal and evaluates potential to reduce the greenhouse gas emissions from the development. It will focus on mobile source emissions and strategies to reduce the amount of vehicle trips generated from the site activity. Different land use options will be analyzed, along with the potential to improve public transportation, bicycling and pedestrian facilities. The results is a redesign of the project to reduce the environmental burden and increase connectivity to the surrounding city.

TEAM #146: SUSTAINABLE LAND USE DESIGN FOR MACE RANCH INNOVATION CENTER
- Department: Civil & Environmental Engineering
- Team members: Robert Lacey, Alysia Love, Lance Taylor, Yiwen Zhang, Huaqing Zhu
- Course Instructor: Tom Kear

Designing the MRIC and surrounding land to reduce GHG emissions and increase transportation safety.

TEAM #147: MRIC SUSTAINABLE DEVELOPMENT PLAN
- Department: Civil & Environmental Engineering
- Team members: Puxuan Cao, Huicheng Hong, Tak Shun Samuel Li, Christopher Wei, Wenjia Yan
- Adviser: Tom Kear

Designing the 212 acres Mace Ranch Innovation Center (including the Mace Triangle) to improve the sustainability of the initial design. This plan will emphasize on the transportation and energy alternatives.

TEAM #148: TRANSPORTATION LAND USE SUSTAINABLE DESIGN OF THE MACE RANCH INNOVATION CENTER (MRIC)
- Department: Civil & Environmental Engineering
- Team members: Alan Espejo, Enrique Gonzalez, David Ly, Krishen Parmar
- Adviser: Tom Kear

We will be design different ways to make the project cite more sustainable.

TEAM #149: SUSTAINABLE TRANSPORTATION DESIGN
- Department: Civil & Environmental Engineering
- Team members: Luis Jimenez, Loriza Khan, Jose Nava, Edgar Orozco, Marvin Perez
- Adviser: Tom Kear

This project consists of different engineering and planning methods to reduce the VMT of single-usage automobiles to and from the proposed MRIC in Davis, CA.

TEAM #150: MACE RANCH INNOVATION CENTER SUSTAINABILITY PROJECT
- Department: Civil & Environmental Engineering
- Team members: Jean Kim, Ryan Yamamoto, You Vang, Daniel Yelsits
- Course Instructor: Tom Kear

Our project will improve the sustainability of the proposed Mace Ranch Innovation Center by lowering vehicle miles traveled via implementing approaches, such as paid & limited parking, parking cash-out, ride sharing, alternative modes of transportation, and mixed land use.

TEAM #151: THE IMPACT OF MIXED USE IN MACE RANCH INNOVATION CENTER
- Department: Civil & Environmental Engineering
- Team members: Saleh Fadhel, Nikki Holte, Jin Seob Kim, Kevin Nguyen, Nicole Riener
- Course Instructor: Tom Kear

The analysis of the impact of mixed use and transportation mitigation on greenhouse gas emissions at the MRIC.

TEAM #152: THE MACE RANCH INNOVATION CENTER: SUSTAINABILITY PLAN
- Department: Civil & Environmental Engineering
- Team members: Danica Alfajora, Crystal Cheung, Charlie Chres, Connie Leung, Karen Magallanes
- Course Instructor: Tom Kear

The Mace Ranch Innovation Center (MRIC) is designed to create opportunities for research expansion and technological growth in Davis, CA. The project site of 229 acres is located immediately east of the City of Davis Limits and is bordered along Mace Boulevard and Country Road 32A. Through the creation and use of the MRIC, the number of trips generated to and near the area will increase. Therefore, the greenhouse gas (GHG) emissions will increase as well. In order to reduce the MRIC’s carbon footprint, a sustainability plan will be proposed with an emphasis on transportation. This plan will develop and analyze transportation methods and scenarios to reduce these harmful emissions.
**TEAM #153: SUSTAINABLE IMPROVEMENTS FOR THE MACE RANCH INNOVATION CENTER**
- Department: Civil & Environmental Engineering
- Team members: Joshua Cho, Sara Dowling, Hany Hassan, Din Hong, Charuni Kurumbalapitiya
- Adviser: Tom Kear

The Ghaus Haus Consulting Inc. intends to provide sustainable developments (with regards to transportation infrastructure and land use strategies) to mitigate overall GHG emissions within the Mace Ranch Innovation Center (MRIC). Hence, the ultimate goal of this project is to reduce the VMT within the MRIC.

