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Engineering

The 40th Annual Senior Projects Celebration

Saturday, April 20, 2024

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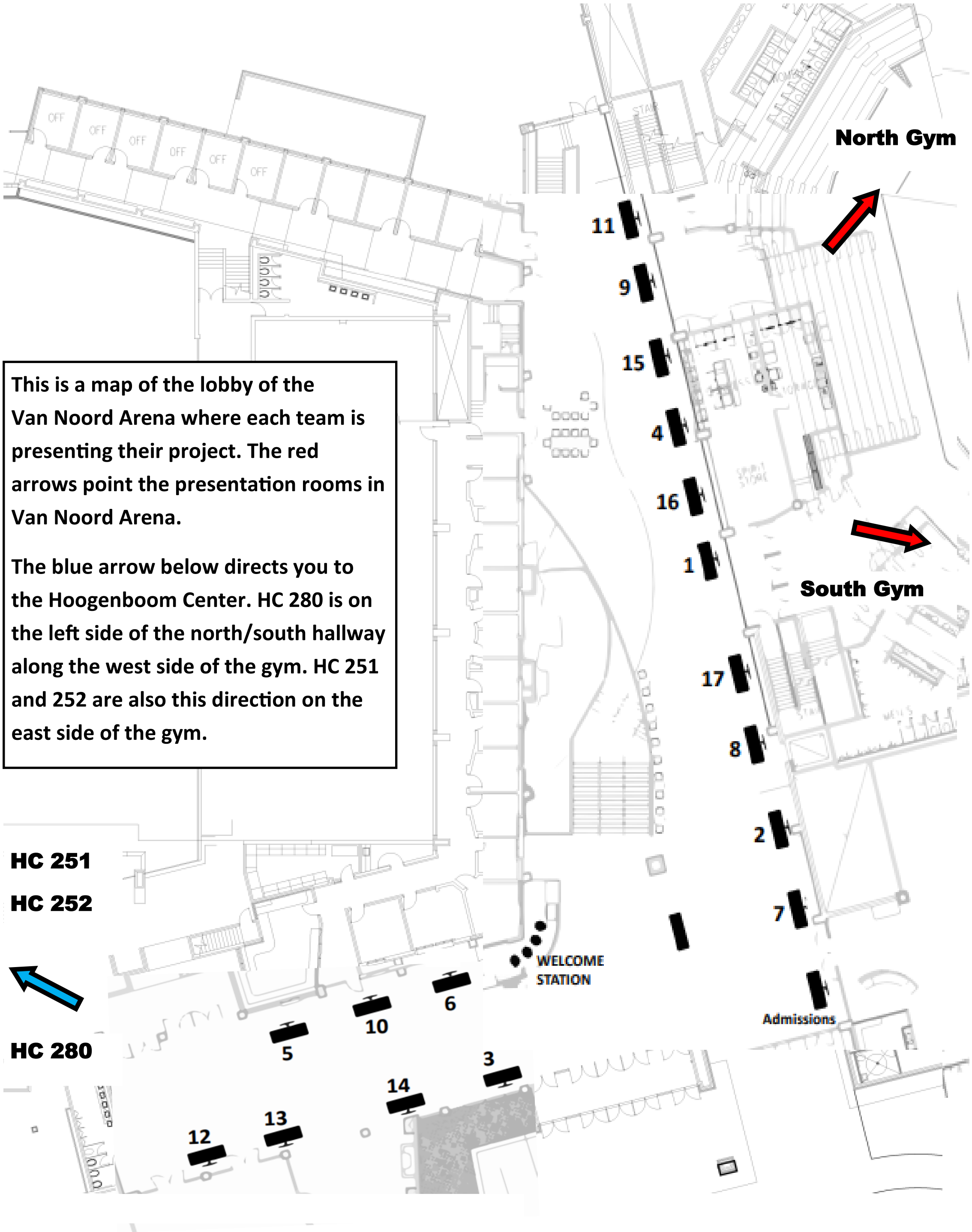
