FAMU-FSU College of Engineering

# Engineering Senior Design

# 2022


Civil and Environmental Engineering faculty, staff, students and alumni gather to celebrate the grand opening of the new Scott Collins Senior Design Lab and to thank alumnus Scott Collins for his generous donation.

Farrukh Alvi, Ph.D.
Engineering Dean, Interim

# Dean's Message

SENIOR DESIGN is always one of our most anticipated events of the year. Our engineering seniors have worked on these projects—from concept to prototype or plan—for the past two semesters. The capstone project is the fulfillment of what seems like a long and arduous journey in the life of an engineering undergrad. But oh, is it worth it!

This year is especially meaningful because it is the first year we are back in person after two years being "virtual" for the pandemic. To say our students have prevailed amidst challenging conditions is an understatement. This book is filled with projects that will inspire you for their imagination and technical savvy, doubly so when you consider the uniquely challenging circumstances during which these soon-to-be-engineers have studied, worked and prevailed since the spring of 2020.

As a mechanical engineer myself, I'm especially delighted by the mechanical engineering projects that are close to my heart. (I know I'm supposed to be unbiased.) But then I read the civil engineering projects that juggle so many important factors like client budgets and the environment, I'm awed. The industrial engineering teams that can see a way to improve efficiency in just about any scenario and electrical and computer engineering teams that are working on projects for Mars and beyond…these are truly inspiring students that have put their education and creativity to work. The chemical and biomedical team projects lead me to believe our world problems will, indeed, be solved by these enterprising young minds.

I hope you enjoy reading through this book and learning about what challenges our sponsors brought to the table and the solutions our students provided. They worked in largely mixed teams with colleagues who learn, think and work differently than they do. We don't identify the students' university in this book because we don't usually know (without asking) which student "belongs" to FAMU or FSU. Ours is a unique college and these career-ready engineering graduates are well-positioned to infuse their new companies with enthusiasm, drive and the critical "soft" skills (that are actually hard to master) they honed on our campus.

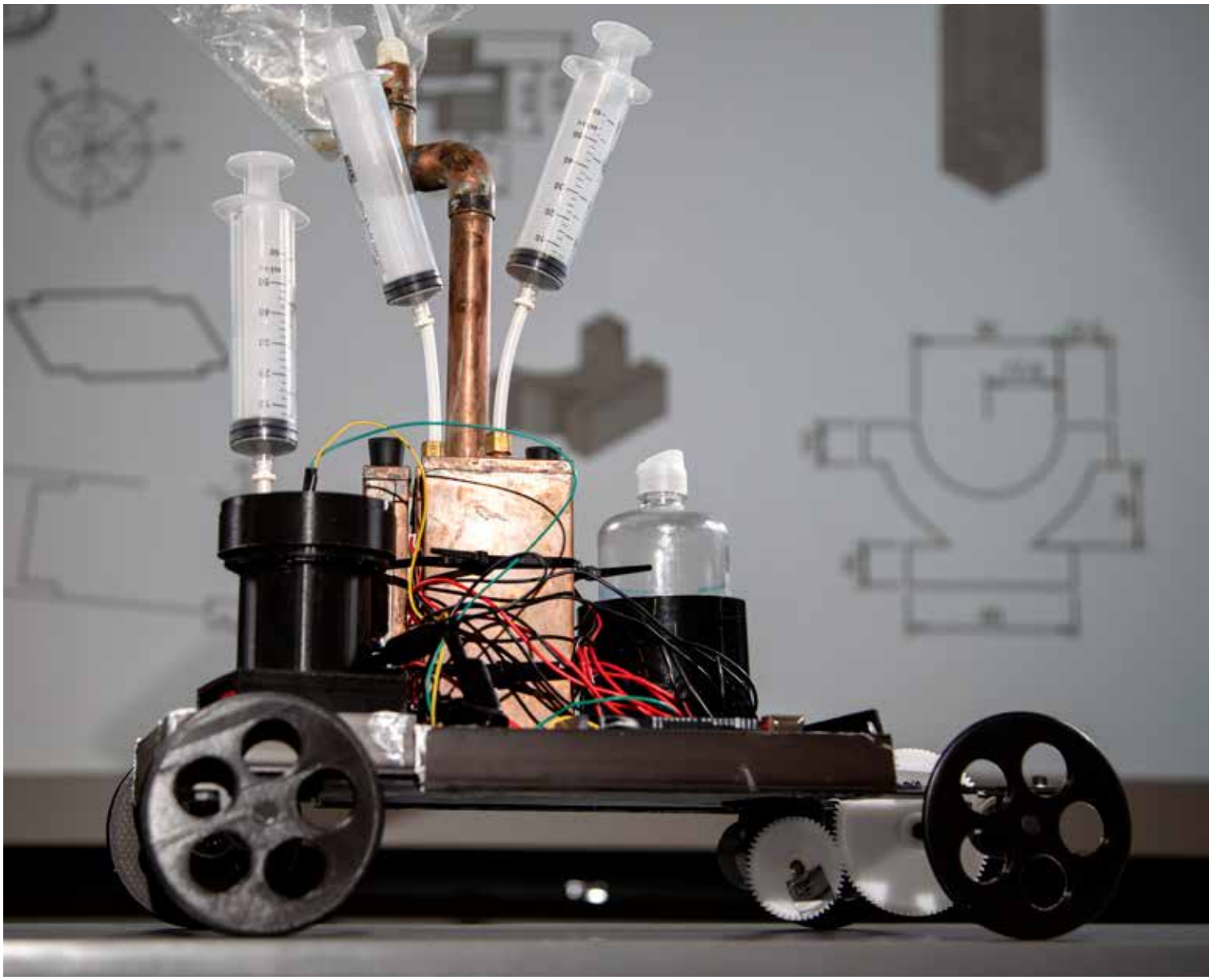
A special thank you to the faculty who have mentored these teams over the past two semesters. Without these important educators and researchers, our college—and our students—would not be where they are today. Most have known these students for many years now. I hope we will continue to know them as engaged alumni and future project sponsors/mentors.

It's been my distinct pleasure to be the interim dean for this year's Engineering Senior Design and I'm so proud of the accomplishments this book represents.

One of the many presenation rooms used by teams during Engineering's Senior Design Day.

# Table of Contents

# Chemical & Biomedical Senior Design



**CHEMICAL ENGINEERING SENIORS** designed their chemical car, which is entirely run (and governed) by chemical reactions. From “gas” to brake, they engineer the hardware and reactions that enable movement and control.

## 113: AIChE Chem-E-Car Competition

Global warming has a significant long-term negative effect on the environment and earth's atmosphere due to the CO2 emissions from various human-developed sources. Global warming is an overarching problem humanity must overcome and it begins with finding alternatives for transportation and power generation rather than utilizing fossil fuels.

In 1999, AIChE (American Institute of Chemical Engineers) introduced efforts towards producing technologies and processes that are more environmentally friendly by starting an annual student chemical engineering competition, the AIChE Chem-E-Car Competition. This competition revolves around building a small-scale (shoebox-size) car that is powered by energy produced by a chemical reaction. A chemical reaction must also be used to stop the vehicle after it has traveled a specified distance. Students compete with teams from other universities in guiding their car to a certain distance while carrying a load with a specified weight. The distance the car must travel and the weight it must carry are not revealed until the day of the competition. Operation of the car is controlled by varying the concentrations and volumes of the reactants.

The car must be capable of driving 15-30 meters in less than two minutes while carrying a load of up to 500 mL of water.

To achieve this goal, we utilized 12 thermal electric generators (TEGs), which use a temperature differential to generate the current and voltage to power the car. To create this temperature differential, an acid base reaction of NaOH and HCl generates heat in a "hot reactor," while a "cold reactor" is filled with an isopropyl alcohol dry ice bath. The TEGs are sandwiched between the reactors and wired to produce the necessary current and voltage requirements.

For the stopping mechanism, we used an iodine clock reaction, using hydrogen peroxide, potassium iodine, hydrochloric acid, sodium thiosulfate and starch. The reaction has two steps: the first step generates iodine molecules, and the second step consumes the iodine very quickly. After the second step reaches completion, the iodine molecules are free to form a complex with the starch; this turns the solution a very dark blue/black color. The time before color change can be altered by varying the amount of thiosulfate. The color change is monitored by a photosensor which relays the information to an onboard Arduino control board which triggers the car to stop after the solution turns dark. The time of the iodine clock reaction is calculated based on the specified weight and distance the car must travel. We use an equation to predict the required volume of thiosulfate to the time it takes to reach the specified distance based on the speed the car travels with various loads.

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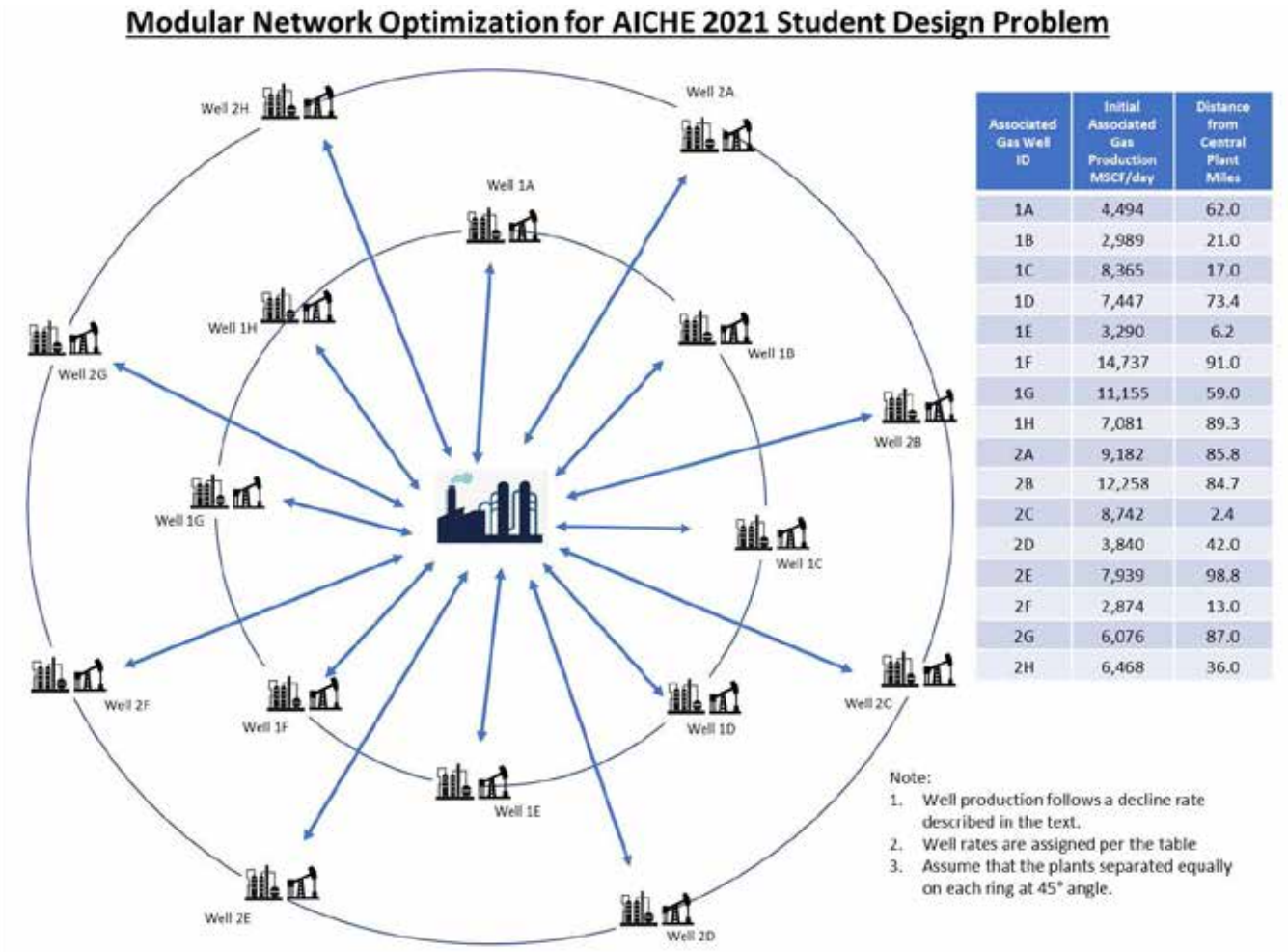
## Modular Distributed Gas-to-Liquid Methane Conversion

By 2050, energy demand worldwide is forecasted to increase by 50%. To sustain this growth, it will be crucial to invest in new sources of energy and to maximize the efficiency of existing energy sources such as fossil fuels. The ongoing challenge of climate change has emphasized the need for advancements in technologies and production methods in industry applications to eliminate or significantly reduced carbon emission.

Handling natural methane gas from stranded oil production is currently a prevalent climate issue worldwide. This stranded methane gas cannot be economically collected or stored due to its remote location. Therefore, large manufacturing sites are forced to burn the produced methane gas through on-site flares. Flaring is the process of initiating a controlled burn at an oil well head to combust the methane into CO2. Estimates report that approximately 30% of associated natural gas is flared for disposal, which equates to 111,000 metric tons of generated carbon dioxide per year.

A potential solution to this problem is to convert the natural gas to liquid petroleum products that can be easily stored on site and later transported. One method to achieve this is through the "Fischer-Tropsch process." The process generates long chain liquid hydrocarbons such as propane, gasoline and diesel, as well as other products from carbon monoxide and hydrogen (syngas). A water gas shift reaction can be used to generate hydrogen from the methane feedstock.

The objective of this Chemical Engineering Senior Design Project is to design a profitable process of converting natural gas into liquid petroleum products utilizing modular manufacturing techniques. Modular manufacturing is the process of creating small-scale infrastructure that can be assembled and installed directly at the well head with a numbering-up approach to suit production capacity. This allows economy of scale. Ideally, these modular GTL units can be manufactured off site then transported and assembled at well heads. They can then be redeployed to alternative sites as production capacity decreases, to optimize the overall profitability of the modules.




| Associated Gas Well ID | Initial Associated Gas Production MSCF/day | Distance from Central Plant Miles |
|---|---|---|
| 1A | 4,494 | 62.0 |
| 1B | 2,989 | 21.0 |
| 1C | 8,365 | 17.0 |
| 1D | 7,447 | 73.4 |
| 1E | 3,290 | 6.2 |
| 1F | 14,737 | 91.0 |
| 1G | 11,155 | 59.0 |
| 1H | 7,081 | 89.3 |
| 2A | 9,182 | 85.8 |
| 2B | 12,258 | 84.7 |
| 2C | 8,742 | 2.4 |
| 2D | 3,840 | 42.0 |
| 2E | 7,939 | 98.8 |
| 2f | 2,874 | 13.0 |
| 2G | 6,076 | 87.0 |
| 2H | 6,468 | 36.0 |

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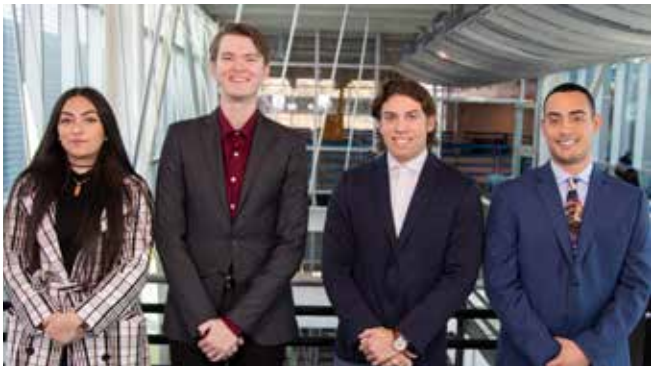

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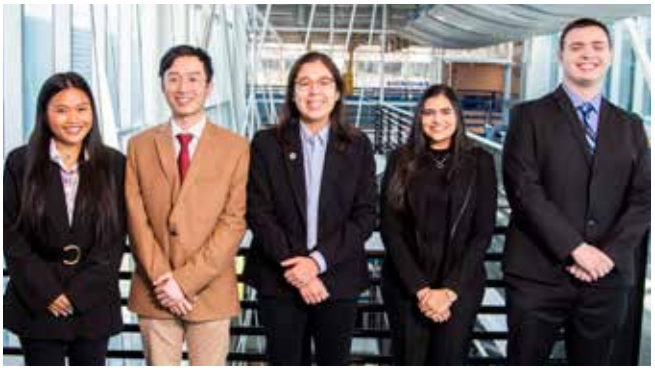

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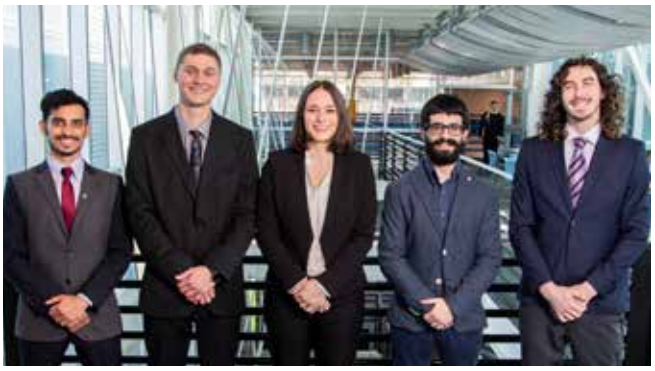

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## 121: Exactech

Exactech is a manufacturer of replacement shoulder joints and wants to create a tool to measure bone quality quantitatively. Exactech asked us to make such a device. Bone quality is an important factor in shoulder replacement surgery.

Age, injury, disease, or a combination of these, can cause damage to the shoulder joint. When a joint is damaged, shoulder replacement surgery is a treatment option, removing the damaged joint and replacing it with an artificial joint. These artificial joints fall into two general categories: stemmed or stemless implants. Stemless implants provide shorter recovery times and less invasive surgeries. However, these need sufficient humeral bone quality to be used safely and effectively. If the bone quality is not acceptable for a stemless implant, the surgeon uses a stemmed implant.

To determine the quality of the bone, the surgeon uses a manual "thumb test." The humeral head is cut off, then the surgeon places their thumb on the cut plane of the bone. The surgeon applies pressure to the bone where the artificial joint will be implanted. Based on the bone's deflection, the surgeon assesses the bone quality and determines the appropriate implant type. However, this qualitative measurement based only on the surgeon's experience and is difficult to communicate.

We designed a tool to replace the subjective "thumb test" with a handheld indenter to create a quantitative score of bone quality. The indenter uses a spring to accelerate an indenting pin at known and constant force, causing the pin to strike the cut face of the bone. The tool measures the maximum distance the pin penetrates the bone, which indicates the bone quality. The pin enters the portion of the bone that is removed as part of the surgery, which prevents interference between the measurement and the replacement joint. Data from the device can be easily recorded and communicated across the field, as well as be used to study implant success rates as they pertain to bone quality.

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**SPONSOR**
Exactech; Tom Vanasse

## 114: KiDDs-Tech

We designed a digital assistive technology for use in speech/language treatment to improve the quality of care for anyone suffering from speech/language disorders. These software tools will serve as an aid for speech therapy treatment and evaluation.

The applications, developed using Python and Unity, are programmed into a portable and handheld Raspberry Pi 4. The first application is an automated data collection system to assist speech language pathologists (SLP) during the evaluation process. The application facilitates the process and allows the SLP to keep their attention on the patient rather than having to look away to write them down on paper, potentially missing important non-verbal cues.

The second application, WordQuest, is an interactive level-based game that serves as a form of speech therapy treatment by encouraging the patient to practice proper sentence structure and language skills. With its engaging visuals and challenges, patients navigate the seas and battle using the power of language.

For this project we partnered with KiDDs, an interdisciplinary training program designed to prepare graduate students for work with children with developmental disabilities and culturally diverse backgrounds.

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## 115: Nope-ioid

Opioid misuse is prevalent in America, impacting an estimated 10.1 million people ages 12 and up. We found a deficiency in the present pharmacological options used to assist in the recovery of opioid use disorder (OUD). Many treatment plans focus on the behavioral aspect of addiction and provide only certain medications, and those can cause discomfort and inconvenience for patients. Our goal was to create a form of medication delivery that is effective in assisting opioid recovery in a pain-free way, while maintaining ease of use and availability for the patient.

Our product eliminates the need for constant physician visits (after minimum 1 year of sobriety), painful medication delivery, and ineffective symptom assistance by giving patients long-term, steady release of methadone in the form of transdermal patches. Nope-ioid, our patch, is contained in descriptive, protective packaging, providing details on both safety and usability. The patch is composed of a backing layer, a drug/hydrogel matrix, an adhesive layer and a removable liner. Methadone is incorporated into the hydrogel matrix in specific doses to ensure that patients will receive the benefits without accidental overdose.