**TEAM #154: MACE RANCH INNOVATION CENTER PROJECT**
- Department: Civil & Environmental Engineering
- Team members: Armaandeep Bhattal, Moises Guandique, Phuc Hoang, Marc Pineda, Xingyang Zhang
- Course Instructor: Tom Kear

In order to bring leading high-tech institutions, companies, and start-up businesses together in an area driven by world class research at UC Davis, a sustainable development project, the Mace Ranch Innovation Center (MRIC), has been planned to be constructed on the eastern edge of Davis, California. Our project team aims to alter the current design plans for the MRIC through two main aspects - construction and transportation. Our MRIC project proposal aims for the following objectives: 1) creating sustainable construction methods that reduce environmental impacts, but are safe and convenient for the surrounding public, 2) sustainable transportation methods that minimize the travel distance of a minimum number of vehicles desired on the site while optimizing access to all facilities and site entrances.

**TEAM #155: WATER AND CONSTRUCTION MITIGATION MEASURES TO THE MACE RANCH INNOVATION CENTER**
- Department: Civil & Environmental Engineering
- Team members: Eduardo Castillo-Aguilar, Gladys Ferrero, Bradley Howard, Michael Mount
- Adviser: Tom Kear

Our project consists of improvement to the currently planned Mace Ranch Innovation Center. Such improvement will include sustainable changes to water usage including low flow fixtures, improved irrigation as well as changes to construction.

**TEAM #156: BUILDING A MORE SUSTAINABLE MIRC**
- Department: Civil & Environmental Engineering
- Team members: Kristin Cooper, Marissa Freise, Alex Garcia, Brittany Sattler
- Adviser: Tom Kear

Using mitigation techniques to analyze the project, the Mace Ranch Innovation Center was redesigned in order to create a more environmentally friendly project.

**TEAM #157: MACE RANCH INNOVATION CENTER DEVELOPMENT PROJECT**
- Department: Civil & Environmental Engineering
- Team members: Marisa Bachelor, Cassandra Hom, Alejandra Ruiz, Kimberley Tellez, Stephanie Wong
- Adviser: Tom Kear

Due to the current Mace Ranch Innovation Center project hold placed by the City Council of Davis, our project will offer improvements on the proposed project to address some of the Council’s and developers’ concerns. To proceed with the project, our civil engineering group will present a design for sustainable land use, safe multi-modal connectivity, and greenhouse gas reductions, in and around the Mace Ranch Innovation Center site. The goal for sustainable land use is to utilize the physical footprint of the innovation center in an efficient and environmentally friendly way. This design will incorporate mixed-use infrastructure to reduce the annual vehicle miles traveled and traffic congestion. In addition, it will improve multi-modal connectivity and safety within the site, as well as entering and exiting the site. This will encourage the use of alternative modes of transportation to ultimately reduce emissions. Implementing these modifications will foster a sense of community and will be an enriching addition to the City of Davis.

**TEAM #158: MACE RANCH INNOVATION CENTER (MRIC)**
- Department: Civil & Environmental Engineering
- Team members: Yannick Aranas, Justin Darr, Arancha Ducaud, Brent Lund
- Adviser: Tom Kear

The purpose of this project is to determine an efficient use of the land designated for the Mace Ranch Innovation Center (MRIC), as well as design any transportation infrastructure enhancements that may be required for the project to not strain any existing infrastructure adjacent to the site. In addition, changes will be made to the existing project description to accommodate the needs of the city, such as including housing on the site and increased retail use. The primary focus of this project will be transportation zoning in and around the MRIC. Accessibility through the I-80 freeway will be altered using a diverging diamond design for smoother traffic flow. Additionally, separated bike and pedestrian pathways will be included leading into the MRIC. Housing will be a part of the MRIC. Currently, the City of Davis has little room to expand its population. R&D and retail workers would need
the option to make the city their home. To make the best use of space, the MRIC will have a shopping center. This will allow the MRIC to always be active economically regardless of the time of day. This will include a 24 hour food court that will serve as the main source of food for the entire MRIC. The goal of this project is to provide the people of Davis a place to congregate with entertainment venues, as well as fostering new opportunities for cooperation between UC Davis and future research and development that will occur on site.