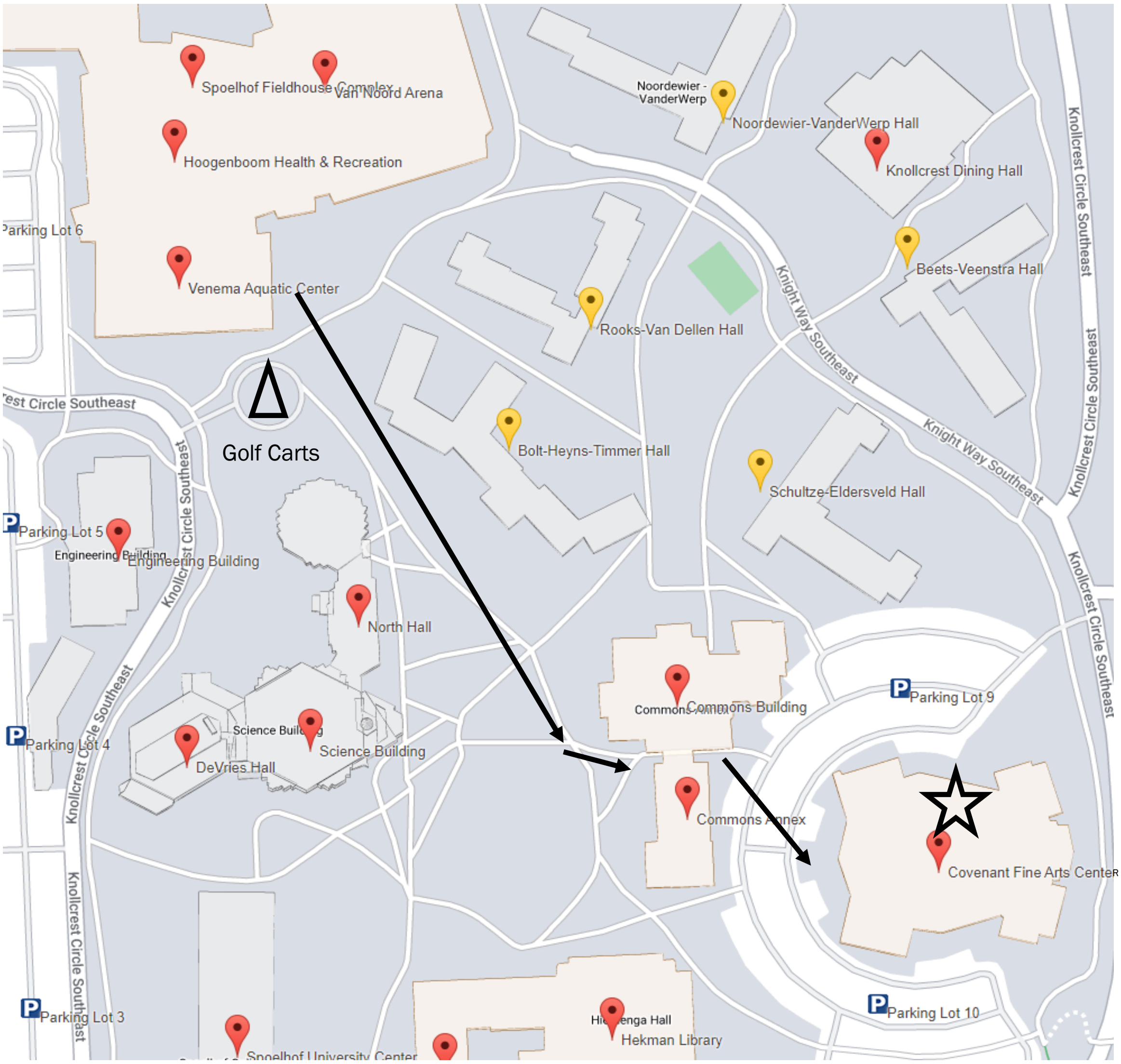
This is a map of the lobby of the Van Noord Arena where each team is presenting their project. The red arrows point the presentation rooms in Van Noord Arena.