## 116: Adiponect-In

In the United States alone, there are over 6.5 million individuals who suffer from peripheral artery disease (PAD). Currently, there is no cure for PAD, but instead it is recommended to take action to alleviate symptoms, and most physicians recommend lifestyle changes. This can include, but is not limited to, increasing exercise, taking medications for lower cholesterol, lowering blood sugar, or quitting smoking. While these actions may help in temporarily alleviating the symptoms, they are not long-term or permanent solutions. With no long-term solutions for PAD, we created an implantable, biocompatible, and porous device that allows adiponectin to act locally over a frame of 3-6 months in order to curb the symptoms of PAD.

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Mayo Clinic

## 117: Tracheobronchial Reflux Diagnostic System

Tracheobronchial Reflux Diagnostic System (TRDS) is a medical device intended to accurately diagnose patients with gastroesophageal reflux disease (GERD) and increase efficacy in treatment. These patients often experience GI reflux symptoms like heartburn, chest pain, chronic cough, hoarseness, etc. Chronic GI reflux has also been associated with more serious consequences like tracheal stenosis, tracheobronchomalacia and pulmonary fibrosis. We created a diagnostic system that monitors the frequency and duration of GI content in the airway (acid and non-acid) relative to patient activity and symptoms. By promoting the diagnosis of GERD, the TRDS will allow for earlier treatment intervention to improve symptoms and reduce the chances of lung permanent damage. This system enables physicians to be more confident in their diagnosis, thus providing better and faster quality care to patients.

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## 118: Ultrateam

Pancreatic cancer is one of the 10 most common cancers in the United States, with a 5-year survival rate of only 5-10%. Despite the prevalence and deadliness of the disease, it is only detected 67% of the time with transabdominal ultrasound. Since the advent of artificial intelligence, the combined use of AI (artificial intelligence) and imaging for medical diagnosis has increased the ability of medical imaging techniques to provide a diagnosis for cancers. We believe that combining artificial intelligence with transabdominal ultrasound will increase its ability to diagnose pancreatic cancers. To test our theory, we gathered a collection of ultrasound images showing pancreatic cancers, denoised and filtered the images, fed them to a trained AI to test for cancer, and then enhanced the contrast of the output image. We then assessed the accuracy of the AI's diagnosis to evaluate this methodology's effectiveness in accurately diagnosing pancreatic cancers.

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Biosense Webster

## 119: Biosense Webster

For more than 30 years Biosense Webster, part of the Johnson & Johnson family of companies, has been the global market leader in the science and technology of cardiac arrhythmia treatment. Due to the complexity and wide range of variation in cardiac anatomy, it is beneficial to create a physical representation of a patients heart prior to surgery. We proposed creating patient-specific cardiac models via 3D printing following translation of CARTO 3 System data. Providing surgeons this resource prior to surgery will lead to decreased postoperative complications, surgical times and incidence of recurrence in treated cardiac pathology.

By improving metrics related to surgical efficiency, institutions will cut operating costs and save time, therefore increasing efficiency. The heart is an extremely complex organ consisting of muscular tissue, fluid components and electrical conductivity nodes. Recreating a model involves implementing multiple systems including electrical components, realistic, mechanical properties, blood-like fluid and a pumping system. The integration of multiple sets of patient data will allow Biosense Webster to individualize and customize each patient heart according to their pathologies and anatomies.

## 120: Operation Hanger

We worked closely with the Hanger Clinic to develop an improved splint model that treats ankle contractures and other foot-ankle misalignments. The Hanger Clinic is a clinical prosthetic and orthotic outfitting company that offers individualized care for patients.

The FlexNite is a KAFO (knee-ankle-foot orthotic) splint model meant to be worn by a patient overnight to treat ankle contractures. FlexNite's design intends to effectively stretch the Achilles tendon and other tight musculature that can cause contractures over time. This allows an increased range of motion and improved overall quality of life for the patient. The device is produced with a variety of biocompatible materials: polyethylene terephthalate glycol, high density viscoelastic foam, medical-grade Poron foam, Velcro straps and aluminum gears.

The issues of competitor models of AFOs (ankle-foot-orthotic) are addressed in the design of the FlexNite by taking fitting, stretch quality and cost into account. One unique feature in the design of the FlexNite is its dissociating foot and leg components. This required for patients with extreme contractures who are unable to wear other AFOs. By allocating a gear mechanism to the ankle joint (as opposed to a continuous plastic brace), the FlexNite opens up to allow even the most extreme contracture to fit. We intend to financially benefit the patient and consumer by making the model affordable and reimbursement friendly.

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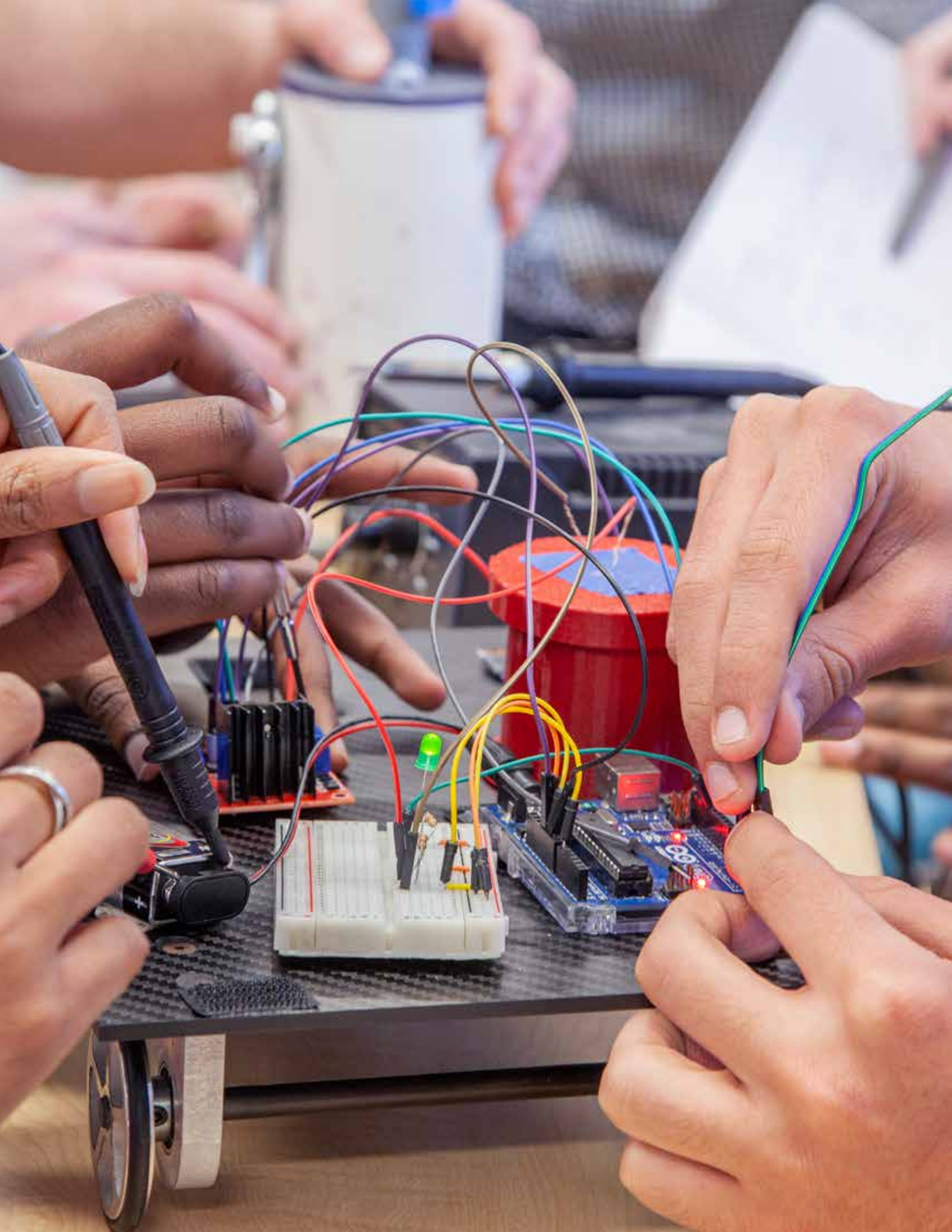
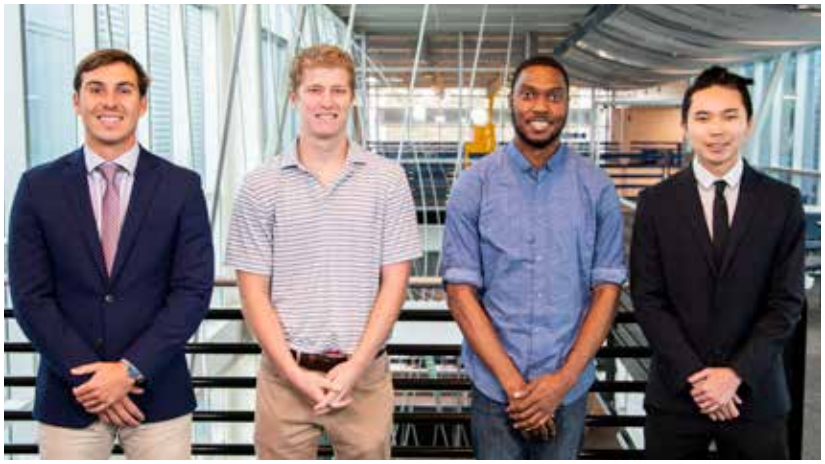


# Civil & Environmental Senior Design


The old existing water tank will soon be out of service, and the new tank will provide enough water to meet the camp's needs.

## 216: Camp Weed

Our senior design project improves the water treatment system at Camp Weed and Cerveny Conference Center located in Live Oak, Florida. The retreat center's primary function is hosting summer camps. During the summer, the large number of campers increases the scale of the water demand, which varies throughout the year. This out-of-date system needs new hardware, a new system order, and a new storage tank to meet the camp's needs. Our design uses different chemicals (H2O2 and Cl) to produce clean water while meeting the camp's water requirements. Using the average daily consumption during peak times and the calculated amounts of chemicals, we will provide the necessary clean water to Camp Weed. The old, existing water tank will soon be out of service, and a new tank will replace the water supply stored in the old tank. The design follows all laws and guidelines developed by the FDEP, AWWA, ASTM, and EPA. Though the focus of our design is on the improvement of the current water treatment system, other designs are a part of our plans. We prepared concrete footing pads, steel supports, and soil analysis. These together will create clean water for the people of Camp Weed and the Cerveny Conference Center.



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Florida Rural Water Association;
Sterling L. Carroll, P.E. and
Peyton Piotrowski

## 201: Timber Bridge Replacement

The Florida Department of Transportation (FDOT) has proposed the replacement of bridge 524014 on Horsebarn Road and Blue Creek. The project is in Holmes County, Florida, a quarter of a mile off Samson Highway along Horsebarn Road over Blue Creek. Holmes County is a rural community, based around agriculture and farming.

FDOT needs a complete replacement of the current timber bridge, built in 1979, which has a current sufficiency rating of 29.5 out of 100.

Sufficiency rating refers to a bridge that has been determined structurally deficient or functionally obsolete. FDOT decided that bridge 524014 requires replacement to produce a sufficiency rating of 90 or higher. Our goal is to increase the sufficiency rating with our design.

The existing bridge is 29.6 feet long and 16 feet wide, with two spans measuring 12.6 feet and 14.3 feet. The bridge area is designated at FEMA Zone A, but due to Horsebarn Road being unpaved with a low frequency of average daily traffic, we chose a 10-year frequency. The roadway approach was updated to match the elevation and transition into the structure. This is accomplished by paving the roadway and adding a guardrail.

We evaluated the replacement of the Timber Bridge on Horsebarn Road and Blue Creek using a cast-in-place concrete single-span bridge and box culvert. Due to cost efficiency, we chose the box culvert. Maintenance and operations will be handed over to the county.

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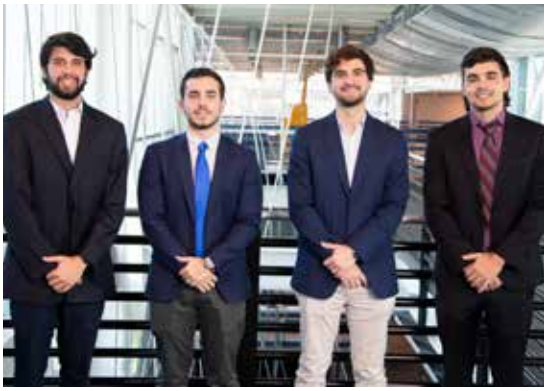
## 202: Residential Community Amenity Campus Project



The Residential Amenity Campus is located near Rattlesnake Hammock Rd. and Collier Blvd. in Collier County, Florida, near Naples. The project is inside a residential community that consists of about a hundred units, of mostly senior citizen living. Our project included the site planning and development of a 10,000 $ft^2$ clubhouse, 4,000 $ft^2$ pool, pool equipment area, three tennis courts, parking lot, mail kiosk and one bocce court. To address the project needs, we prepared a plan that maximizes the usage of the site to accommodate all the necessities within a reasonable space and with a smooth flow of traffic. While addressing the project's impacts, we developed a plan for site grading to emphasize the effectiveness of the drainage system without compromising the existing water and sewage line. The elevations and sloping for our grading plan meet the required guidelines and ensure that the site is safe yet effective in draining runoff to the stormwater management facility. In addition, we developed an erosion mitigation plan. In the geotechnical aspect, the soil in the project area consists mainly of poorly graded sand and silty sand; this raises the cost since a lot of earthwork will need to be done. Residents in the amenity campus will have a chance to perform physical activities with the help of the planned sporting facilities. Overall, the residential community amenity campus will work as a place for the elderly to socialize and meet new people while using the proposed facilities in the complex.

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## 203: Chaire's Crossing Townhomes

With the recent growth in Tallahassee in recent years, developers are looking for potential new project sites. An ideal area for future development is a vacant parcel of land located at 10701 Capitola Rd., Tallahassee, FL. This site consists of over 80 acres, making it large enough to sustain a new development. The ultimate goal is to help bring people to the fairly rural area and promote long-term growth.

A mixed-use development is ideal for this site because it blends residential living with shopping and dining establishments. We provided the engineering plans for the development of this site. The building consists of several first floor retail spaces with residential spaces available for rent on the second and third floors.

We focused on various aspects of civil engineering that are required to develop this site. Specifically, we focused on the areas of structural, land development, environmental and stormwater engineering. We created a viable set of plans that could one day be used to bring our vision of Chaire's Crossing Townhomes into reality. This development could be the foundation for future growth near the area and one of Tallahassee's premier living communities.

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## 204: Summit at Brooklyn Yard

Tallahassee is the home of two universities and a community college serving a student population of approximately 60,000 – 65,000. As the universities plan more expansion, student housing must also increase. Many investors buy land and build apartment complexes around Florida Agricultural & Mechanical University (FAMU) and Florida State University (FSU). The owner of 604 Eugenia St. wants to do the same.

We developed a site design for a five-floor student housing complex located at this site. Our main goals when designing this site were to provide housing for as many residents as possible and have enough parking for residents and employees. The site had existing on-site stormwater management and walking access to FAMU Way and Eugenia St., and is 1.8 acres in size. A very steep slope presents itself as a challenge for the project, which we took into account. The apartment complex will face FAMU Way with a partial first-story parking garage. Access to the site will be on Eugenia St. and the surface parking lot.

The student housing complex will contain up to 126 rooms. We propose two detention ponds onsite that will hold and drain excess water from storm events to the nearby city stormwater outlet on FAMU Way. Proposed site grading will require three concrete retaining walls to accommodate existing slopes. This addition in housing will increase the foot traffic of the area for local businesses in the College Town area.

**TEAM MEMBERS** (L to R)
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**SPONSOR**
DHM Melvin Engineering; Paul Davidson, M.S., P.E.

## 205: Stone's Home Center

Stone's Home Center is a chain of hardware stores in the southern United States. The store in Quincy, Florida, is overcrowded and driving there is difficult. The owners chose a new site in Quincy, approximately 1 mile west of the existing store, along Blue Star Highway (Highway 90). We created a design and site layout for the new Stone's Home Center. The project's primary purpose is to provide the area with a store that can better meet the community's needs. Our main goal was to design a larger store than the existing Stone's Home Center in the area. In addition, we also had to develop a new lumber shed and feed building, a parking area, new driveway access onto Highway 90, an on-site stormwater management facility, an on-site septic system, and a connection to the existing water main pipes along Highway 90. This project had several challenges and constraints. The first was our project's location. We had to research information about codes and permits in Gadsden County. We referenced documents such as the Gadsden County Comprehensive Plan, Land Development Code, Stormwater Policy Manual, and more throughout the design phase.

Another challenge we faced was a small wetlands area near the southwestern corner of the land. To avoid this area, we focused our design on the eastern side of the lot. This means there is still some space on the western side for the owners to expand the business. Our method not only exceeds the size of the existing Stone Home Center but also has enough parking to accommodate regular vehicles and trucks, including semi-trailers. Additionally, there is the on-site stormwater management facility, on-site septic system, driveway access onto Highway 90, and connection to the existing water mains.

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## 206: Gulf Specimen Marine Lab Hammerhead Shark Exhibit

The Gulf Specimen Marine Laboratory in Wakulla County, Florida, is a fun and exciting experience for all ages. Since the lab was created, it has been a growing ocean life protection facility. This lab is a safe space for ocean life and has become a well-known tourist attraction for all ages. To make sure the excitement of the marine lab continues to grow, they will be adding more attractions for everyone to experience. The next exhibit they would like to add will be a hammerhead shark exhibit.

The laboratory asked us to create plans for this exhibit, including a new shark tank, utilities, materials for a shelter, foundation work, concrete slabs and a parking lot. This project follows state and county building codes to protect visitors' safety. By making this addition to the laboratory, more people would want to visit, creating more chances for growth. The idea is to protect ocean life and provide a fun memory for everyone, and this step towards the future will accomplish that. Visit the Gulf Coast Marine Laboratory, where each visit will be bigger and better than the last.

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**SPONSOR**
Wakulla County Gulf Specimen Marine Laboratory; Cypress Rudloe

## 207: Weems Road Culvert Reconstruction

Located in Tallahassee, Florida, Weems Road is a two-lane residential roadway. Weems Road improvements consist of street and drainage improvements to the Weems Pond Outfall structure. The pre-existing conditions of the street are fair. Flooding onto the roadway from the adjacent ten-acre Weems Pond is typical. Sidewalks for pedestrian use are not available. Excess flooding during peak storms causes the road to be inaccessible. We designed the following solutions to these problems.

The bridge design consists of a Three-Span Continuous 16" C.I.P. Flat Slab. The retaining wall is a Mechanically Stabilized Earth (MSE) retaining wall. We designed a weir sufficient to prevent flooding onto the roadway. Increased flow under the three-span bridge benefits the downstream water body. The bridge also provides sidewalks for pedestrian traffic, increasing transportation options. MSE retaining walls support the channel created under the bridge span. The MSE walls also provide erosion control.

These design alternatives provide a long-lasting solution to the flooding issues on Weems Road. We selected improvements with input from residents. Design considerations account for the surrounding environment. The project at hand consists of hydraulic and roadway improvements to the site at Weems Road. This project will ultimately benefit Tallahassee's residents on this busy collector roadway. We created construction cost analysis based on current material quantities and labor tasks and construction scheduling was planned to minimize project completion time.

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## 208: SR 75 (US 231) Resurfacing and Reconstruction

Our project is to reconstruct an intersection along Florida's State Road 75. The intersection is located in Jackson County, FL, where Jacob Road intersects State Route 75. Florida Department of Transportation (FDOT) requested a redesign of this intersection due to an abnormally high number of car accidents. Most of these accidents are classified as angle-related. They are caused by Jacob Road users being struck as they cross State Route 75. We were asked to increase the safety of the road and reduce the number of crashes with our redesign and to extend the life of the road by 20 years.

We chose to implement an Unsignalized Restricted Crossing U-Turn (RCUT) at the intersection to increase road safety. This redesign restricts Jacob Road users from crossing straight through the intersection. Instead, it redirects them to turn right, where they travel a short distance before making a U-turn onto the other side of the road. We created our R-CUT using multiple references provided by the FDOT. We produced drawings and plans, pavement design, drainage calculations, and typical roadway section details for the new intersection. Along with the plans for the intersection, we provided a budget and sample construction schedule. The final plans follow FDOT regulations while keeping safety, traffic patterns and project cost optimum.

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**SPONSOR**
Chipola Engineering Group; Blaine Varn, P.E., Nick Grosso, P.E.