TEAM #159: MACE RANCH INNOVATION CENTER TRANSPORTATION AND LAND USE DESIGN

- Department: Civil & Environmental Engineering
- Team members: Anne Avellar, Hagr Balla, Jacqueline Buenrostro, Daniela Garcia, Jane Tannous
- Adviser: Tom Kear

The Mace Ranch Innovation Center project addresses a 228 acre site which is easily accessible off Interstate 880 and the Mace Boulevard exit. The site is currently undeveloped land combined with areas of developed land on the Mace Triangle. Since the City has little undeveloped land, this project presents an opportunity to develop a sustainable mixed-use community. Our project offers safe and efficient connectivity, reliable transportation networks, and housing. These project characteristics are essential in creating an efficient transportation system while reducing emissions.

TEAM #160: MACE RANCH INNOVATION CENTER TRANSPORTATION AND SUSTAINABILITY DESIGN

- Department: Civil & Environmental Engineering
- Team members: Negina Ayar, Darren Easterling, Simon Pan, John Seymour, Hannah Young
- Adviser: Tom Kear

The Mace Ranch Innovation Center (MRIC) is a proposed project in east Davis, CA that will house numerous technology companies centering on Research and Development as well as commercial office space. In accordance with the California environmental quality Act this project hopes to promote enhanced business within Davis as well as provide a sustainable plan for the completion of the project. This design project is a sustainability plan for the MRIC after implementing transportation solutions to reduce carbon emissions.

TEAM #161: SEMI-CONTINUOUS PRODUCTION OF BUTYRYLCHOLINESTERASE USING RICE CELL CULTURES

- Department: Chemical Engineering & Materials Science
- Team members: Peter Kedzierski, Jason Lam, Victoria Louie, Jordan Sheade
- Course Instructor: Dr. Karen McDonald

Butyrylcholinesterase (BChE) is a naturally occurring human enzyme that can be used to hydrolyze organophosphates. It can be injected intravenously into the human bloodstream and can act as a bioscavenger to break down organophosphates, protecting and preventing organophosphate poisoning. We are using SuperPro to design and simulate a biomanufacturing facility to produce over 25 kg of BChE using transgenic rice (Oryza Sativa) cultures in a large scale biopharmaceutical facility that uses stainless steel bioreactors, and present an economic analysis and environmental assessment. Our upstream process consists of a seed train to produce inoculum for a 25,000 L production bioreactor. We will have 10 main production bioreactors running 24/7 for 330 days a year. This will then go to our downstream processing where we will harvest, purify, and formulate our product. The market price for BChE is anticipated to be greater than $10,000 for a 400 mg dose purified from donated blood. However, through our large scale production, we intend to decrease the cost, to allow the creation of a stockpile for governmental distribution to American farmers and the military as the government sees fit.

TEAM #162: CONTINUOUS PRODUCTION OF ETHYL ACETATE IN ESCHERICHIA COLI

- Department: Chemical Engineering & Materials Science
- Team members: Derek Chai, Yousef Fararjeh, Ryan Lewis, Kathryn Mains
- Course Instructor: Dr. Karen McDonald
- Project Adviser: Dr. Shota Atsumi