## 209: Centrate Equalization Tank

The Thomas P. Smith Water Reclamation facility faced efficiency and load capacity problems at its waste treatment plant. We designed an equalization tank to fix it. The current storage tank at the facility reached capacity at three and a half days, with 17 million gallons. The nutrient-rich sludge that undergoes treatment at the waste facility caused a strain on the pipes within the system—the load would become too heavy at the end of a three-day cycle. To mitigate this, we designed a centrate equalization tank with a capacity of 31 million gallons and a flow system that operated for six and a half days. The goal in implementing the centrate tank is to regulate the impact of the nutrient-rich liquid on the system and increase the facility's storage capacity to further the lifespan of the plant. The new centrate tank was designed to be located adjacent to the Centrifuge Dewatering Facility at the plant. We considered essential constraints including odor emissions, material sizing, permitting and environmental safety factors.

The project scope aimed to design a sustainable centrate equalization tank with a steady flow that transported the liquid filtrate back to the front of the water reclamation facility. Drawings were instrumental in implementing our design, mass balance and hydraulic flow calculations were completed to ensure full functionality of the tank and treatment system.

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City of Tallahassee; Sondra Lee, P.E.

## 210: Apalachee Regional Park Entrance and Roundabout

Apalachee Regional Park is located off Apalachee Parkway in Tallahassee, FL. The park is home to the NCAA Cross Country championship competitions, football fields, a city waste center and a drone field. It is the center of interest in the tourism strategy to bring in more money for Leon County Parks and Recreation. However, the park needs a few upgrades to bring a more vibrant and welcoming feel to the landmark.

After analyzing the existing entrance to the park, we designed a roundabout that considers existing ditches, trees, a sealed landfill and parking lots for sporting clubs at the park. We provided the design decisions for roundabout size and location, determined the drainage impacts, erosion control, and protected existing features. We created a demolition and tree removal plan.

Our plan proposes ridding the site of the existing poor-quality asphalt intersection and replacing the four-way stop with a high-quality roundabout. We will cut down and remove any interfering plant life. The pre-existing devices and power lines will be capped and/or shut off until construction is completed. Removed trees will be replanted in the center island of our roundabout. Manhole covers will cover the devices for easy access for future inspections.

Upon completion, the roundabout will be the ideal entrance, allowing tourists access to all parts of the park and will protect the park's existing drainage and amenities. It will also provide a visually appealing entrance to Apalachee Park.

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Halff Associates, Inc.;
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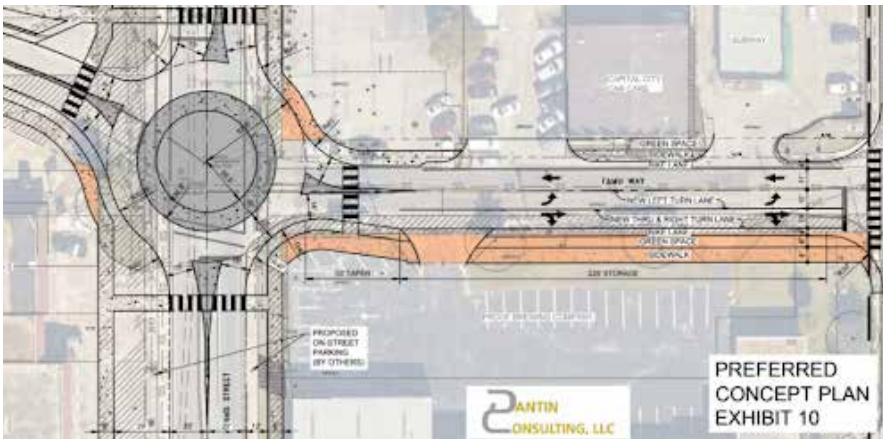
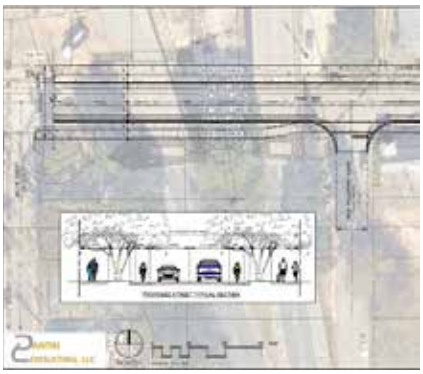
## 211: FAMU Way - Phase IV

Creating FAMU Way: Phase IV continues the existing roadway to S. Monroe St. and replaces a current signalized intersection with a roundabout. The hardest part of this project was deciding the best route and optimum width of Right of Way (R.O.W). All possible routes have detrimental impacts on existing developed properties loved by the Tallahassee community, especially Shell's Restaurant and the True Fellowship of Holiness Church. If a narrower R.O.W. is used to keep the buildings intact, the roundabout will not meet the specifications turning design speed and turning radius. A narrower R.O.W. also limits pedestrian and landscape features incorporated in the previous phases of the roadway. We created an alternative design matrix to judge two project alternatives. Both choices were almost the same when using a weighted-point system, so the higher-scoring alternative was selected.

Using the alternative design matrix and the specifications detailed in the scope of work, we decided that the best solution was to go with the full-width R.O.W.

A new roundabout in place of the existing signalized intersection will help increase traffic flow while keeping the current level of service. The new design is pedestrian-friendly and will align pedestrian traffic throughout the new road and roundabout. The new roundabout and signalized crossing will continue to display a nice area that has been provided in the city's infrastructure and throughout the connection of FAMU Way to the community.



## 212: Little Pine Barren Creek Bridge Replacement

This project aims to replace the aging State Road (SR) 97 bridge over Little Pine Barren Creek in Escambia County. The bridge is over 80 years old and located along a hurricane evacuation route. There are noticeable cracks in the piling that hold up the bridge, which indicate the settling of the foundation. The bridge was declared structurally deficient by FDOT and must be replaced. This bridge is in a rural farm community and farm equipment vehicles use this roadway.

Since SR 97 is a designated hurricane evacuation route, a detour is not allowed because the road must always be open. We decided that building a new bridge to the side of the existing structure is our best option. Once the new bridge is completed, the street will be reconstructed to match the new alignment, and the existing bridge will be demolished.

The northbound lane approaching the bridge has a spot where it is hard to see and has resulted in several crashes since 2005. Realigning the road will correct the area and provide an additional safety improvement to the project. Construction must follow strict guidelines to protect the surrounding wetlands, and we worked to minimize impacts to surrounding wetlands and water resources to the greatest extent possible.

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**SPONSOR**
HNTB Corporation; David Crombie, P.E.

## 213: Zillah Street Redesign

Zillah Street is a residential roadway that connects East Paul Russell Road and Tram Road in Tallahassee, Florida. Dozens of homes and Fairview Middle School are located along this street, meaning many people utilize it.

Currently, the condition of Zillah Street is subpar. It is marred by open ditches along the road that represent outdated stormwater infrastructure that is unsafe for current standards. Cracks and potholes in the street and sidewalks are also prevalent, undesirable features. These contribute to decreased pedestrian and vehicular safety. The open ditches reduce the amount of usable space that could otherwise be used for roadway or sidewalk.

We planned many items to fix these issues. The roadway will be milled and resurfaced. Additionally, the sidewalk will be demolished, reconstructed to be slightly wider, and added to additional parts of the street. Furthermore, the stormwater management system will be updated. The roadside ditches will be replaced with a curb and gutter system with the addition of fill and landscape. Moreover, additional pedestrian crossings will be introduced. This will include a four-way crosswalk and stop signs at a concerning intersection on Zillah Street (Bahama Drive & Omega Avenue).

Our ultimate goal is to provide safe travel for motorists and pedestrians. Additionally, we want to ensure that all the Americans with Disabilities Act (ADA) requirements are more than satisfied. Widening the sidewalk is one of the main issues where this is a concern that we believe to be essential to address.

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**SPONSOR**
H.W. Lochner; Scott Simmons, P.E.

## 214: Residential Subdivision

Our project was to design a residential subdivision near Pedrick Road and Mahan Drive in Tallahassee, FL. The desired outcome was a design with a low negative impact on the community's environmental, economic and societal conditions. Providing new housing in this up-and-coming area of the city contributes to the growth and economy in the neighborhood. It also adds more housing to the active community and allows easy access to Pedrick Pond Park. While community impacts were significant to consider, the client's request prioritized profit. Considering all factors, the optimal number of units was 17 units with an average lot size of 11,000 square feet and a home size of 2,400 square feet.

The proposed project closely follows the land development codes for Leon County. This includes the design of stormwater, grading, tree mitigation and transportation plans. The parcels for the project include a large floodplain area, which greatly influenced the site layout. We designed the stormwater pond based on volume control standards. Tree mitigation was done based on the tree credit and debit system outlined in the county code. Our grading plan was designed so runoff would not cause flooding on or off-site. We designed a looping road through the subdivision for access to the homes. The rear portion of the lot is mainly a floodplain and contains a gas easement. It is designated a conservation easement with a recreational walking path.

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**SPONSOR**
Magnolia Engineering LLC; Scott Kelly, P.E.

## 215: Dillard Street

Dillard Street in Winter Garden, Florida, serves as one of the main thoroughfares between downtown and State Rd 50. As it currently stands, Dillard St. is a five-lane road with a 35-mph speed limit. The amount of existing high-speed traffic creates issues for small businesses located along the road and pedestrians trying to cross. In its current state, Dillard St. acts as a barrier between the east and west wings of the city. With most of the amenities located on the western side of town—such as the downtown area and several biking and walking trails—residents there feel cut off from half the city. Our design takes the concern of the residents and local businesses into account. We plan to reduce the number of lanes on Dillard St. to three and include a designated pedestrian path. Our objective is to increase foot traffic for local businesses by creating a more pedestrian-friendly space and expanding the area's walkability and access to the western portion of the city. Intersections will be replaced with roundabouts to reduce speeds as well. Our design features a more environmentally-friendly approach to drainage, using bioswales to filter and retain stormwater runoff.

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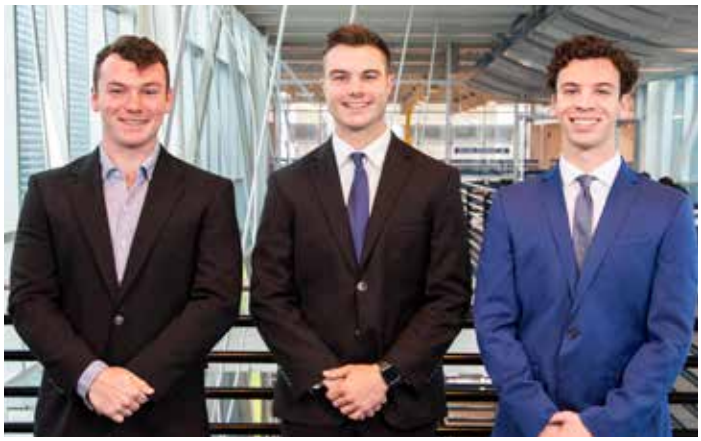
**SPONSOR**
Toole Design; Kristof Devastey, P.E., P.T.O.E, P.T.P and Ian Lockwood, P.E.



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**SPONSOR**
Florida State University; Gary Feldman

## 217: Traditions Parking Garage

The Florida State Traditions Way Parking Garage is a four-story parking facility in Tallahassee, Florida, that is open and at risk to poor weather conditions. Due to the parking garage's constant exposure to weather, we evaluated the structure to ensure the university community was safe. We found the joints and areas holding together the concrete sections have become brittle over time, with cracked concrete crack and exposed rebar. We suggested a solution to fix the structure and increase its lifespan. Our plan first corrects the rusted rebar by spraying it with high-pressure water. We recommend filling the cracks in the concrete with a sealer. We also proposed a new solution that would resolve any rusting of the rebar or cracking concrete in the future: a new design for the joints used between the concrete sections. Typical joints can quickly become hard from weather exposure. We presented the idea of a new kind of joint that requires little care and can withstand the weather for a more extended period. These proposed solutions increase the life span of the parking garage and provide a safe place for the community to park for years to come.

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**SPONSOR**
DDA Engineers; Aida Albaisa, P.E.

## 218: Homestead Student Success Center

Our project aims to prepare the construction documents for a new Miami Dade College (MDC) Student Success Center at the Homestead campus. This four-story educational building will include offices for Admissions and Registration, Financial Aid, Business Development, and added classrooms and laboratories. This building will simplify student life at Miami Dade College's Homestead campus. These students will now have many different services not offered before on this campus. With Homestead being one of the smallest of the eight total campuses, this building will also attract more students, hopefully bringing more business to the Homestead area.

Our primary responsibility was to design this building using different codes. This included preparing the framing plans, calculating column and wind loads, and designing the beams, columns and footings. Using the 2020 Florida Building Code, ACI-318 Building Code Requirements for Structural Concrete, and ASCE 7-16 Minimum Design Loads for Buildings and Other Structures, we were able to find the values needed to design this building. To complete the design, we also used different computer programs, including SpSlab, SpColumn, and AutoCAD. The unique design of this building created some challenges, but using the listed codes and our sponsor's help, we were able to work through these challenges as a team. We look forward to leaving our legacy on the Miami Dade College Homestead Campus and having many students enjoy the Student Success Center that we have successfully designed.

# 219: SR 847 / NW 47th Ave Reconstruction

NW 47th Avenue is a busy roadway in South Florida that runs from Miami-Dade County through Broward County. We reconstructed the area of NW 47th Avenue that runs from NW 215th St to Premier Parkway, which is 0.5 miles long. The primary purpose of this project was to convert the existing two-way two-lane road into a two-way four-lane highway. This change is expected to improve traffic in the area by preparing for potential traffic growth. Other benefits are: rebuilding outdated roadways and sidewalks, enhancing safety for pedestrians, bicyclists, and transit users, and upgrading drainage throughout the area.

The adjacent street segments at each end of the project were converted into four-lane highways in the past, so this section of the road is the final section to be completed. There is a nearby landfill in this area—one of the biggest challenges we face is to have the most environmentally friendly design. Not only did we design two extra lanes, but also traffic signalization, pavement markings, signage and drainage plans. Construction includes flattening the road to improve driving conditions and putting in deep foundations for light poles. Medians will be installed to separate the two northbound and two southbound lanes, making a safe barrier between the roads. New pavement markings and LED street lighting will help improve driver safety and the overall aesthetic of the new road. Our drainage design consists of curbs that will relocate the water into the nearby adjacent Snake Creek canal.

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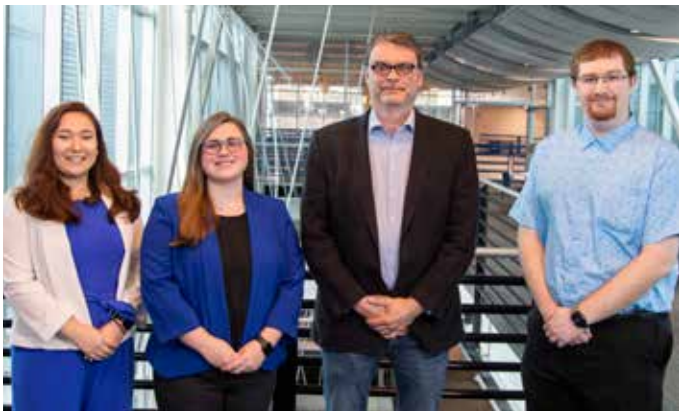
**SPONSOR**
FDOT District 6; Nathalie Garganta, P.E.

**Team 219** reconstructed the area of NW 47th Avenue that runs from NW 215th St to Premier Parkway, which is 0.5 miles long.

## 220: Navarre Bayside Park



We redesigned the Navarre Bayside Park to create a one-of-a-kind experience for locals and tourists in the Navarre community of Santa Rosa County, Florida. Due to limited funds, poor maintenance, and intense storms, the park has declined over time.

We focused on the east side of the park and provided plans showing the updated park. These plans included more parking spaces, additional landscaping, a new restroom, an enhanced seawall, a new water play area and playground. The quality, size and purpose of the features within the park were upgraded.

The biggest challenge for this project is the park's artificial pond within the park and the park's location next to a large body of water, allowing the public to access the beach. We chose the best design to provide the public with a better park while considering the public's safety and the environment.

It was essential to consider the project's social, economic and environmental effects. The primary purpose of this park is to bring in visitors and provide an entertaining area for the locals, which will bring in more culture to the Navarre community. The park will have better drainage and more environmentally safe materials. When complete, it will provide the best use of financial resources with the increasing number of locals and tourists visiting the area.

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Magnolia Engineering LLC;
Carmen Bourgeois Greene, P.E.

## 221: Lloyd Nursery Irrigation and Water Reclamation

Lloyd Nursery in Jefferson County, Florida is expanding their current growing operation. The nursery lacks a sufficient irrigation system that would support an expansion of their flower growing operation. The 34-acre operation includes above ground growing pots that are irrigated by rotor sprinklers which are supplied water from the irrigation pond. The site slopes from north to south and water is collected in an irrigation pond at the south side of the site. The nursery currently pumps groundwater into their irrigation pond due to lack of runoff capture on the site. DMB Sustainable Solutions designed an irrigation and water reclamation system to meet the needs of the nursery expansion. The team aimed to create a closed loop irrigation system that reuses all irrigation and storm runoff.

The additional planting bed will contribute to agricultural runoff during the rainy season. The design uses stormwater and agricultural runoff that would otherwise be leaving the site during these months. This enables the nursery to reduce irrigation and nutrient costs by reusing these resources. Additionally, the design will be more environmentally friendly due to the reduction in harmful nutrients leaving the site.

The team accomplished this by designing a large planting bed that slopes into the center to create a channel. There are two sides for plants with a channel in the middle that is graded to flow towards the pond. Water flows from the channel into a pipe that leads to the pond utilizing the natural slope of the site. Pumps were sized to accommodate for the amount of energy necessary to irrigate water back uphill.

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**SPONSOR**
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## 222: Conklin Street Apartments

The Conklin Street Apartments are located at 1220-1230 Conklin Street. The Tallahasee, Florida site consists of two apartment buildings and a small leasing office. We aimed to satisfy the client's needs by increasing the housing capacity and the site's stormwater capacity. With limited site space, it was essential to maximize land use efficiently. The project's scope included a design of a new apartment complex with parking and an improvement of the existing stormwater drainage system.

The current site is vulnerable to flooding due to insufficient stormwater drainage. Our solution includes two retention ponds that will serve as a stormwater drainage system and as a new aesthetic feature. The stormwater retention pond provides maximum storage for a 25-year critical storm and the drainage is designed to flow through the site's natural slope. Additionally, a large downslope near the back of the site requires a retaining wall to support the new building. The retaining wall will reduce the risk of mudslide and soil erosion and protect surrounding apartment buildings from damage due to sliding and overturning pressures.

We designed an elevated two-story building to increase the population density within the neighborhood. The ground floor serves as a parking area, and the two floors above contain housing units. The proposed designs will follow the necessary Tallahassee codes and requirements. This will ensure adequate safety for current and future residents while satisfying client needs for increased housing and stormwater drainage solutions.

## 223: Airline Road Extension

Henry County is looking to improve its intercounty travel and general traffic flow. They requested design of a roadway extension to Airline Road, which would connect the intersection of Airline Road and Rodgers Road to the intersection of SR 81 and Old Jackson Road. The project is roughly one mile in length and is in a very rural area of McDonough, Georgia. A set of large artificial ponds and a distinct water stream are on the site. There are also significant elevation changes and a few properties that may conflict with the construction of the roadway.

The roadway needs to minimize impacts to this existing environment while staying cost-effective. The road must not cross the water stream parallel to its flow, so that a culvert can maintain the original flow. Detention ponds and ditches are needed for proper drainage and to minimize environmental impacts.

We should note that the only area that doesn't cross one of the artificial ponds requires impacting more properties. Therefore, we evaluated the best alignment that avoids the ponds against an alignment that goes over the main pond. We decided that avoiding the ponds is the best fit for the project needs while staying economical.

Our design features include the roadway alignment, a representative detention pond, the main culvert and pavement design. We followed the natural elevation changes to minimize changes to the existing area and the number of properties impacted by the project's construction.