With an increasing concern about the effects of global climate change, the U.S. government is pushing for the investigation of new biofuels and fuel additives. Currently, ethanol remains the main fuel additive in gasoline despite issues caused by the molecule’s hygroscopic nature. Ethyl acetate has been identified as a strong candidate for use as a biofuel additive due to its four carbon and doubly oxygenated structure. BIOFAVA is designing a manufacturing facility that produces 10,000 tons of ethyl acetate per year for biofuel applications using genetically engineered Escherichia coli as a production platform. To capture the design, BIOFAVA’s upstream and downstream processes are modeled using SuperPro Designer®. The facility includes a seed train for the preparation of E. coli inoculum, a continuous production fermenter, and separation and purification units. BIOFAVA’s facility will operate 330 days per year with the continuous production fermenter operating at steady state and producing ethyl acetate continuously for a month at a time. The engineered E. coli utilizes ethane to produce ethyl acetate in a 2:1 molar ratio via an enzymatic pathway. Ethyl acetate is secreted from the cells and recovered from the stream exiting the production fermenter continuously through a gas stripping step. Purified ethyl acetate is condensed into liquid form, and exported for final processing and packaging. An economic analysis for the BIOFAVA process is presented including total capital investment, annual operating costs, cost of goods sold and potential profit.
Spinal cord injury therapy using bone marrow mesenchymal stem cells (BM-MSCs) is currently going through Phase I and Phase II clinical trials. These therapies will eventually pass Phase III and would need to be manufactured at a larger scale to accommodate the annual 12,000 individuals diagnosed with a spinal cord injury. The goal of our project is to perform a conceptual engineering design and technoeconomic assessment for a BM-MSC manufacturing facility to accommodate a fraction of the annual demand. The upstream process focuses on the expansion of the BM-MSCs through a seed train, utilizing T-flasks, hyperflasks, hollow fiber bioreactors, and serum-free media. The selected equipment mimics the in vivo environment to ensure cell viability when administered. The downstream process utilizes centrifugation for the recovery and purification of the BM-MSCs. A quality control protocol is incorporated throughout the entire process to screen for viruses, fungi, bacteria, and other unwanted microbial substances that may have contaminated the BM-MSCs during production. The facility contains twenty seed trains, where each train produces nineteen batches per year. The facility produces 5.29 x 10^11 cells annually, which will be cryopreserved and transferred to a different company for final formulation. The facility operates for 24 hours per day over a span of 330 days. An economic analysis of the proposed facility was also performed that reviews revenue, process costs, maintenance, utilities, and labor. Additionally, an environmental and safety analysis was conducted to analyze the environmental impact of the design and to ensure compliance with state and federal regulations.

Griffithsin is a microbicide that prevents the transmission of viruses such as HIV, hepatitis C, herpes, and HPV. This carbohydrate-binding protein is found naturally in red algae, but it can be produced in different hosts if a gene for its expression is introduced. Nicotiana benthamiana, a relative of the tobacco plant, was chosen as the host platform and the tobacco mosaic virus (TMV) was selected as a vector to introduce a griffithsin expression gene. We propose a facility design that automates the simultaneous growth, harvest, and purification of more than 900,000 plants. To reduce the facility’s footprint, N. benthamiana is cultivated indoors using hydroponics, a soilless media irrigation system, and LED light sources. The host is highly susceptible to infectious agents, and can be infected with TMV to induce griffithsin production. In SuperPro Designer®, we simulate the annual recovery of 20 kilograms of griffithsin from N. benthamiana harvested in 95 batches. At least 60% of expressed griffithsin is recovered in downstream purification. Infected waste is treated to minimize environmental impact. Griffithsin is incorporated into a stable formulation as the active pharmaceutical ingredient for shipping to downstream manufacturers. These producers will dilute griffithsin into a prophylactic gel for topical application. The SuperPro Designer® simulation software provides an economic analysis to determine total capital investment, annual operating costs, raw material costs, revenue, and profitability. The ambitious scale of this facility offers a novel method for producing plant-made pharmaceuticals in response to the growing market for economical biotherapeutics.
facility; the sizing and scheduling of the equipment; and the economical and environmental impact.

**TEAM #166: CONTINUOUS PRODUCTION OF CETUXIMAB BIOSIMILAR USING CHINESE HAMSTER OVARY (CHO) CELLS**
- Department: Chemical Engineering & Materials Science
- Team members: Joey Bridger, Nadia Duenas, Michael Kagan, Calvin La
- Adviser: Dr. Karen McDonald

At Perfugen, our motto “continuously working for a healthier you” not only applies to our patients, but carries over to our community, staff, and production process. We are designing a biomanufacturing facility for production of a monoclonal antibody (mAb) biosimilar to cetuximab using CHO cells. This mAb treats most cases of metastatic colon cancer. With our product, colorectal cancer patients will have more accessibility to their treatment because of the biosimilars reduced cost. In 2016 there is projected to be 135,000 new cases of colorectal cancer in the U.S. alone. Treatment consists of weekly intravenous injections over a 10 week period. We are also targeting 3.5% of the global market and will be operating 330 days a year in order to produce 230 kg of our product to meet large scale demand. Purfugen’s manufacturing facility is modeled and designed around continuous upstream and downstream processing with the incorporation of single-use technology simulated on SuperPro Designer. Single-use technology reduces the cost of processing while also reducing our generated chemical waste and water usage. Our upstream process will use Sartorius BIOSTAT® RM with Flexsafe® RM bags and General Electric’s (GE) Xcellerex XDR-2000 production bioreactor. Downstream processing will use GE chromatography resin in periodic counter-current steps consisting of one affinity and two ion-exchange steps. We will provide a techno-economic analysis on the capital costs, operating costs, and cost of goods to determine the profitability of our operation. The continuous production of a cetuximab biosimilar will provide a constant supply of the mAb treatment and support to patients.