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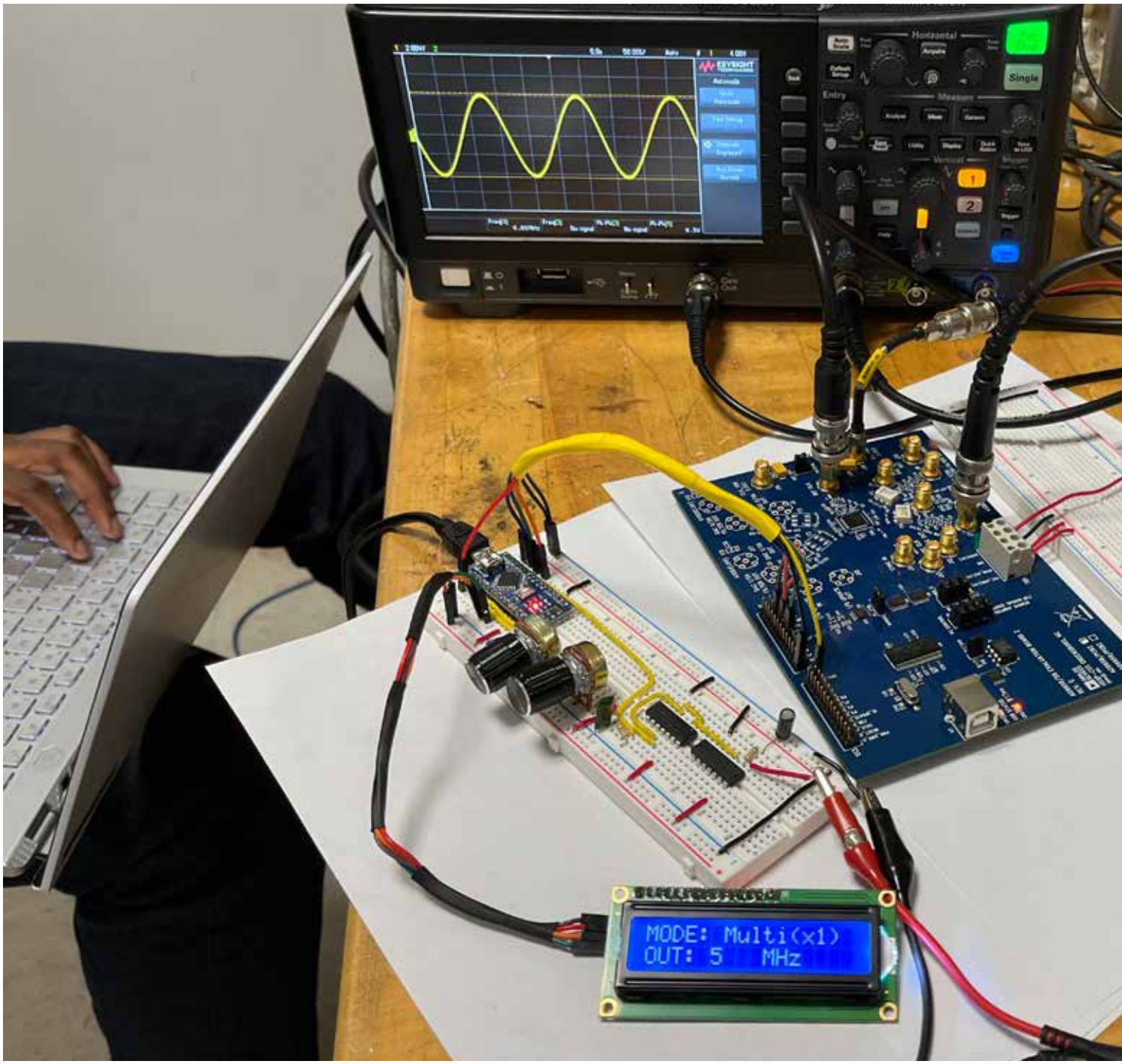
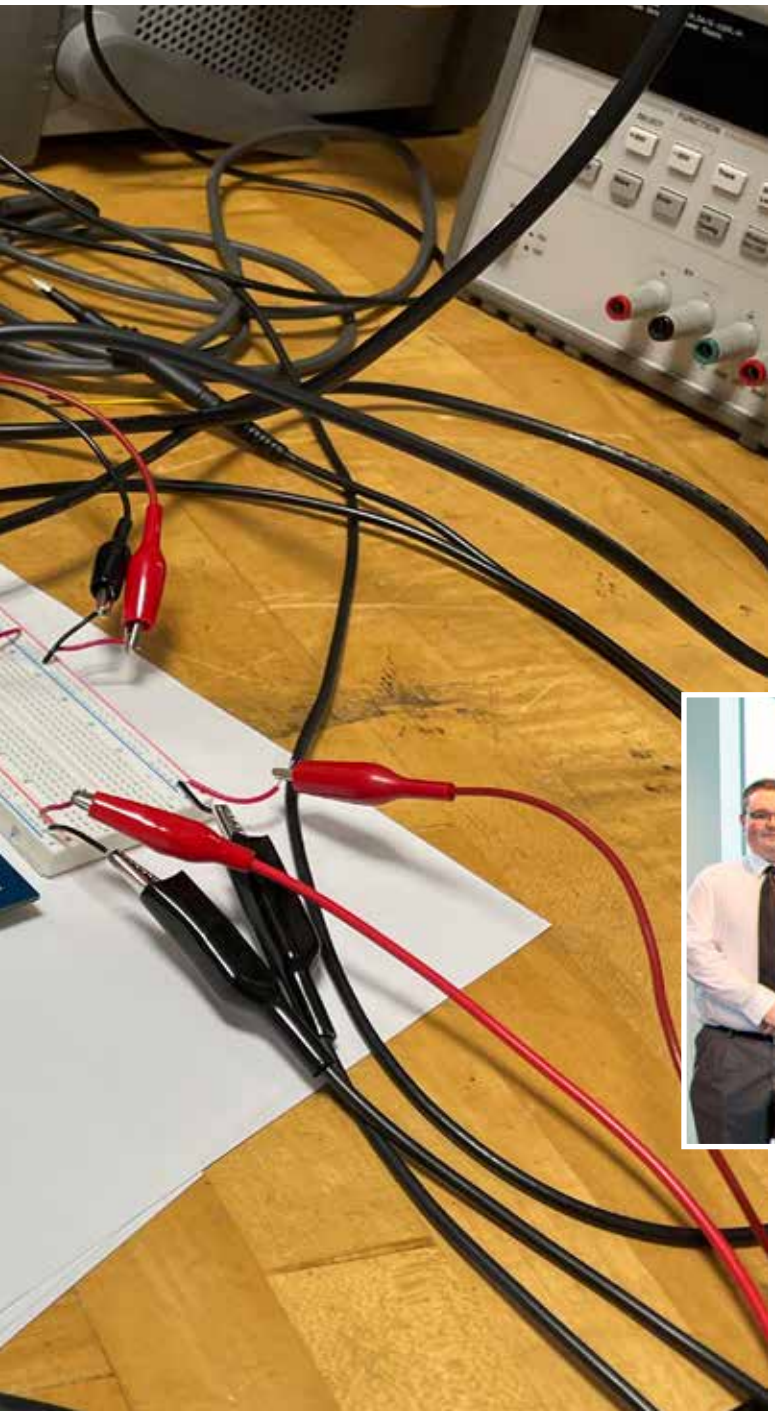
**SPONSOR**
EXP; David McFarlin, P.E., P.T.O.E.

# Electrical & Computer Senior Design



## 302: Frequency Multiplier



The signal generator and oscilloscope are the heart and mind of electrical engineering. They are used to create and read signals, respectively, and are vital for learning and real-world testing. However, cost and usability limit these devices. They cost thousands of dollars, do not always have matching ranges, and require manual adjustments for any level of use cases. We hope to solve these problems by creating a signal generator that can cover most oscilloscope ranges for under a $100, as well as automate the process of testing through a computer program.

There are two major parts to our project, the physical multiplier, and the computer controls. Our multiplier takes a user input and outputs a faster version of a signal. It can also work independently, creating a signal of any value within range. The computer controls set a multiplication value or signal but can also run an automated test through a range of signals. In addition, all the data maybe viewed on a computer interface and saved on the computer local drive.

No matter the user, our signal generator prototype will make electrical engineering testing and learning easier and more affordable.

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Keysight Technologies

## 301: SoutheastCon Hardware Competition 2022

The annual IEEE SoutheastCon Hardware Competition is a robotics design contest. This year's competition is held in the birthplace of Mardi Gras, Mobile, Alabama, and thus is Mardi Gras-themed. Our task is to design a small-scale model of a driverless parade float that follows a parade route, collects and throws beads and pushes a marshmallow. Additionally, we can earn points by including a display and music that demonstrates our school spirit. Our display will be a screen with the images of FSU and FAMU logos, and the music will be FSU's War Chant and FAMU's War Cry.

There are three rounds to the competition, with 10, 15, and 20 beads available in each round. At the start of each round, our robot follows a painted line located in the center of the game board. It uses a camera with image recognition to detect beads located on poles hanging over the track. Using its robotic arm, it collects these beads and deposits them into a holding area. Once the beads are collected, the robot continues along the parade route unless more beads are detected. Along the way, the robot places the beads in a launcher to throw into nets along the route, also detected by using image recognition. Each round will have one marshmallow on the board that represents a member of the crowd that is on the road. If the robot senses a marshmallow, an extendable arm located on the bottom of the robot will move the marshmallow to an alleyway on the side of the parade route. Points are earned for each bead collected and thrown into a net, for each marshmallow pushed into an alleyway, and for completing the course. Our goal is to have our robot finish the obstacle course and the tasks in the least amount of time to maximize points.

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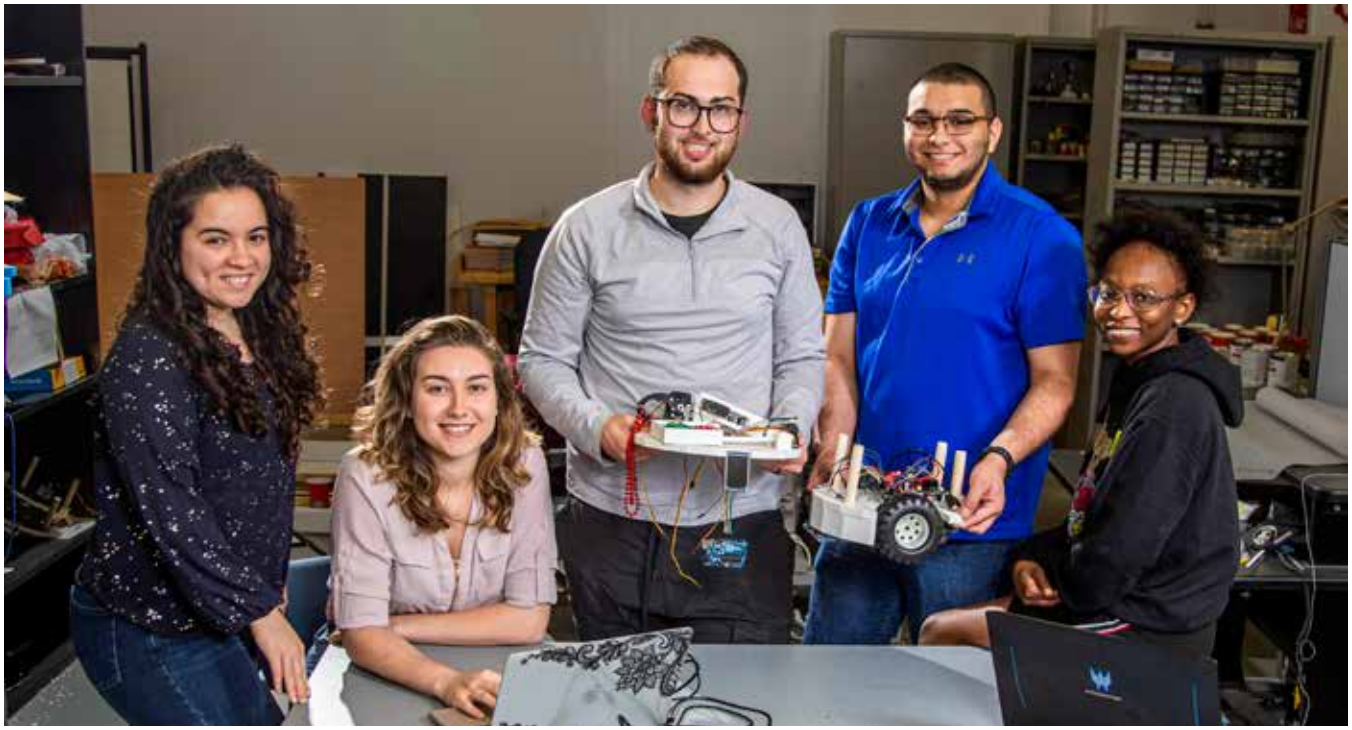
FAMU-FSU Engineering



**Team 301** (Left to right) Melissa Emery, Allison Rosenbaum, Kelvin Hamilton, Raymond Martinez and Destiny Law.

## 303: Automated Non-Destructive Cleaning of Solar Panels

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Raa Tech

New technology is being created every day to help the need for renewable energy. One of the most promising renewable energy sources is solar power. Solar panels are used to harness the solar power in both homes and businesses and their use is growing rapidly.

Over the course of use, solar panels provide renewable energy to homes, but sustain a lot of wear on their ability to produce energy. One of the main drawbacks to solar panel productivity is typically in the form of dirt or debris that builds up over time and is baked into the panel by the hot solar rays. This project aims to develop a device that automates the process of cleaning solar panels.

Currently, buildup is removed by cleaning the panel using brushes and cleaning solution. The main benefit of the device will be to bring down the time spent manually cleaning the solar panels and put that time towards other productive tasks.

This automated cleaning device moves across the entire solar panel to clean it, removing dirt and debris. The mechanical side of the project creates the cleaver structure of the device to make it lightweight, efficient and balanced on the solar panel. The electrical side of the project powers the device and allows it to move around the panel. Device movement is controlled by multiple motors and sensors tracking movement across the panels.

The main benefactors of this device are solar panel companies and solar panel owners. They will benefit by having cleaner solar panels which will make them more efficient and able to produce more power.

## 304: Image Recognition for Padmounted Equipment

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Florida Power and Light

Pad-mounted transformers are responsible for lowering voltages to the standard household levels. Florida Light and Power (FPL) includes devices called fault current indicators within their transformers. When an area has lost power, these indicators detect whether their transformer's current is faulty. However, FPL teams must manually check the indicator within each transformer to locate a fault, which is a time consuming and challenging procedure. We were tasked with detecting faulted transformers using computer vision, inspired by how FPL's existing drone program locates damage on powerlines.

Our design includes a physical beacon that visually indicates faults and a computer vision system that recognizes the beacon. The beacon must be reliable and weather resistant while securely mounted to the transformer's exterior, it must also connect internally to the fault current indicator. When the beacon receives power, a spring releases it into an upright position and its LED light turns on. The FPL Air drone program captures video of the beacon.

The second design component is a computer vision system that can detect the transformer, beacon and beacon state utilizing the algorithm You Only Look Once (YOLO) to accurately detect objects in real time footage.

We developed a method of visually indicating faults and detecting them using computer vision. The solution speeds the process of locating a faulted transformer and reduces the time it takes for FPL to return power to an area.

## 305: Data Collection and Aggregation (Tame the Beast)

The Naval Air Warfare Center Training Systems Division (NAWCTSD) is a Navy training systems center in Orlando, Florida. NAWCTSD works to test and implement new equipment on aircraft platforms. The test points and results are currently on handwritten sheets. Manually transferring the data from the test into a database makes the process time-consuming and inefficient.

To address this issue, we developed a new system for collecting and organizing test data. This application can be used on any tablet. It allows an operator to input the test data electronically and then output the results to a local server. The application can also export the collected test results into a .csv file. NAWCTSD can use the collected results to evaluate their new equipment.

Our application's code works with both Windows and Android devices. For testing, we implemented it on a variety of mobile electronic devices. The application is easy to use and works in a secure environment. NAWCTSD can now collect and analyze test results directly on the application instead of writing them by hand and manually typing each test on Excel.

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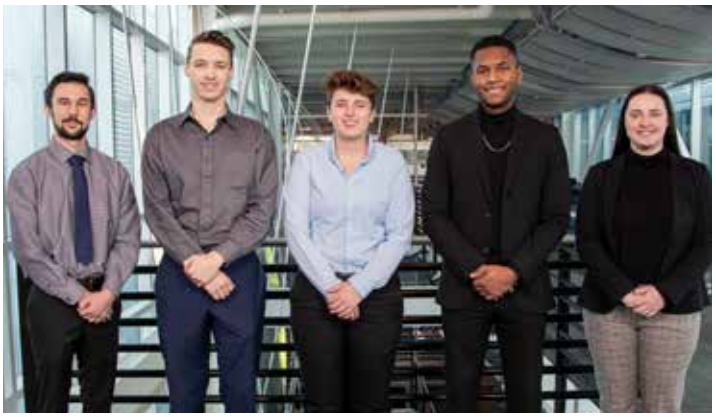
## 306: Engagement Channel

Online interactions between producers and consumers are increasing, bringing more leads than ever before. A lead is any information gathered on a consumer that could help make a sale. It is important that businesses change their sales and marketing strategies to prepare for this shift in their markets. Our project, sponsored by Accenture, aims to improve sales by looking at leads and intelligently deciding how to use them. This increases how fast a company can respond and provides a better consumer experience.

Our solution is a machine learning engine that uses the best software platforms, is easily setup, is reusable across companies and is constantly improving.

Our solution targets companies using Salesforce for their marketing in business-to-business (B2B) sales. B2B sales are those that refer to companies selling to other companies, rather than companies selling to people. To host our product and process leads, we use Salesforce and AWS (Amazon Web Services) cloud platforms. A cloud platform is a system that leverages the internet to perform various tasks making it available all across the world. Salesforce utilizes leads that the client is already receiving and sends it to AWS to run the machine learning algorithm. The algorithm detects similarities in the leads to predict where new leads might be found, sending the prediction back to Salesforce. If the prediction is wrong and a sale is not made, the engine marks this so it can continue to improve over time. This provides insights to companies on how to make better marketing decisions.

## 307: Light Loop



Modern medicine requires imaging technology to identify hidden medical issues and treat patients. Traditional imaging devices are massive, expensive and use harmful radiation on high-risk patients like pregnant women and children. Research suggests near-infrared (NIR) light could be a safer and more portable alternative to medical imaging. Our project explores the use of NIR as an imaging approach and will be referred to as Light Loop.

Light Loop uses a series of lasers and receivers in a circular structure that determines the substance that is placed in the center. While the ultimate goal of Light Loop is to portably scan any part of the human body, we focused on the research behind near infrared imaging and building an initial prototype that will detect light as it passes through various materials.

The Light Loop uses three main variables to categorize tissues/substances: time of flight (the time it takes the light to travel from the laser through the subject and back to the receivers), angle of refraction and the intensity of light the receivers pick up.

In order to develop imaging software, we conducted extensive testing using the Light Loop on different substances of known densities (such as air, water, fat solution, etc.). The results of these experiments determined a mathematical relationship between substance density and the variables discussed. This project serves to further the future of near-infrared based imaging devices.

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**SPONSOR**
FSU-Institute for Successful Longevity

## 308: Navigation Design Challenge

Older people who have limited freedom and social contact due to cognitive disorders often find it hard to remember where they are or what they are doing. Becoming lost is one of the main problems resulting from these disorders. We aimed to create a solution for one (or more) of the following problems: aid the elderly to navigate healthcare facilities or malls, aid the elderly to return home after a walk, and/or aid the elderly to use public transportation or ridesharing services.

We created a phone application that uses a mapping service to find a path for the user. A mapping service is the use of a global positioning system (GPS) to help our user navigate their way home. The app connects to a wearable device via Bluetooth. The design for the device will either be a phone case or watch. The device gives the user the option to press one of four buttons which directs them to an appointed location.

This project is also a Navigation Design Challenge. We will present in an entrepreneurial competition at the end of the year. For this project, we studied the importance of designing for older adults and how this project can improve their daily lives. We learned the struggles of navigational design as well.

## 309: Battery-Less Internet of Things Device

We created a battery-less, wearable, internet of things (IoT) device. Harvesting radio frequencies (cellular, Wi-Fi) and light to produce power is a source of renewable energy that has yet to be used for small devices. Our goal was to design a device capable of harvesting energy, sensing user activity, and transferring data to a user's phone via a Bluetooth module. The device acts as a personal fitness device, keeping track of the user's physical activity such as tracking their steps. It also detects falls and alerts loved ones or authorities to prevent the user from enduring serious injuries while alone. Although the device cannot prevent falls, the goal is to shorten the time between collapse and emergency reaction to limit the severity of the injury.

This wearable device uses two types of circuits: a radio frequency harvester, which captures and converts radiofrequency waves into usable energy, and a light harvester, which collects and converts light waves. An accelerometer is used to detect movements such as steps and distance. In the case of a fall, the device identifies if an accident has occurred, then utilizes Bluetooth to send a notification to their emergency contact. The Bluetooth module is the bridge that transfers important data from the IoT device to the user's phone.

The user wears the device via a bracelet where the design is based on feel, functionality and size (like smartwatches). It allows the device to operate correctly while also remaining comfortable for the consumer to use.

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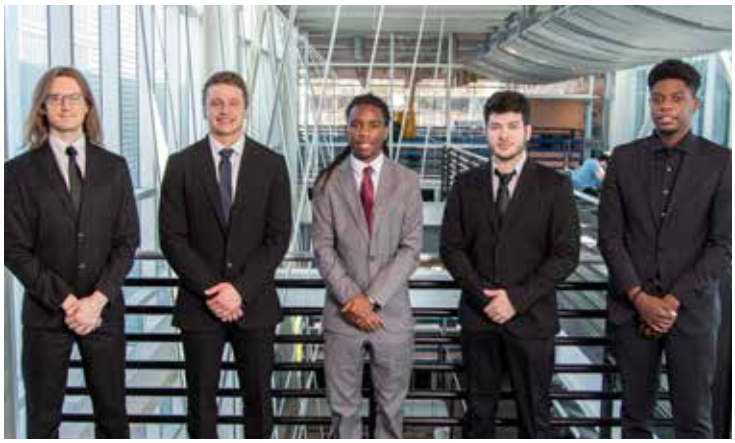

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BAE Systems

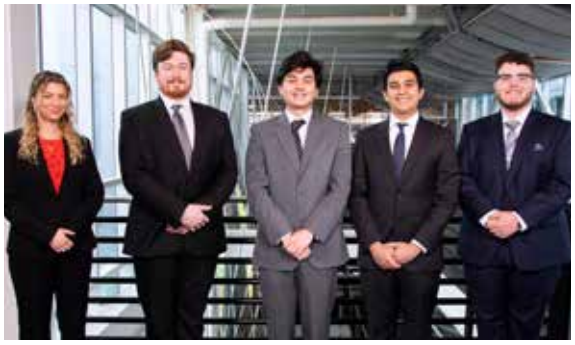
## 310: Artificial Intelligence and Swarm Control

Swarm control is the use of multiple robots to complete a task. It is used to tackle tasks that either require many individuals or are too dangerous for humans to complete. For example, swarms are used for assembly lines, demining and cleaning toxic spills. Also, in cases where every second counts, it's great to use a swarm because they're able to perform the task quickly.

This project aims to combine artificial intelligence (AI) and swarm control to perform a search for missing persons using three ground robots. In the search, the robots navigate through an unfamiliar area and work together to discover the location of people in the area. To complete the mission, each robot uses a laser sensor to create a map of the area. Based on specific point conditions in the map, the robots can confirm if the point is a person. For example, if the point is moving then it's likely that the point is truly a person. To not mistake another robot within the swarm for a person, all robots share their coordinate positions through a server. Also, once one robot finds the person then the others are notified of their coordinates as well. Once all robots in the swarm are aware of the person's location, then the mission is complete. In a successful mission, the swarm must provide accurate coordinate points of the person in the area.

Although the project is focused on performing a search mission to find a person, the idea of using AI to control a swarm can be used in other cases like stocking warehouses and air traffic control.

## 311: Digital Beamsteering Phased Array



Beamsteering is a technique of rotating the direction of a signal through a series of signal delays. This changes the radiation direction without physically moving the transmitting antennas. The market for beamsteering antenna arrays is extremely vast and can be used across multiple industries. For military applications, it is useful for improving the speed, range and size of radar systems. For civilian applications, it can be useful in communication systems, allowing for the technological progression of 5G systems and satellite to ground communications.

This project is software-based and uses digital techniques for flexibility. The setup contains commercially available parts, such as the four transmitting antennas, to reduce the cost of the system and it is controlled by an FPGA development board. It supports a high intensity signal of 2.4 GHz and can transmit the signal in any given direction with a range comparable to an average household router.

To steer the beam, the user inputs a 6-bit representation of the desired angle through the FPGA board. The FPGA uses this value to calculate the required phase offset for each of the four antennas to point the radiation pattern in the indicated direction.

We developed a setup that allows easy and cheap implementation of beamsteering. In addition, it can be used to implement various beamsteering approaches educational and research purposes.

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Power Angel

## 312: Wearable Anti-Sexual Assault Device

In the US, more than 400,000 women age 12 or older become the victim of rape and sexual assault each year, with more than 2 out of 3 of those cases going unreported. We wanted to give victims of sexual assault a chance at protection and justice. To do this, we created our wearable anti-sexual assault device. We designed this device to be wearable, sleek and prevent crime.

The goal is also to collect evidence and have the device protect itself from tampering. The user wears our Magnet-Sheet Metal Trigger System and Wire-Waistband Trigger System. Both connect to our alarm system controlled by a chip. The undergarment is between the magnet and our metal, so the alarm goes off when the undergarment is taken off without permission. The user also wears a waistband with copper wire inside, so when cut, the alarm is triggered as well.

With our wearable device capabilities, women can build a case to support them if they become victims of sexual assault and better deter sexual assault. The alarm system includes Bluetooth and is connected to a buzzer, microphone and an SD card reader and writer. The buzzer is used to alert the user that the device is armed, disarmed or triggered. The microphone records to the microSD card writer, used as a black box for the user's need. In partnership with the alarm system, our companion app uses Bluetooth to receive audio files and control the device from the user's phone. This app acts on the trigger-texting emergency contacts that the user is in trouble with location-and user friendly for connecting to the device.

## 313: Demand Pro

The electric distribution industry is practically a localized monopoly within large stretches of service zones. Utility companies sell the power they create to consumers based on the highest peak kilowatt usage for the month and the total energy used (kWh). Monthly electric service bills for commercial spaces can exceed thousands of dollars. We believe Demand Pro is a business alternative at an affordable cost.

We developed a Demand Pro system to reduce demand spikes for up to three phases. Demand Pro uses renewable energy to reduce demand spikes seen on utility bills. The system has energy storage modules, an inverter/rectifier and an artificial intelligence (AI) entity. When demand increases, the batteries discharge, thereby reducing utility fees.

An earlier prototype of the Demand Pro without AI or proper configuration failed prematurely. We incorporated AI into the system and optimized it for lowering the utility bills while balancing system longevity. When faults are detected, the AI accesses previous and live data and make predictions on when the best allocation of resources. The system receives live updates to add future functionality or support upgraded hardware modules. Current systems that achieve similar results are costly and are not available to small and mid-size businesses.

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Adaptive Carbon Systems

## 314: Reusable RF Probes

Radio Frequency (RF) Spinal Ablation is a minimally-invasive procedure used to treat chronic nerve pain along the spinal cord. During the process, a small portion of nerve tissue is heated up, which stops pain signals from being sent to the brain. Abbott Laboratories, makes a reusable device that can withstand up to fifty repeated uses.

We aimed to increase Abbott's device reusability to 100 uses or more, while keeping the manufacturing price down. The device is composed of three main elements: the shaft, the hub and the RF transmission cable. The shaft is a thin metal cylinder inserted into the body. The hub is a plastic component that connects the shaft to the RF transmission cable. After receiving test data from our sponsor, we found that the hub is the problem. Due to repeated stress of the sterilization procedure, the plastic hub is the first element of the probe to break down. To fix this, we swapped out the hub's material with a different polymer.

We researched polymers that are suitable for medical devices and chose one best suited for our needs, polyphenylsulfone (PPSU). Making prototypes based on the original device's hub allows us to compare both materials through different testing procedures. These tests included cleaning with an enzyme solution followed by sterilization. To test for reuseablility, we ran tensile stress tests. PPSU is being used as a replacement material for the hub and should increase the reusability while keeping the cost down.

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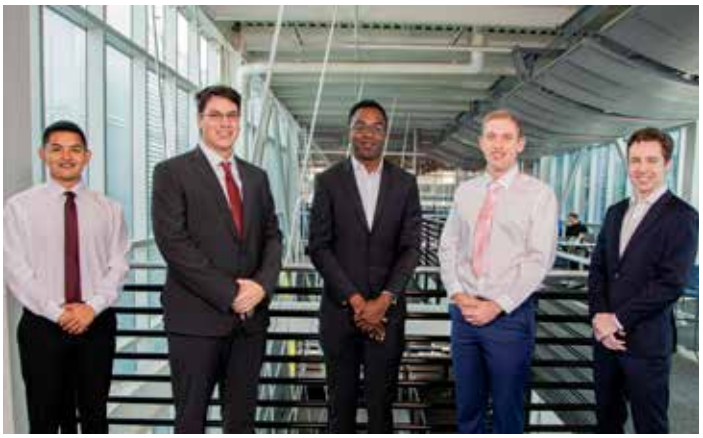
Abbott

## 315: Service Robot



Automation, machine learning and robotics are becoming more prevalent and are replacing or assisting manual labor in many fields. These processes can be applied to pushing around carts in fulfillment centers, groceries stores and hospitals. Instead, this task can be accomplished by having the cart follow the user.

Our goal was to create a device that allows a motorized cart to semi-autonomously follow a person. We used a motorized wheelchair as our motorized cart. Additionally, we developed a control module to provide a seamless transfer from semi-autonomous to manual mode. The user can use hand gestures and a mobile app to have the robot follow and stop. The control module is designed to be a low-cost solution to install on motorized systems that lack semi-autonomy.

The control module uses a camera to process images for object detection. It differentiates between the user and other objects/people in the environment. The camera also finds the distance to the user and other objects/people which controls the motor. This creates feedback that is fed into a pathfinding algorithm which determines the best way to navigate the environment and follow the user. The control module includes an emergency stop feature to avoid harming people and nearby objects.

The benefit of this project automates a manual process so the user can focus on other tasks rather than manually pushing a cart.

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FAMU-FSU College of Engineering

# Industrial & Manufacturing

## Senior Design

## 404: Health and Safety Box for 3D Printing

With its rise in popularity, thousands of industries worldwide have switched to 3D printing for production due to its low-cost for manufacturing and testing parts. The 3D printing process involves melting plastic materials at high temperatures to build up the desired product. However, melting plastic emits harmful chemicals into the air, which can cause health risks ranging from mild to severe. Some solutions to tackle this problem include adding an enclosure and filtering the air. An enclosure is a box that keeps the emissions within it so they are not released into the open air, while also filtering to remove some or all the emissions.

We designed a carbon capture system, which includes sensors, filters, and an enclosure for a 3D printer farm. A 3D printing farm is a group of printers running together for larger-scale production. This task is sponsored by Ford Motor Company and the Centers of Research Excellence in Science and Technology's Center for Additive Manufacturing who will use it for future development. The proposed system improves user safety and environmental impacts. We used CAD to digitally create a printer enclosure suitable for the 3D printing farm. Sensors verify that adding an enclosure with filters lowers emissions released into the open air.

We tested with a Creality Ender 3 Pro, a 3D printer model provided by the FAMU-FSU College of Engineering. We also proposed an improved layout of the 3D printing room at the college to perfect workflow with OSHA standards in mind. There are plans to implement the 3D print farm enclosure and room layout in the college's 3D printer room.

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CREST-Ford

## 401: Right of Way Unscheduled Maintenance Analysis

The City of Tallahassee spends more than $200,000 a year in labor costs maintaining right of ways (ROW) around the city. The ROW is the grass between the sidewalk and the road. Tallahassee does not have a law requiring private property owners to keep up their adjacent ROWs. The city performs work on these private properties ROWs as requested or when it becomes too overgrown, interfering with the road or sidewalk. To determine the total costs of these jobs, we worked closely with the city.

Total cost of ROW work includes labor, equipment, fuel and employee benefits. We focused on the labor cost for 2019-2021. There are seven types of work done: blind corners, edging, graffiti, litter, mowing, sidewalk cleaning and trimming. Mowing makes up more than half the total labor cost. We presented the city with a data application that includes custom charts and tables detailing cost information.

We investigated 10 cities in Florida that require property owners to upkeep their ROW, providing COT with examples of alternative ROW maintenance options.

After reviewing costs, the city will better understand how much is spent on ROW maintenance and can compare their costs to others. Our project allows our sponsor to determine the best course of action for the future of ROW maintenance in Tallahassee.

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City of Tallahassee

## 402: Tallahassee's Future for Bulk Waste Collection

Tallahassee has a population of more than 197,000, which is increasing every year. Bulk waste is therefore increasing. Bulky waste or bulky refuse is a technical term to describe waste types that are too large to be accepted by the regular waste collection. To keep up with pick up demand, Tallahassee Public Utilities collects bulk trash every day to prevent build-up around the city. If Tallahassee's population increase continues, current trash routes may not be able to keep up with future demand.

We looked for ways to help the city keep up with potential increased bulk waste pick-ups. Our goal was to determine if an extra route would help improve current collection methods. First, we determined if there are enough routes to keep up with current demand and if additional pickups are possible.

We measured the travel and collection time for each dump site location and created a simulation to see the current strengths and weaknesses with this data. The results reveal how much each route can service under maximum demand. Our model shows that 134 bulk trash piles can be collected in one day. Each route costs around $714,000, so minimizing the number of routes to meet demand would be financially beneficial to the city. Ultimately, a method of measurement and simulation could help improve TPUs bulk waste collection system. Other cities that use similar collection methods may find this process useful, as well.

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**SPONSOR**
City of Tallahassee

**Team 402** (left to right)
Daniel Ramirez, Jade Rakia Sherrod, Luis Tapia and Brian Galloway checking current collection methods that may or may not be keeping up with current growth in bulk trash pick-up in Tallahassee.

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Clarke Miley
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**SPONSOR**
Tallahassee Memorial HealthCare

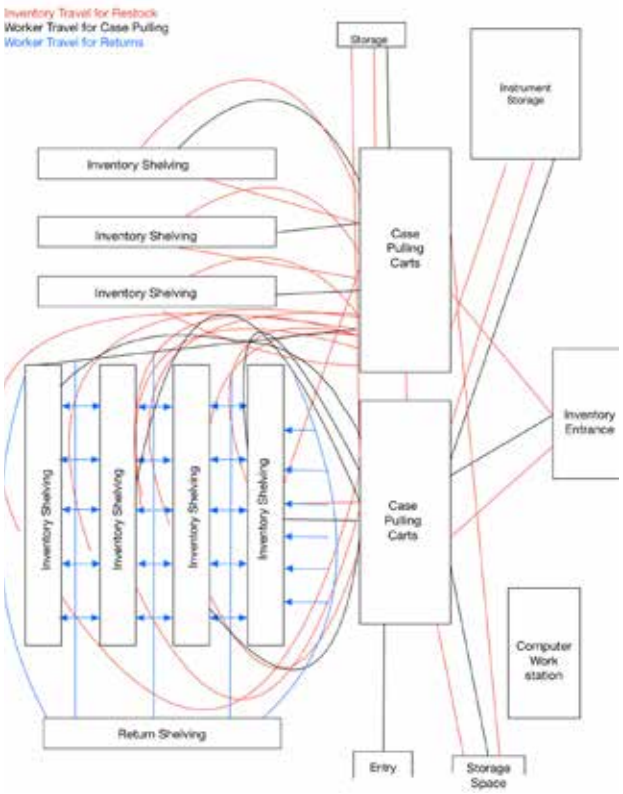
## 403: Improving Surgical Supply Workflow

The M.T. Mustian Center at Tallahassee Memorial HealthCare (TMH) has a disorganized medical supply room. Staff are frustrated when checking out supplies for surgical services, in particular.

This disorganization increases the risk of not getting proper medical supplies to surgeons in a timely manner. This directly affects the quality of patient treatment and could be the difference between life or death. The supply room's disorder also makes returning supplies more difficult. For this reason, we improved how surgical supplies are stored in the supply room and created a new system for receiving and restocking supplies.

Medical supplies are always going to waste. Surgeons tend to order too many supplies and usually don't use them all. These supplies are eventually wasted due to expiration, contamination or damage. Just one medical supply item could cost up to $10,000, contributing to millions of dollars in waste each year. We designed a plan that will decrease over-ordering to reduce waste and improve organization of supplies.

We determined the return rate for supplies and used this data to determine which supplies are being wasted. By decreasing the number of supplies by 25%, we found more space in the supply room to properly organize necessary supplies. TMH plans to use our solutions to improve medical staff job performance, limit the purchase of unneeded suplies and decrease waste. We believe our solutions can be apppied to other departments in TMH and other hospitals, as well.



## 405: Book Production Printer Optimization

Canon Solutions America (CSA) printers produce thousands of books daily for their client, Company A. These jobs are affected by printing errors and machine failures, leading to the reprint of hundreds of books. We improved the overall equipment effectiveness (OEE) of Canon's book production printers. OEE gages efficiency; it measures the operation of a manufacturing line to its full potential. We improved the OEE rate by decreasing machine downtime.

We ran a time study to collect data from Company A's facility showing how long it takes to complete different tasks. We focused on shift changes, shift cleanings, downstream issues and operational starts and stops. This data showed us where to implement new techniques to reduce the completion time of these jobs. For example, the lack of experience among the Company A employees led to tasks taking longer and the machine being down for a longer period. We implemented increased training helping workers become more comfortable with the printer equipment.

Overall, improving the OEE enhances the efficiency in the number of books produced per hour. If Canon does not meet their desired OEE rate with our suggestions, the rate will increase by approximately 10%. We provided a new break schedule, replacing employees rather than shutting down the entire printing line for breaks. The positive impact of our team's adjustments can be applied to other Canon facilities. These changes help to increase Canon's profits as their clients become capable of printing more books in a set amount of time.

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Canon Solutions America (CSA)

Training print production workers on the use of the equipment will contribute to lower equipment down time and increased productivity.

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Pratt & Whitney

## 406: Aerospace Composites Production

In modern planes, composites make up about 40% of the materials. This makes it important to check on the production of a composite to ensure the material is as effective as possible. Our goal was to evaluate different methods for testing composites and determine which method is best. This applies beyond the aerospace industry because many industries also use composites, including automobile and marine industries.

Our first step was to order aerospace composite samples to test. Using samples can confirm the accuracy of our testing methods. A common testing method currently is the C-Scan method. A C-Scan machine works similarly to a printer but scans material samples. This method is useful because the user can adjust the scanning duration based on the desired quality for a scan. We also planned to evaluate similar, faster testing methods. However, these alternate methods might be less accurate than the C-Scan.

The testing process starts by scanning a composite sample without damages and checking that the results look accurate. The next step is to perform an impact test on the sample, leaving it with a defect. Finally, the sample goes again through the chosen testing method. Here, we document the duration of the test, the cost of testing, and the test's accuracy in identifying the defect. In the end, the proper method to test these composites should possess the best balance of testing time, accuracy and cost.

## 407: Airport Staff Scheduling Plan

Copa Airlines is recognized for having a 92% punctuality rate for on-time flights. Delayed flights can impact the number of workers needed in each station at any point in time. Our goal was to ensure the best number of staff required throughout the day while minimizing their unproductive time and human resources costs. We began by evaluating the frequency of delayed flights using mathematical tools. Our results show that most delays occur during the morning and afternoon. With this data, we produced an improved staff schedule plan, which saves the company money and time, while increasing productivity. We found the new schedule provides a more organized environment for the workers, avoiding idle time and confusion.

However, this project requires continuous improvement. Copa Airlines will continue its analysis based on historical data as delayed flights change uncontrollably every day. For the future, our analysis will help reduce staff scheduling issues in other airports where Copa Airlines operates.

Overall, our findings significantly improve the company's future. Our solutions help Copa Airlines maintain its high standards, and Copa's customers benefit from the new staff plan since having the appropriate number of workers for each task allows for faster and better service.

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Copa Airlines

## 408: Return on Investment for Military Training

Soldiers in the U.S. military proudly serve their country, knowing the many risks involved. It is up to individuals and dependable training gear to ensure that these soldiers are well-equipped and well trained. The Naval Air Warfare Center Training Systems Division (NAWCTSD) is a government agency focused on providing the highest quality training for the U.S. military. To do this, NAWCTSD hosts events that encourage collaboration between companies and the government, which collaboration motivates companies and the U.S. military to innovate faster.

We aimed to provide a return on investment (ROI) analysis on these collaboration events. Since government is a non-profit entity, it hard to use a regular ROI analysis. Therefore, we calculated an untraditional ROI for the Procurement Administrative Lead Time events held by NAWCTSD. This showed that the current process is saving them $10,000.

We also created a recommendation list of data for future use. This list can be used to do more in-depth ROI analysis for each collaboration event, including collecting data on company involvement with contracts. NAWCTSD can now carry out larger and more detailed ROI projects with minimal work.

Collecting data is analogous to collecting profits for this project. NAWCTSD continues to collect large amounts of data, which can then be used with our provided plan to get the ROI analysis they want. This project serves as the first step to show politicians and high-ranking officers the value of NAWCTSD's collaboration with companies. The ROI can potentially increase funding and provide overall better training simulations for the U.S. military.