**TEAM #167: DESIGN AND ECONOMIC EVALUATION FOR THE PRODUCTION OF CYCLOHEXANE**
- Department: Chemical Engineering & Materials Science
- Team members: Phan Dang, Christina Deng, Tim Montoya, Angel Sitan
- Adviser: Dr. Ahmet Palazoglu

The major production of cyclohexane is used to produce intermediates for nylon 6 and nylon 6,6. Virtually all cyclohexane is produced commercially by hydrogenation of benzene. The purpose of this project is to prepare a conceptual design package and economic evaluation of the hydrogenation of benzene to cyclohexane. Our group has designed an cyclohexane plant to be located in Ulsan, South Korea. The annual production rate was aimed at 60 million gallons per year. With the Aspen Plus simulation program, we were able to estimate the annual production, necessary capital investment, plant operating cost and profitability.

**TEAM #168: NOVEL PROCESS OF THE CATALYTIC HYDROGENATION OF BENZENE**
- Department: Chemical Engineering & Materials Science
- Team members: Annabel Halford, Theresa Tran, Allen Yau
- Adviser: Dr. Ahmet Palazoglu

A process plant will be created to create cyclohexane from the hydrogenation of benzene. Series of reactors, distillation columns and coolers are used to optimally yield high purity of cyclohexane. The product is used to produce nylon, so the production of cyclohexane on the industrial scale is of large interest in todays society.

**TEAM #169: CYCLOHEXANE PRODUCTION PLANT**
- Department: Chemical Engineering & Materials Science
- Team members: Gordon Dickson, Long Nguyen, Nicholas Silva, Yi Zhang
- Adviser: Dr. Ahmet Palazoglu

Our project is the development of a cyclohexane production plant utilizing benzene in the Far East.

**TEAM #170: ESTERIFICATION OF ACETIC ACID WITH METHANOL TO PRODUCE METHYL ACETATE**
- Department: Chemical Engineering & Materials Science
- Team members: Francis Distor, Edgar Hernandez, Nicholas Tockey
- Course Instructor: Dr. Jason White

Plant design on the production of 200 million pounds per year of methyl acetate. Reactants and homogenous catalyst are heated and pumped into a stainless steel type-317, jacketed plug flow reactor (PFR). The effluent is passed through two distillation columns to achieve 99.5% purity of methyl acetate in the distillate. Unreacted reactants and catalyst are recycled back into the reactor. This plant design is estimated to make $38.4 million over the ten year life of the plant, with a 68% return on investment (ROI). The breakeven year was determined to be year 4. The plant consisted of an adiabatic plug flow reactor (PFR), three heat exchangers (HEX), five distillation columns (COL), six valves, one flash drum, two mixers, and six pumps. Pressure swing distillation was used to overcome the azeotrope formed by methyl acetate and methanol. A recycle stream was used to save approximately $1.8 million/yr on raw material cost. The plant has zero emissions and poses low environmental risk.
**TEAM #171: CONCEPTUAL DESIGN AND ECONOMIC FEASIBILITY OF LARGE-SCALE METHYL ACETATE FACILITY**

- **Department:** Chemical Engineering & Materials Science
- **Team members:** Bryan Eglan, Daron Fong, Brett Koehn, Simar Singh
- **Adviser:** Dr. Jason White

The goal of the project is to design and conduct a study-level estimate of an industrial scale methyl acetate production facility in Thailand. The plant will utilize the esterification reaction of acetic acid and methanol to produce 200 million pounds per year of methyl acetate. This reaction will be conducted in the liquid phase and catalyzed homogeneously by a sulfuric acid catalyst, and conducted in a tubular plug-flow reactor at 300 degrees Fahrenheit. The downstream separations train includes several distillation columns operated at different pressures to purify the methyl acetate to 99.5 weight % purity. Lastly, an economic evaluation of the facility factors in costs of raw materials and capital, utilities, labor, and taxes. The final prognosis of the project’s feasibility will look at return on investment to estimate the facility’s overall profitability.