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**SPONSOR**
Naval Air Warfare Center Training Systems Division (NAWCTSD)

A tech industry civilian worker helps a military member with new training technology. *Photo source: Kevin Mikalsen, Central Florida Tech*

# 409: Database Centralization and Visualization

The Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) develops and delivers soldier training. With many training projects going on at once, they leverage schedulers to manage project statuses via scheduling visualizations. A scheduling visualization is like a calendar with pictures and colors. PEO STRI faces variability in schedule data due to a decentralized data source. The data used to create scheduling data visualizations comes from three sources, which includes contracted personnel, government, and department schedulers. We used the Define, Measure, Analyze, Improve, and Control (DMAIC) methodology to identify the root causes of the current problem.

Data coming from multiple sources creates differences in the data that lead to reduced efficiency and increased errors in the scheduling visualizations. Additionally, scheduling data visualizations are created manually, which is a time-consuming process prone to mistakes. To solve this, we began by researching database and visualization software solutions to improve the current process. We proposed two different approaches for a suitable database and worked with our sponsors to determine the best solution for their needs, as determined through direct feedback during weekly team meetings.

We used Milestones Professional, a software visualization tool that imports the schedules from the database and automatically generates a scheduling visualization.

The implementation of the database and Milestones Professional improves overall efficiency in the data collection and visualization process for the PEO STRI. This solution will save PEO STRI both time and money in the future, with less employee time needed to create the data visualizations and revise errors. This approach could apply to other industries or areas within the government that conduct training.

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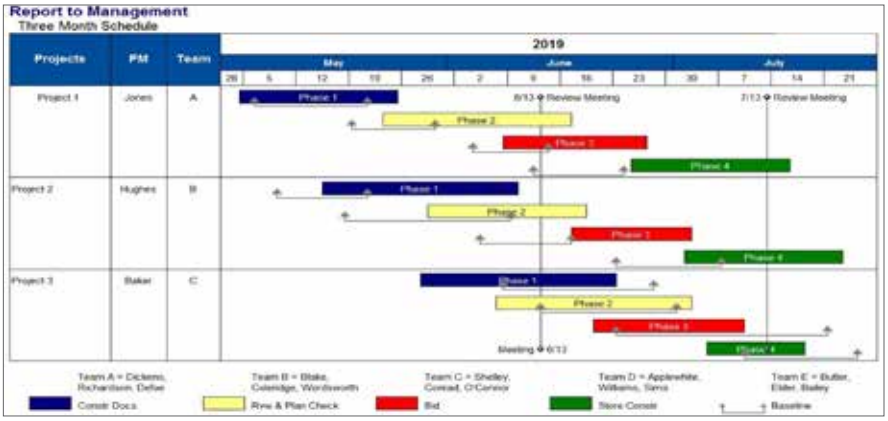
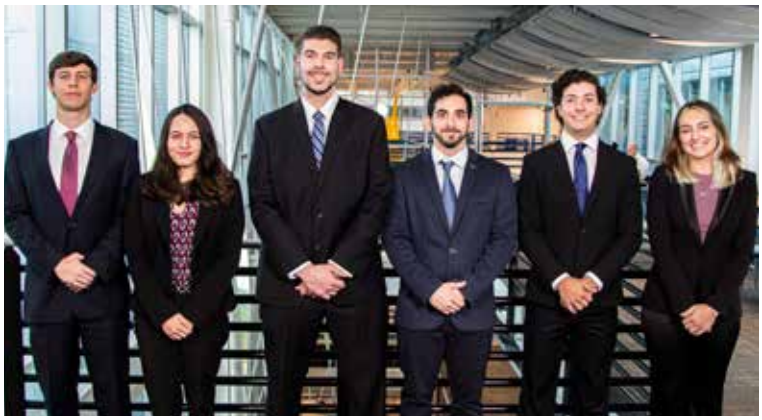
**SPONSOR**
Program Executive Office for Simulation, Training and Instrumentation (PEO STRI)




Milestones Professional software improves overall efficiency in the data collection and visualization process.



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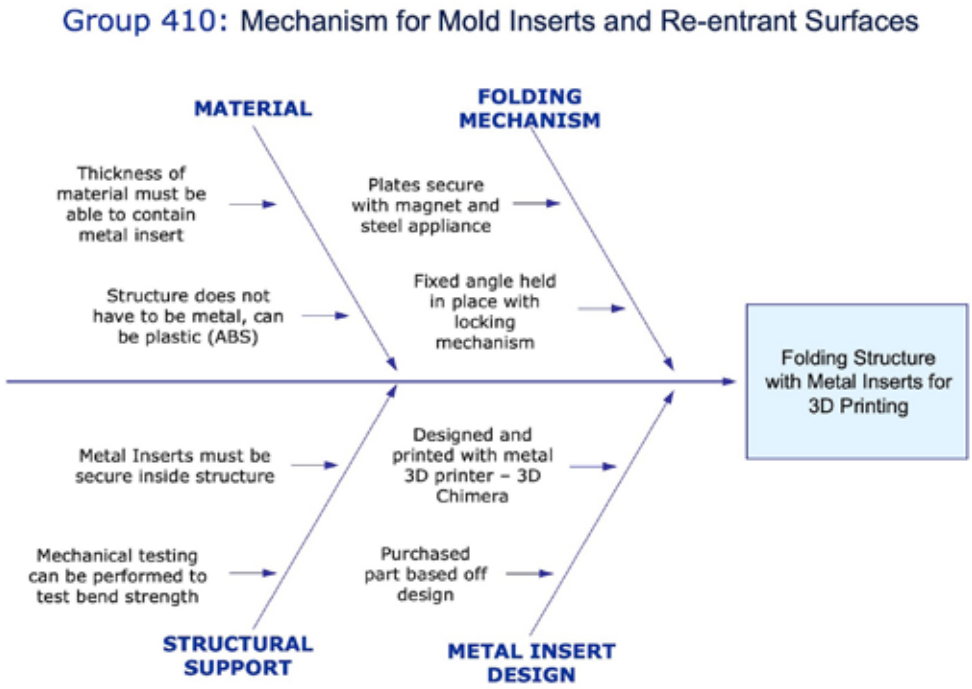
**SPONSOR**
US-COMP

## 410: Mechanism Insert Study

The space industry is in constant development to make space exploration more efficient. The amount of equipment that can be transported to space is limited due to the high cost and difficulty of travel to space. For that reason, US-COMP is looking for new methods to create structures that can be used for tooling and equipment.

To achieve this, we designed a method to create different shapes by connecting two or more plates to one another. The plates are attached by an interlocking mechanism that allows them to move to different angles. The plates are fixed to a position using screws that go through inserts to prevent them from moving, and prevent the folds and seams from collapsing. We oversaw designing the hot-threaded-inserts each plate must contain to allow screws to go through the material without damaging it. The inserts create a pattern for the screws being used so they will enter and exit the holes easily.

We used origami and kirigami-inspired design because they are stable and flexible. Our design simulated this concept using light and durable material to create low and high-scale models that can sustain stress. Plates are made of acrylonitrile butadiene styrene (ABS) which is a rigid and impact resistant plastic. Several structures were created and tested to analyze the amount of stress needed to break the interlocking mechanism.



# Mechanical Senior Design

## 501: Landing System for Uncertain Terrain

It's a bird, it's a plane, no it's an … asteroid! NASA scientists believe that the asteroid Psyche may be remnant core material from a planetesimal.

Launching in 2022 and arriving in 2026, a NASA orbiter will get a closer look at Psyche and gather information. Scientists are hopeful that this asteroid could provide useful information about the formation of the solar system and the cores of rocky planets like Earth. And potentially, many more proposals for future mission teams landing a spacecraft on Psyche.

We were tasked with designing a spacecraft landing system capable of landing on the hypothesized surfaces of the Psyche asteroid, an M-Type asteroid. Unlike other solar system bodies visited before, the surface of the asteroid is unknown but thought to be uneven, with a mix of rock and metal. The proposed landing attachment will be able to land a spacecraft on the asteroid's hypothesized surfaces. Our design uses three legs to support the spacecraft. Each leg features a shock absorber to take the impact force of landing.The shock absorber is a piston-like assembly with an aluminum honeycomb-filled cylinder that deforms on impact. To stabilize the spacecraft, each leg adjusts its height independently for a leveled position. At the bottom of the leg is a pin screen foot, modeled after the popular children's toy. The pin screen toy is known for being able to form to the shape of any three-dimensional relief it is placed on. We believe our landing system that can successfully put a spacecraft on Psyche's range of suspected surfaces.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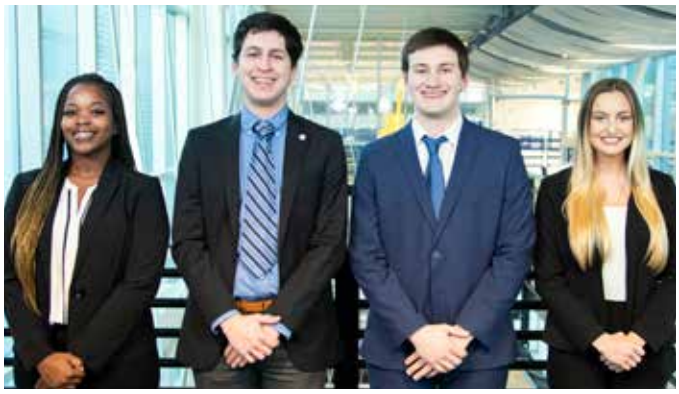

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**SPONSOR**
Corning

## 502: Material Handling of Ceramics

Corning produces brittle, cylindrical ceramic filters for vehicles with internal combustion engines to filter exhaust air. They discovered that these ceramic filters are often damaged when moved from one manufacturing stage to another, typically occurring when the filter's skin is crushed, making the filters unusable. We were tasked with providing a solution for handling ceramic filters without introducing damage during the production process. Our design prevents visible damage at the location where the production handler contacts the filter's outer walls.

Our handler design has three fingers that approach the filter's surface in separate places around the its circumference. The design is adjustable depending on the size of the filter it is handling. There is compliant padding attached to the design that contacts the filter's surface to lessen the contact forces applied on the filter. Force sensors indicate when the handler should stop applying pressure, allowing for part movement. This procedure is quick and consistent with the use of motors and a computer, making it usable in a lean manufacturing system. The linear motion of the padded three-finger design also allows the handler to pick and place various sizes of these ceramic filters with a controlled motion.

We valuated the handler performance with sample filters provided by Corning. A successful test resulted in the handler not causing damage to the ceramic parts after contact by regulating the forces applied by the handler, adding cushioning to the interface, and increasing the contact area.

## 503: Test and Measurement Support

Compressors are parts of air-conditioners that compress a liquid to cool down and draw moisture from the air. Each one must work in the weather where it will be used. Our goal was to design an air control system that attaches to a plastic chamber to test compressors at different temperatures and humidity levels. The main issues when testing are air leaks and heat loss through the testing cell. Our design addresses this problem by putting the air control unit right next to the chamber. This reduces the amount of duct needed, which lessens air leaks and heat transfer. All cracks and holes seal tightly to create a closed volume of air, as well. These choices allow for accurate control of inner conditions within 15 minutes. The design also stops condensed water from building up by collecting and returning it to the humidifier.

We improved an existing design by increasing the range of cooling, humidity and mobility, decreasing heat loss to the surrounding air. Our design has a more powerful air chiller, humidifier and two more heaters. Ducts attach to the chamber's sidewalls and are easily removable. Installing the unit on the floor instead of a wall is another improvement. Sensors check the inner temperature and humidity levels, allowing adjustment to the user's desired values. This design achieves hands-free testing in harsh and mild weather, allowing the user to discover its abilities before selling or using it. In many ways our project has wide applications across many industries.

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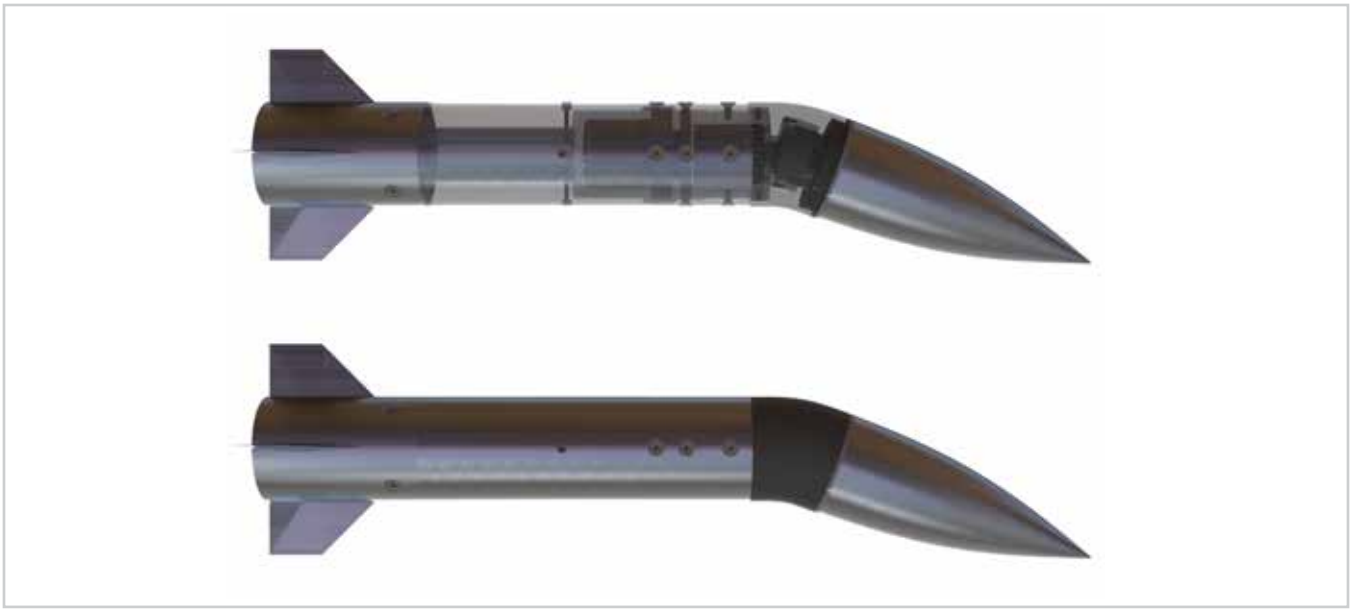
**SPONSOR**
Florida Center for Advanced Aero-Propulsion

## 504: Smart Projectile

The Florida Center for Advanced Aero-Propulsion focuses on aerospace and aviation research and technology. FCAAP continually seeks to improve current technology by providing testing and evaluation services to this industry. Because FCAAP has identified the benefits of finless missiles, we looked into new methods of flight control without using fins, specifically a missile with a rotating and deflecting nose.

Missile technologies often use fins to control the missile. Removing the fins allows for more usable space within the design, allowing for increased storage of items such as fuel or electronics. The nose of the missile shows promise when used as a tool for improving mobility. Compared to fins, a rotating nose needs less power to move at high speeds. This means the motors will need less space in the missile. Adjusting the nose is an ideal choice for improving missile control.

We tested the model in the lab to understand the benefit of the rotating nose for control. To control the nose, internal motors connect to a controller outside the tunnel. This controller enables the nose to move during testing. Using existing software and coding, the influence of the rotating nose on the missile control can be seen using advanced testing techniques. Our tests show a picture of how the air moves near the missile nose to better understand the changes caused by the nose rotating. Our results allow for the comparison between the effectiveness of the moving nose compared to the rotated fins.



Because of the benefits of finless missiles, we are looking into new methods of flight control without using fins.

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Evaline Cantarero

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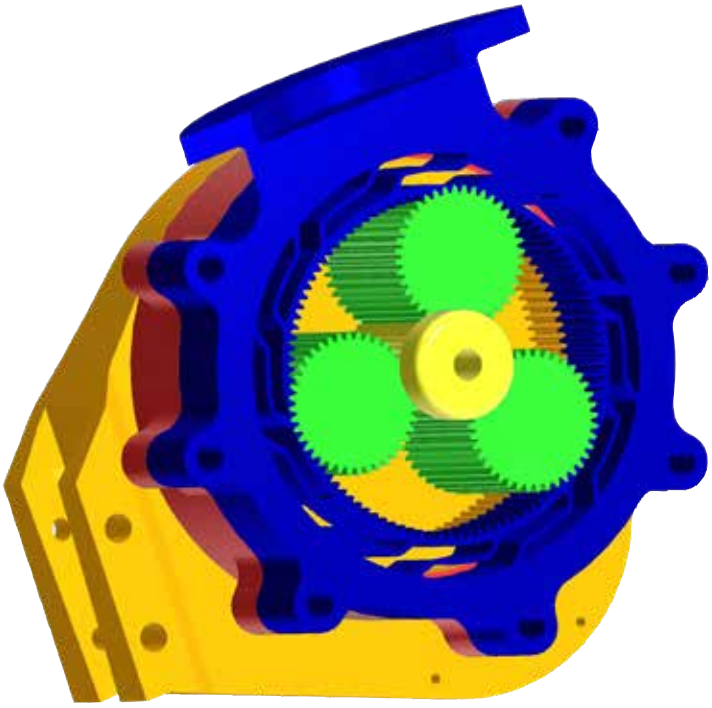
**SPONSOR**
Florida Space Grant Consortium

## 505: RASSOR Arm

The RE-RASSOR project is a mining rover designed for STEM education. The project is based on NASA's RASSOR that mines soil on different planets and moons. Both feature two rotating drums hinged to the body with a shoulder joint and arm. The drums spin from opposite sides allowing the rover to collect samples. As space exploration expands, this movement is crucial to excavate in locations with low gravitational forces.

The Florida Space Institute and NASA appointed us to design the shoulder joint and arm. The shoulder joint is responsible for moving the arm to the desired position during mining, transporting heavy loads and adjusting the drums to travel through tough terrain. The goal is a light, inexpensive and durable design that is cohesive to the rest of the rover. The project includes the design and selection of housing, gear box, motor, bearings, materials and arm.

To make the rover affordable and accessible for schools, most parts need to be 3D printed. This ensures it is replicable and budget friendly (cost of supplies is $60). Since filament is fragile, the design focused on the structural integrity of the housing, gearbox and arm. The optimal weight of the design allows it to be sturdy yet functional. Because filament is not optimal for bearings, bolts and motors, they will be outsourced and selected based on their price and availability. The gearbox design needs to achieve the required torque from the motor to mobilize itself with added loads. The arm must withstand the loads and stressors that come with 270 degrees range of motion. Our design provides the necessary torque, range of motion and support to perform its tasks with the given budget and power.



**Team 505** designed a shoulder joint and arm for NASAs RASSOR mining robot. The shoulder joint is responsible for moving the arm to the desired position during mining, transporting heavy loads, and adjusting the drums to travel through tough terrain.

## 506: Microgravity Machine

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**ADVISOR**
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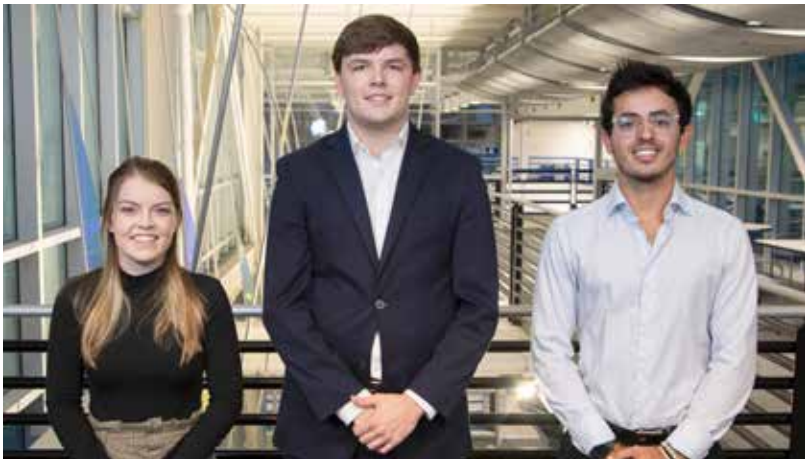
Florida Space Grant Consortium

As exploring space grows in popularity, understanding zero gravity conditions becomes more and more important. Zero gravity, also known as microgravity, provides challenges in matters where Earth's gravity is taken for granted. Tests are performed to solve issues that occur due to the lack of gravity. Normally, drop towers are used to simulate zero gravity for packages to experience free fall. Because of the small number of drop towers around the world, we designed an easier method to conduct these tests. We engineered an air vehicle that will be dropped from a drone, provide zero gravity conditions to a package inside the vehicle, and fall safely to the ground. We created a missile-shaped vehicle, helpful for limiting the force that the surrounding air provides as the vehicle falls. This force is the main issue that limits zero gravity conditions, as it creates an undesired acceleration. Our solution includes a track for the package to move on inside the vehicle. The outside of the vehicle will slow down when the force from air acts against it, but the package will remain in zero gravity because it is free to move on the track. To increase the duration of the event, we used compressed water to propel the air vehicle down. The position of the package on the track inside the vehicle will determine when the compressed water will be released. After the test is complete, a parachute deployes for the vehicle to descend safely to the ground. Our air vehicle is reusable and easily operated. This is a huge step for space exploration as the process of preparing for space's atmosphere is quickened.

## 507: SAE Aero Design (Fuselage)



We built the fuselage for a 3D printed, radio-controlled airplane to compete in the Society of Automotive Engineers Aero Design competition. The plane must take-off within 100 feet and land within 400 feet while carrying a payload, or a 9-inch diameter soccer ball and a 1-lb weight. We focused on the fuselage of the plane, because it is the housing location for the electronics and payload. This year's fuselage features a streamlined design that appears whale-like to lessen the drag on the plane as much as possible. A hatch on top of the plane opens to load and unload the payload. The landing gear is setup as a tail-dragger, meaning two wheels are close to the front of the plane and one wheel toward the rear section of the plane. The front two wheels rest under the wings to increase stability on land and decrease landing impact, and the back wheel is close to the tail. Our partner team, Team 508, was responsible for the wings, tail and electronics of the plane. The fuselage accommodates our partner team's design decisions, which were a dihedral, low-wing aircraft and a standard tail. We accommodated these design decisions with our whale-shape fuselage. The entire plane (apart from the landing gear and electronics) is 3D printed using lightweight PLA, a filament made of plastic and foam. The main challenges we overcame in this project include designing a fuselage that's easy to print and maintains structural integrity.

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## 508: SAE Aero Design (Aero)

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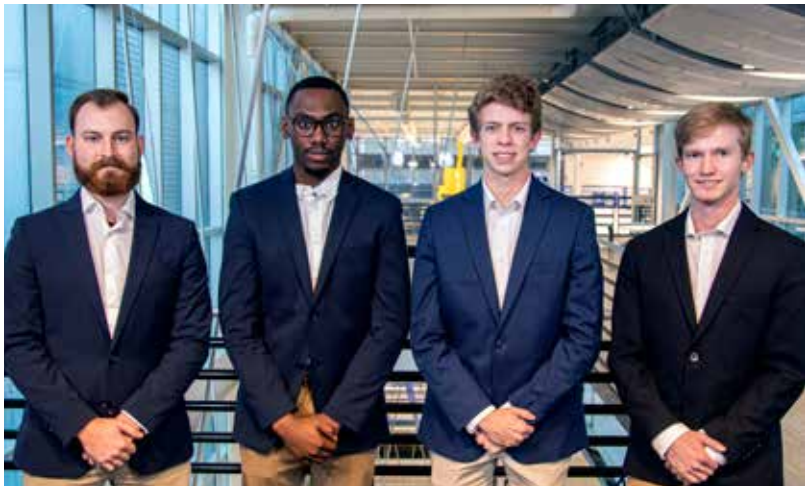
Yousuf Ali, Ph.D.

**SPONSOR**
Florida Space Grant Consortium

Our objective was to design, test and construct the wings and tail of a radio-controlled airplane to compete in the 2022 Society of Automotive Engineers (SAE) Aero Design Competition. As part of the parameters of the competition, the plane must take off within 100 feet, load a standard-size soccer ball and have a single engine. Our team's responsibility was to design the wing and tail to ensure the plane will generate enough lift to get off the ground, while still maintaining stability and control to correctly maneuver in the air. We worked alongside another team whose primary focus is the plane's main body, fuselage and the landing gear. Maintaining communication with the fuselage team was essential in building an operational plane that meets all the necessary standards. To manufacture the plane, we used an emerging technology known as additive manufacturing, commonly referred to as 3D printing. While most radio-controlled airplanes use wood or other lightweight materials, we decided to take on the added challenge of 3D printing the airplane's makeup. 3D printing allows for the rapid production of geometrically complex objects that would not be feasible using other manufacturing methods. We used a specialized foaming plastic material (LW-PLA) which is up to 60% lighter than typical materials used in a 3D printer. The LW-PLA filament provides a lightweight choice to enhance the plane's overall design, innovation and complexity.



## 509: Floating Shock Absorber for Gate Control

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**ADVISOR**
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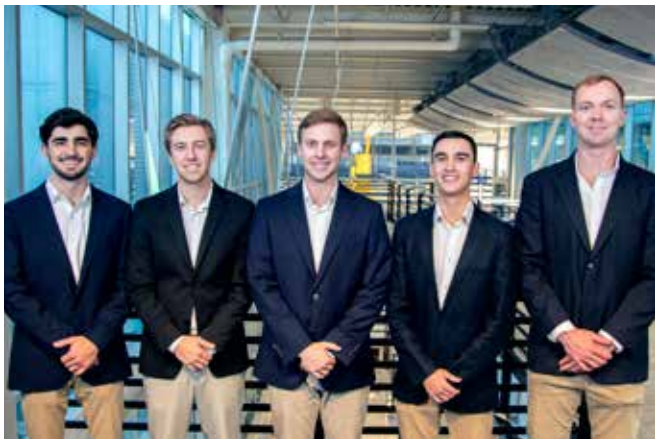
**SPONSOR**
Ghost Controls

Ghost Controls produces gate control products that improve customer's preexisting gates. Gates with widths varying from a few feet wide up to 20 feet utilize these systems. However, over time gates can experience issues preventing these products from operating as intended. We determined two problems to address: closing and locking issues. Gates tend to sag over time causing misalignment in the locking process. They also occasionally slam closed, bouncing out of position as the lock engages. Our goal was to fix these problems by designing a simple add-on to the Ghost Controls gate system that does not affect the current product.

The forces involved in closing and preventing gate sag are measured as factors to consider in the design. Our solution works with gates of many sizes and mounts to the gate in a way that does not obstruct preexisting arrangements. This is a benefit to more than just Ghost Control's customers since the device does not stop the gate from locking.

The solution we designed is a four-bar linkage with a spring and damper incorporated. It uses the closing force of the incoming gate to lift the gate if it is sagging, moving slowly to avoid slamming. This ensures the gate closes and locks regardless of prior issues related to the gate sagging or slamming closed.



## 510: Low-Cost Rudder Pedal System

Every plane has three ways to control how it can fly and turn. They are the rudder (turn left or turn right), elevators (up and down), and ailerons (roll left or roll right). We created a set of foot pedals that can control a plane's rudder in Lockheed Martin's desktop flight simulators. The pilot can press on one of the pedals turning the plane left or right. The pedals currently in use do not react to events occurring in the simulator, meaning the pilot experiences a consistent amount of force. In the real world, pilots experience forces dependent on speeds. This means the current training experience is less than ideal.

We improved this issue by developing pedals that offer a changing resistance as events change in the flight simulator. For example, a pilot must press harder on the pedals because of air resistance at high speeds compared with how hard they press when driving around on the runway.

Our final design includes pedals that will use a hydraulic disc brake positioned in between the pedals. When the pilot pushes the pedal, a center beam will rotate causing the disk to rotate as well. When a new event occurs in the simulator, our pedals will take in that data and force a clamp to press onto the center disk. The simulation will tell the clamp how much pressure to exert on that disk creating resistance for the foot pedals. How much the pedal is pressed is then sent to the simulation to control the plan accordingly. This change in resistance will lead to a more accurate simulation experience for any pilots using the pedals.

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Brighton Stapleton
Lance Mayo

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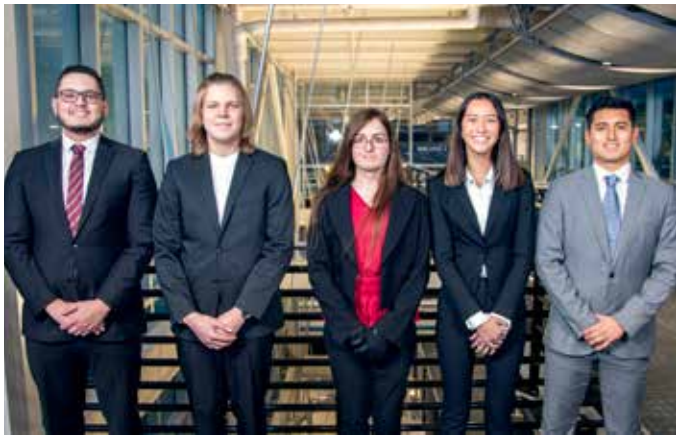
**SPONSOR**
Lockheed-Martin



## 511: Improving Oscillatory Ventilation

This project involved redesigning ventilation, with the objective of improving ventilation to the specifications provided by the doctors. Throughout this project, the team was required to utilize a variety of mechanical engineering principles to provide a solution for Mayo Clinic.

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**SPONSOR**
Mayo Clinic

# 512: In-Space Cryogenic Propellant Storage

NASA (National Aeronautics and Space Administration) strives to improve space travel technology to extend the amount of time crews can remain in space on various missions. We designed a storage tank that holds the amount of fuel required for spacecraft to return to Earth from any mission destination. It maintains the temperature and pressure of fuel by reducing heat transfer into it. This reduces fuel loss and increases storage time, resulting in longer missions. The design of a prototype is necessary for testing and validation, as well as a full-scale tank that will be recommended to NASA.

The rocket fuel we designed is cryogenic, meaning it is in a usable, liquid state from -238° F to -460° F. Our tank protects propellant from heat transfer to sustain temperatures lower than the fluid's boiling point. This heat transfer is from conduction through connections, convection through liquids and gases, and radiation from surroundings. If the temperature exceeds the boiling point, a fluid goes through a phase change from liquid to gas. This gas causes a rise in pressure inside the tank. This gas must be released to prevent the internal pressure of the tank from exceeding its limit, causing rupture. However, this release reduces the amount of usable fuel in the tank.

We designed the tank by selecting the ideal geometry, scale, wall thickness, supports and insulation type. Prototype testing will determine the mass flow rate of gas leaving our tank, which should be less than the rate from existing tanks. The results are compared to heat transfer calculations to predict the performance of the recommended large-scale tank. A successful tank prototype reduces the mass flow rate and does not fail during testing. Data obtained from testing should validate all design choices for both the prototype and full-scale design.

**TEAM MEMBERS** (L to R)
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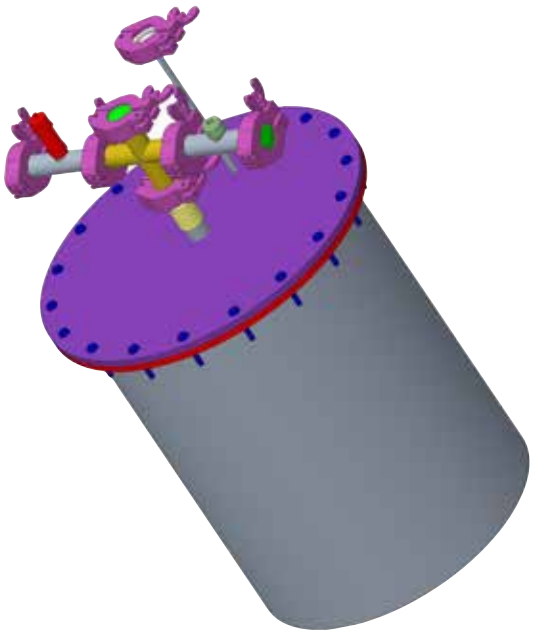
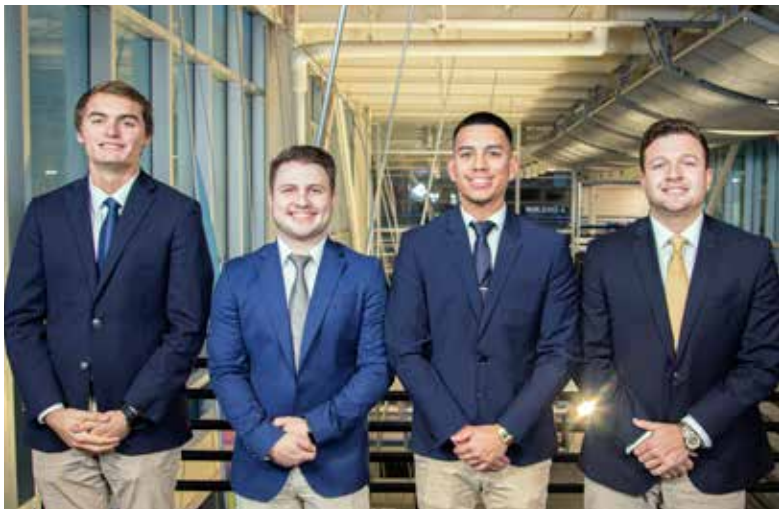


**Team 512** designed a storage tank that will hold the amount of fuel required for spacecraft to return to Earth from any mission destination.



## 513: Reusable Cryogenic Connectors

As Mission to Mars curiosity continues to grow, NASA is building a space shuttle refueling depot on the moon. This depot will work similarly to a gas station, but the stored fluid will be liquid oxygen rather than gasoline. A refueling station on the moon will be important to successful long distance space travel, allowing spaceships to travel further without needing to return to Earth. We designed a reusable connector to transfer subzero fuel from a storage tank to the spacecraft, a design that provides a tight seal to prevent leakage. However, transferring liquid oxygen through the connector produces problems. Liquid oxygen boils at around -300°F, therefore materials in contact with the liquid oxygen must withstand temperature variations. Consequently, stainless steel and Kel-f, a thermoplastic used for sealing, are needed for this kind of space application. Unlike most materials, they remain functional in the extreme conditions caused by using liquid oxygen on the moon.

The twisting motion used to screw connections together is difficult for astronauts wearing bulky gloves. For that reason, we designed a system with three latches and three hooks that will easily seal the connection. The connector has two valves with long handles that control the flow, to help the astronauts carry out their mission activities with ease.

We did life cycle testing using liquid nitrogen and helium gas since liquid oxygen can easily ignite. The connector was tested at low temperatures to show the seal's ability to prevent leakage. The results of these tests confirm the reusable connector can used be for multiple missions and refueling needs.

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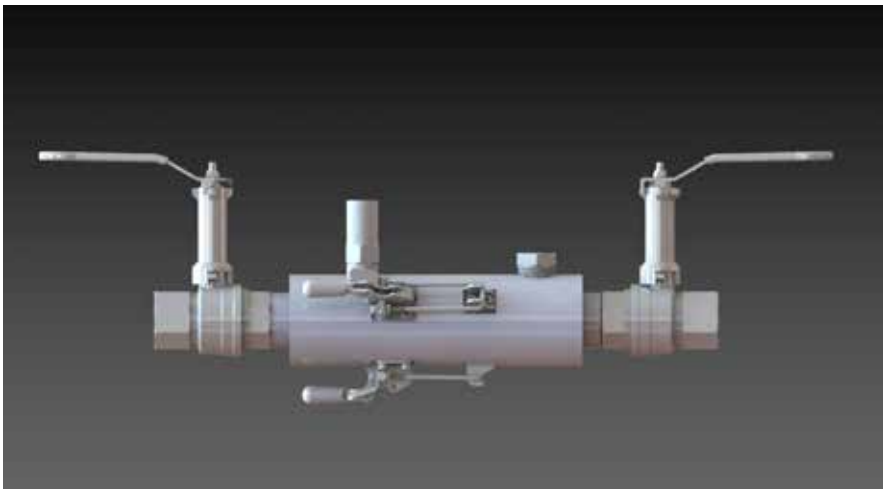

**Team 513** has designed a reusable connector to transfer subzero fuel from a storage tank to the spacecraft.

**TEAM MEMBERS** (L to R)
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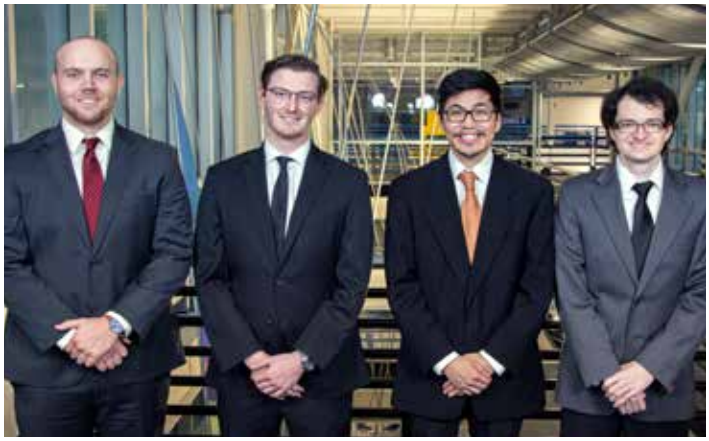
## 514: Electrical Capacitance Tomography for Cryogenic Fluids

The ability to accurately measure fuel levels of cryogenic propellants is important in furthering space travel. Due to the microgravity environment of space and cryogenic exposure, this is a difficult problem with limited solutions. The purpose of this project is to develop a liquid detection system that monitors and gauges fuel within a rocket.

Cryogenic propellants such as liquid methane and liquid hydrogen, used for rocket fuel, have a low boiling point of approximately -253°C. Once past the boiling point, the liquid will change phase, from liquid to gas. The liquid form of these cryogens is used for fuel while the gas phase is useless.

Optical fibers utilize fiber Bragg gratings (FBG) sensors along the optical fiber determine the state of the fluid, gas or liquid, making them a viable option for this application. Design challenges included heat leak, strain and reusability. Fiber optic cable encompasses the center of the tank, surrounding the bubbles that form, to determine where they begin and end. Once the amount of gas is determined, the liquid volume can be calculated.

This detection system will monitor the amount of fuel before and after thrust maneuvers. The precise amount of fuel determined from these readings will decrease extra fuel storage and the overall weight of the shuttle, crucial for aerospace applications.



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## 515: Nuclear Reactor Canister for Space

After almost a 60-year break, NASA decided to refocus their attempts on nuclear thermal propulsion (NTP) as a more efficient way to advance space exploration. NTP uses uranium to heat hydrogen to create thrust, more efficient than conventional rocket engines. A Transient Reactor Test Facility (TREAT) reactor is used to test different fuels for NTP since it heats the fuel rapidly to test engine startup. The objective is to design, build and test a canister to be located inside the SIRIUS (an acronym with no meaning) module. The canister holds uranium that will heat the hydrogen flow to test the different fuels.

The materials used for the canister are tungsten and zirconium carbide to ensure success at high temperatures. Tungsten can withstand high temperatures and zirconium carbide keeps the hydrogen from sticking to the canister. We designed multiple small flow channels to allow for a high, constant flow rate of hydrogen through the canister.

To test, we placed a heating device inside our experimental canister, allowing for a small-scale simulation of nuclear heating without using dangerous and unobtainable materials. Argon functions as liquid hydrogen due to its ease of use and availability. Thermocouples measure the temperature difference and allow for calculations to be made to relate the results from testing to a full-scale test that will be done by NASA.

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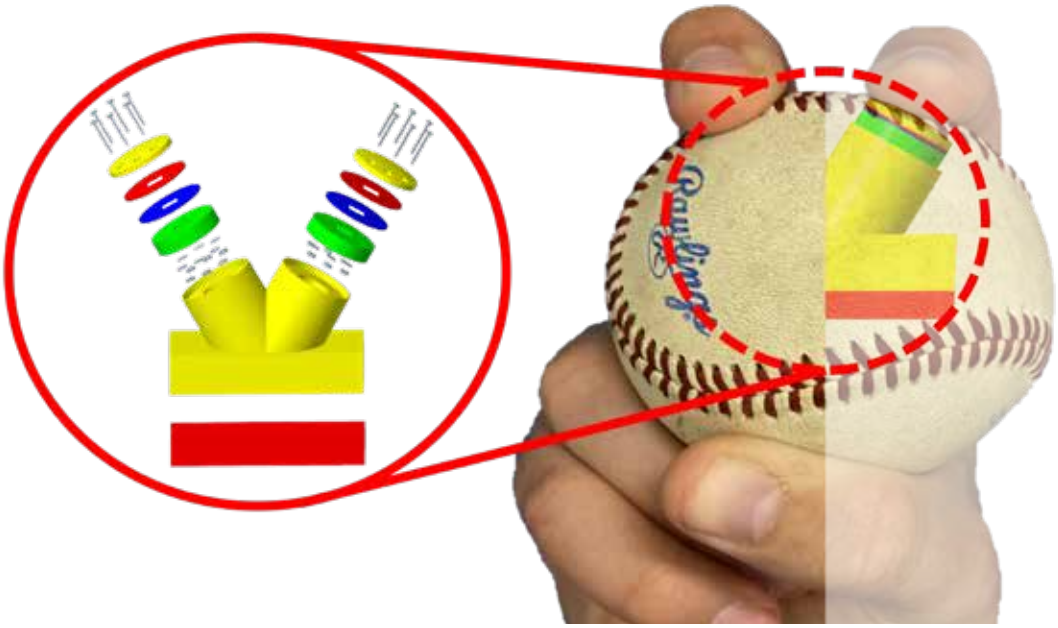
Dr. William Oates, Ph.D.