**TEAM #172: PLANT DESIGN FOR THE SYNTHESIS OF METHYL ACETATE THROUGH THE ESTERIFICATION OF ACETIC ACID BY METHANOL**

- **Department:** Chemical Engineering & Materials Science
- **Team members:** Roberto Altamirano, Christopher Gee, Alexandria MacLyman, Max Oppedahl
- **Course Instructor:** Dr. Jason White

Methyl acetate is used as a solvent in the production of resins, fragrances, and cosmetics, as well as a chemical intermediate for acetic anhydride. One method of producing methyl acetate is through the esterification of acetic acid by methanol using a sulfuric acid catalyst. The purpose of this project is to design the most economically profitable plant to produce 240 million pounds of methyl acetate per year, with a purity of 99.6 wt%. The design of the plant’s processes were modeled using Aspen Plus. Methanol, acetic acid and a liquid catalyst (sulfuric acid) were reacted in a plug flow reactor (PFR) to produce methyl acetate. The reaction in the PFR was carried out under adiabatic conditions at until an exit temperature of 300°F was reached. A pressure of 90 psia was used to ensure a liquid phase for entire the reaction mixture. Proper separation and recycle techniques were used to achieve the desired purity and reduce cost. The production site will be located in Bangkok, Thailand; therefore, the raw material availability, environmental, waste management, and safety regulations were taken into consideration. The profitability of the final design was assessed using before tax return on investment (BTROI), net present value (NPV), and discounted cash flow rate of return (DCFROR) calculations. From our analysis, we found our design to produce a profit of around $24.5 million over a 10 year period, based on a 77.5% reactor conversion. Therefore we recommend pursuing the production of methyl acetate using our final design.

**TEAM #173: INDUSTRIAL ESTERIFICATION OF ACETIC ACID USING METHANOL TO PRODUCE METHYL ACETATE IN AN ADIABATIC PLUG FLOW REACTOR**

- **Department:** Chemical Engineering & Materials Science
- **Team members:** Wameeq Effendi, Jia Jie Huang, Rafay Syed, Vang Xiong
- **Course Instructor:** Dr. Jason White

Methyl acetate is a compound commonly used as an intermediate in industrial applications to produce other chemicals. We designed a chemical plant to produce at least 200 million pounds of methyl acetate per year, with a purity of 99.6 wt%. The design of the plant’s processes were modeled using Aspen Plus. Methanol, acetic acid and a liquid catalyst (sulfuric acid) were reacted in a plug flow reactor (PFR) to produce methyl acetate. The reaction in the PFR was carried out under adiabatic conditions at until an exit temperature of 300°F was reached. A pressure of 90 psia was used to ensure a liquid phase for entire the reaction mixture. Proper separation and recycle techniques were used to achieve the desired purity and reduce cost. The production site will be located in Bangkok, Thailand; therefore, the raw material availability, environmental, waste management, and safety regulations were taken into consideration. The profitability of the final design was assessed using before tax return on investment (BTROI), net present value (NPV), and discounted cash flow rate of return (DCFROR) calculations. From our analysis, we found our design to produce a profit of around $24.5 million over a 10 year period, based on a 77.5% reactor conversion. Therefore we recommend pursuing the production of methyl acetate using our final design.

**BLUM CENTER FOR DEVELOPING ECONOMIES: SUSTAINABLE PROJECTS IN DEVELOPING COUNTRIES**

- **Team members:** Yao Zong Guan, Melissa Gonzalez Lopez, Theresa Mall, Rachel Muradian, Eunice Oprea, Joanne Wu
- **Course Instructor:** Dr. Tu Jarvis

The UC Davis Blum Center for Developing Economies has partnered with the College of Engineering to fund several development projects. Teams are traveling to Cambodia, Peru, and Ghana over the summer to implement projects related to sanitation and manufacturing.

- Yao Guan, Rachel Muradian, and Joanne Wu are senior Mechanical Engineering students refining a sanitation system for use with floating houses along the Tonle Sap Lake in Cambodia.
- Eunice Oprea is a sophomore Civil and Environmental Engineering student improving a water supply system in La Huaylla, Peru.
- Theresa Mall is a freshman Civil and Environmental Engineering student implementing a development project in Ghana.
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