## 516: Instrumented Baseball

The game of baseball is changing rapidly in the modern era. What used to be a sport based on intuition has now become a game revolving around numbers. Professional teams spend time and money focusing on the analytics of the game to seek an edge against competition. Today, the pitcher's motion, baseball speed, baseball rotation and pitch path are all measures tracked during games and practices. Our project involves changing a baseball to find another analytic that allows teams to base their game decisions on.

When a pitcher throws a baseball, each fingertip generates different forces, including compressive and shear forces. The shear forces are what causes the balls spin. With an instrumented baseball, we created an accurate way of measuring these forces applied when throwing the ball. Specialized electrical parts placed within the ball carry out this procedure, allowing the user to obtain data right after performing their throw.

Our design uses force sensors to determine a pitcher's fingertip forces the instant the user throws the baseball. A custom 3D printed design holds the technology inside our baseball to avoid physical damage. This design is capable of supporting difficulties with the baseball's rotation, size and weight on release and makes sure our baseball is up to official standards. Data regarding a pitcher's fingertip forces allows for player-specific performance to be collected and studied during practices. Knowing these forces could decrease the chance of injury and increase overall player performance. A phone or computer can be used to track these changes by means of a Bluetooth receiver inside the ball. This receiver will then connect to an application that shows the information gained from the sensors.



## 517: Carbon Footprint and Energy Usage at Maglab

Tallahassee's Innovation Park is home to world-record-holding magnets at the National High Magnetic Field Laboratory, commonly referred to as the MagLab. These magnets produce an enormous amount of heat and require an equally high amount of energy to cool. This makes the MagLab's carbon footprint extremely large. Trane is the HVAC company that is responsible for cooling the MagLab. We helped Trane redesign the cooling system at the MagLab to lower the energy consumption and carbon footprint of Innovation Park.

We accomplished this goal by two methods: cooling the magnets and sharing the MagLab's cooling ability. Currently the magnets are cooled under the assumption they operate at full power. This is not the case, because the magnets often use less power to run. We designed a system that cools the magnets based on the percentage of power used. This ensures the MagLab does not waste energy by overcooling a magnet. The less energy the MagLab consumes, the lower its carbon footprint. When the magnets are not in use, the MagLab has a vast cooling potential sitting idle. The second way we reduce carbon emissions is using the MagLab's idle cooling ability by sharing it with the rest of Innovation Park.

A new building is slated for the park and it will rely on the MagLab's cooling capability for its air-conditioning. We designed a way to transport the chilled water in the MagLab to the new building two hundred yards away. By relying on the MagLab's chilling ability, the new building will consume far less energy. Running one system will use less energy than two, and the overall energy consumption of the Innovation Park will decrease thus lowering its carbon footprint.

**TEAM MEMBERS** (L to R)
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Nicholas Walker

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Trane


**Team 517** designed a way to transport the chilled water in the MagLab to a new building to be built two hundred yards away. (Left to right) Nicholas Walker, Bianca Marius and Finnbar Rooney.

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Martin Senf
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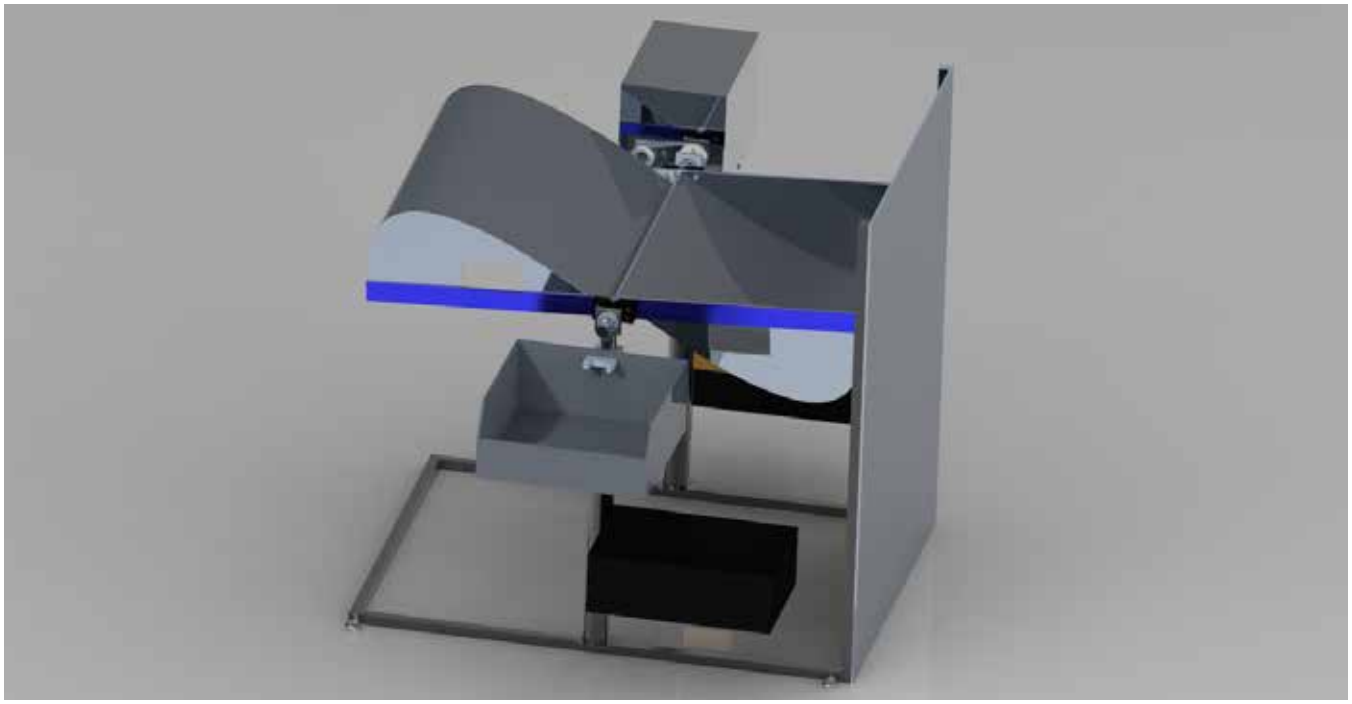
## 518: Trash Interceptor

In 2019, Yamaha Motors created the Rightwaters Initiative to protect marine environments. Using an intercepting device, trash collection occurs in storm drains before it enters larger bodies of water. This stops pollution early in the cycle. Yamaha discovered that the first machine was too solid and heavy, making it difficult to move around. Our objective was to create a trash interceptor to prevent waste from entering these large bodies of water. Collecting debris in storm drains stops trash from reaching both oceans and rivers.

We designed a new machine that is both cheaper and more readily available. Easy setup, sustainability and being scalable are factors this new design addresses. The interceptor consists of a rotating basket wheel that picks up trash and moves it to a single collection site. A conveyor belt moves the trash from the collection site to a dumpster. For easy setup, the device arrives on site in a few, simply assembled pieces. Once put together, the collector rarely needs human contact. The dumpster will be emptied according to a weekly pick-up schedule per city regulations. The collector contains both a solar panel set and battery storage, so it will always have power. Solar panels work during ideal weather, and the battery provides power at all other times. By using renewable energy, the team further protects the environment. This helps to limit human input and reliance on outside power sources. The ability to scale the interceptor allows the device to operate in many environments. The expandable floating boom allows the interceptor to scale to these different environments. To further improve performance, a water jet accelerator pulls the trash into the interceptor. The interceptor collects trash before it spreads into larger water ways, allowing preservation of marine environments.



**Team 518** designed a new machine that is both cheaper and more readily available. Easy setup, sustainability and being scalable are factors this new design addresses.

## 519: Barbot

Barbot is the future of bartending. Barbot is an automated bartender that creates the perfect drinks every time. With Barbot, you can create the best tasting mixtures: from margaritas and lemon drops, to old fashioneds and martinis, and to any other drink you can imagine. Whether you are innovating new cocktails, drinking with friends, or relaxing after a long day at work, Barbot is the perfect machine for you.

The idea behind this entrepreneurship project was to create a home version of the original Barbot. The original Barbot was over four feet long, two feet tall, two feet wide, and weighed a hefty 80 pounds. After speaking with customers, we determined the need for a machine that could fit comfortably in a kitchen.

The new version of Barbot is roughly the same size as an air fryer. Because of it's compact size, you can store the machine in a cabinet when it is not in use. Barbot stands out from its competitors' machines, which have limited accessibility. Competing machines require pods in order for the product to function. Barbot can use any liquid you want, such as juices, sodas, and any liquor you can find in stores. The machine contains a rechargeable battery so you can continue the party wherever you go. Whether that's a tailgate or your next birthday party, Barbot is the bartender you can rely on.

The future of Barbot is to continue the company after college with plans to expand into a mobile application and the commercial service markets. Barbot is the future of bartending and hope we can serve you your next drink.

**TEAM MEMBERS** (L to R)
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Joshua Legis
Matthew Maus
Brett Scharmett

**ADVISOR**
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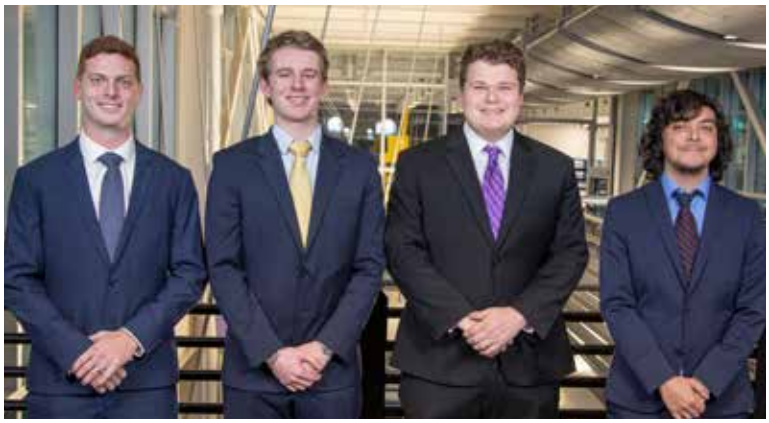
The original Barbot was over four feet long, two feet tall, two feet wide, and weighed a hefty 80 pounds. The new version of Barbot pictured here, is roughly the same size as an air fryer.



## 520: Desktop CNC Machine

We developed Firebird, a desktop-sized five-axis CNC milling machine. This machine fills the current void between the 3D printer and the CNC milling machine markets. 3D printers currently control the market because they fit on a desk, are easy to use and are cheap enough for the average person. However, 3D printers make low quality parts, are slow, and only work with plastic. CNC milling machines are extremely fast, very precise, and can work with a range of materials. However, they are expensive, hard to operate, and require a large space to store. Firebird bridges the best of both markets, including ease of use, size, and price of a high-end 3D printer. It also has the versatility, capability, and precision from a five-axis CNC mill. By using the most advanced technology available, Firebird has more options, faster production times and produces higher quality parts than current machines. The most important components are the structure, linear guides and operating system. The frame must be able to control and reduce all forces and vibrations on the machine. The linear guides must move around accurately and quickly with minimal error. Finally, the operating system must control the machine, be easy to use and efficient. Combining these leads to a machine that is much more convenient and capable than anything available currently. The goal of the project is to have a complete machine that will be on the market quickly, cost under $8,000 to build, and sold around $15,000. At this price point and with the technology in it, there is nothing available on the market that can compete which makes it more desirable.

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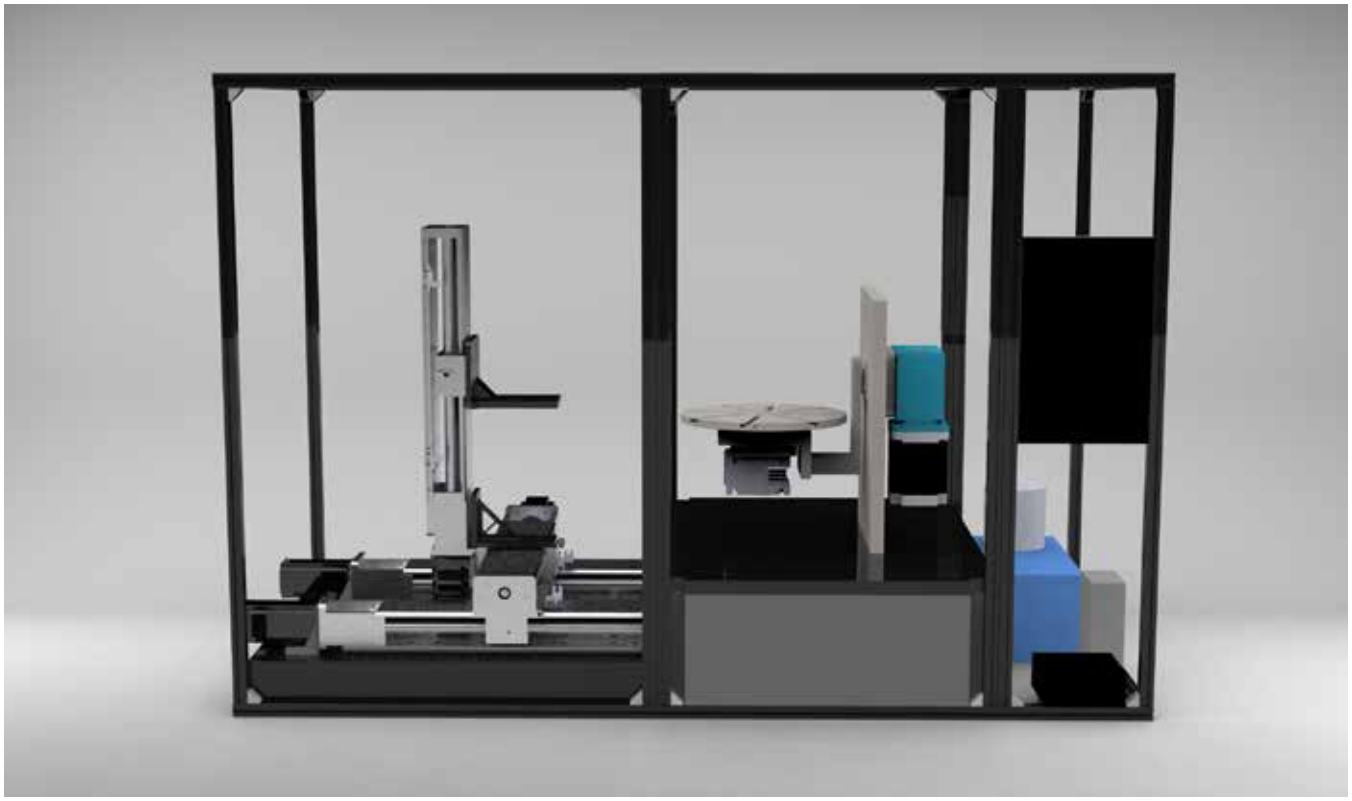

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OSCAR CHUY, PH.D.

SEAN MARTIN, P.E.

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ROBERT WANDELL, PH.D.

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A big round of applause and thanks to our generous sponsors, who not only provide valuable monetary resources for these projects, but who also mentor and serve as important stakeholders for each of these projects. Our students learn many valuable skills from this process and these mentors, including teamwork, professional engineering principles, client and project management.

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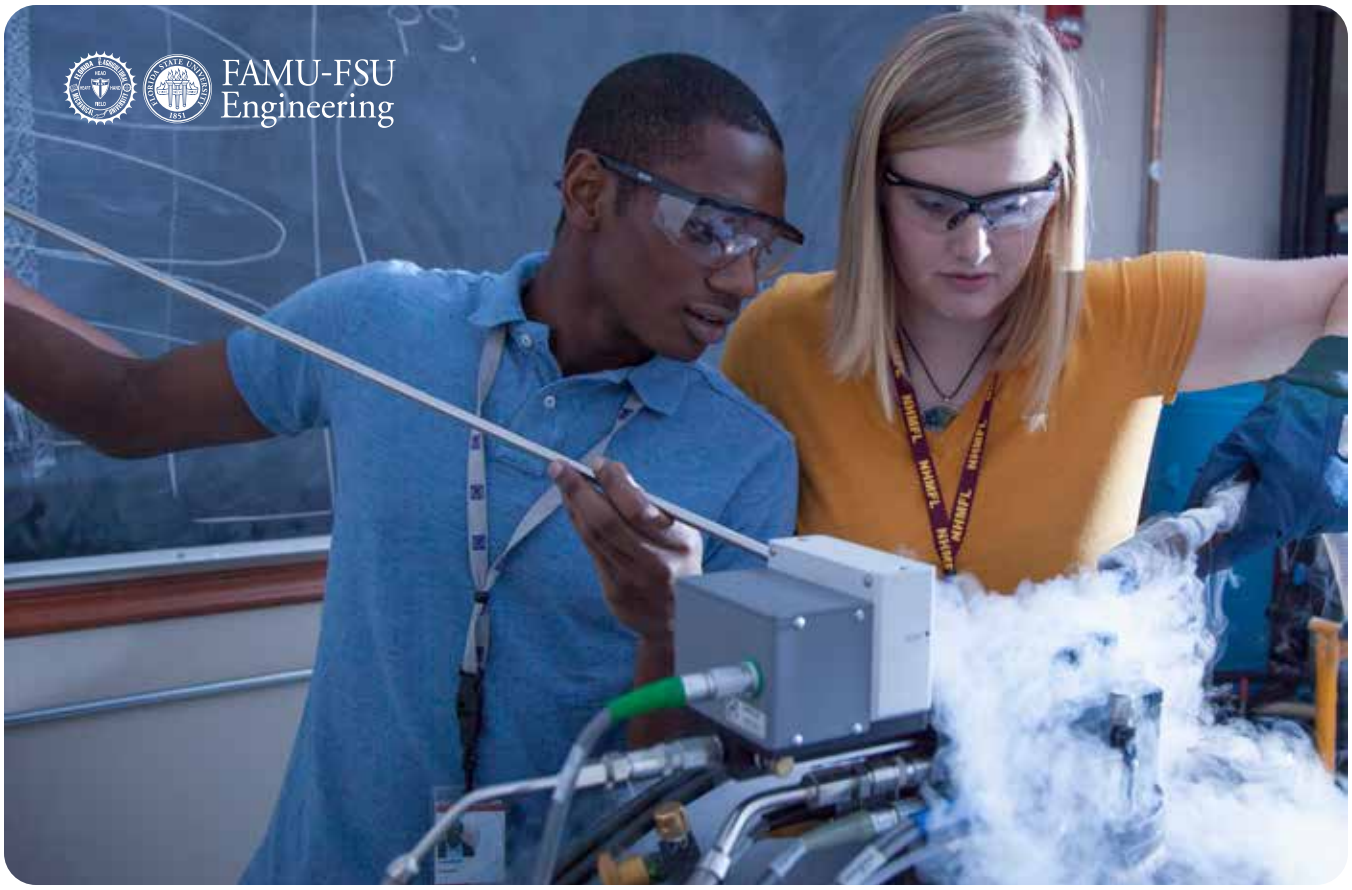


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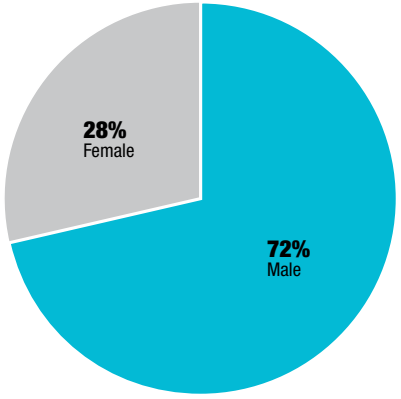


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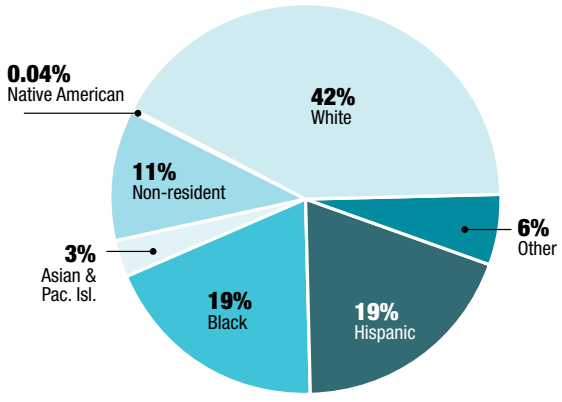


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