The blue arrow below directs you to the Hoogenboom Center. HC 280 is on the left side of the north/south hallway along the west side of the gym. HC 251 and 252 are also this direction on the east side of the gym.





For anyone attending the Celebration Ceremony @ 4:00 p.m., please allow time to walk to the Covenant Performing Arts Center (CFAC). Follow the arrows on the map to the main entrance of the auditorium. For those needing assistance there will be golf carts available at 3:30 p.m. in front of the main entrance to VanNoord Arena. (South entrance by the circle drive.)

Schedule

1:30—3:45 p.m. ***Prototype Open House — Lobby of Van Noord Arena***

2:00—3:30 p.m. ***Presentations of Projects***

Van Noord Arena North Gym (Civil & Environmental)

2:00pm	Team #2	Pave the Way: BSE
2:20 pm	Team #1	Crossing Over The Creek
2:45 pm	Team #3	Eco-Expansion
3:10 pm	Team #4	Dream Stream Team

Van Noord Arena South Gym (Mechanical)

2:00 pm	Team #5	The Sand-Witch
2:20 pm	Team #6	Bike Team
2:45 pm	Team #7	Turret Titans
3:10 pm	Team #8	Ready Recovery

Hoogenboom Center 280 (Mechanical)

2:00 pm	Team #9	PiggyWrap Pro
2:20 pm	Team #10	Auto-Pill
2:45 pm	Team #11	Full Spectrum Design

Hoogenboom Center 251 (Electrical and Mechanical)

2:00 pm	Team #12	VoltRampage
2:20 pm	Team #13	Tandem Scout
2:45 pm	Team #14	Tandem Ranger

Hoogenboom Center 252 (Chemical and Mechanical)

2:00 pm	Team #15	ProFound
2:20 pm	Team # 16	Kombrewcha
2:45 pm	Team #17	The Antibiotic Strikes Back

4:00—4:45 p.m. ***Senior Celebration in CFAC Auditorium****

***** Seniors need to make their way to CFAC no later than 3:45 p.m.

Team 1: Crossing Over the Creek

Isaac Van Essen, Giulianna Giordano,
Caleb Hoogendam, Joel Bylsma

Team 1 is comprised of four civil and environmental engineering students. The Team designed a crossing to allow for access to the back half of a property separated by a creek. The family that owns the parcel had it split to be able to build a new, larger house for their growing family. However, there is a creek that runs through their property. To access the back section of the property, a bridge is needed to cross the creek.

The Team researched numerous designs: a precast concrete bridge, a bridge with steel beams and a wood deck, a bridge with steel beams and a concrete deck, a wood bridge, a culvert, and a precast concrete slab. Ultimately, the Team found that a reinforced precast concrete slab bridge is the most cost-effective option.

Each alternative was designed with the heaviest possible loading case, the HL-93 design truck. This truck weighs a total of 72,000 pounds. Safety factors were used to ensure the bridge is able to carry the loads.

A key part of this project was getting the appropriate permits needed to build the bridge. The permits needed are from the Michigan Department of Environment, Great Lakes, and Energy (EGLE). There are wetlands on the property, so additional rules had to be followed. The Team chose the bridge location that would have the least impact to the wetlands.

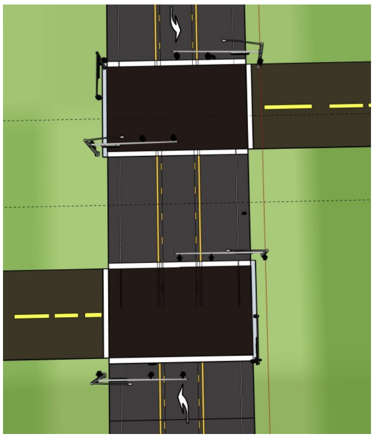
Plans have been produced for the recommended design, a precast concrete slab, and were given to the client. Construction is planned to begin in the Summer of 2024.

Team 2: Pave the Way: Burton St Edition

Eric Swinson, Jacob Buit,

Emilie Gist, Will Mueller

Team 2 is comprised of four Civil and Environmental engineering students. The team performed a road diet analysis on Burton Street from the Calvin Entrance to Breton Rd. A road diet is when a four-lane road, with two lanes in each direction, is converted into a three-lane road, with one lane traveling in each direction and a center turn lane. The team also added bike lanes to match the existing design West of the scope and promote pedestrian traffic. Team 2 looked into the benefits of a road diet because of the backups and crashes that occur on this road. Road diets have been proven to decrease crashes and provide more efficient travel. The team communicated with the City of Grand Rapids to obtain crash and traffic data for this road. Mike DeVries, a Traffic Engineer, also assisted this team by teaching them Synchro, a traffic simulator, and being an overall resource to the project's success. The team created a Civil 3D design of the proposed three lane layout. This layout was modeled on Synchro to show how the road would flow if this design was implemented. The simulation proved that the design would be feasible and efficient. There is a double light on Burton Street located on Woodlawn Ave, a minor street, that causes a disruption in flow. The team looked at alternatives of taking one of the lights out, putting in a roundabout, or changing the signal light timing. Through testing different models in Synchro, the best option was to optimize the signal light timing and to insert a semi actuated light on the minor streets. This means that the minor streets will receive green time if the sensors detect a car is waiting. This allows Burton Street to have longer green times when there is no minor street traffic. The team also created a GIS visual to show the predicted decrease in crashes that will occur with the road diet. Overall, this design promotes safety and efficiency for the public accessing this road.



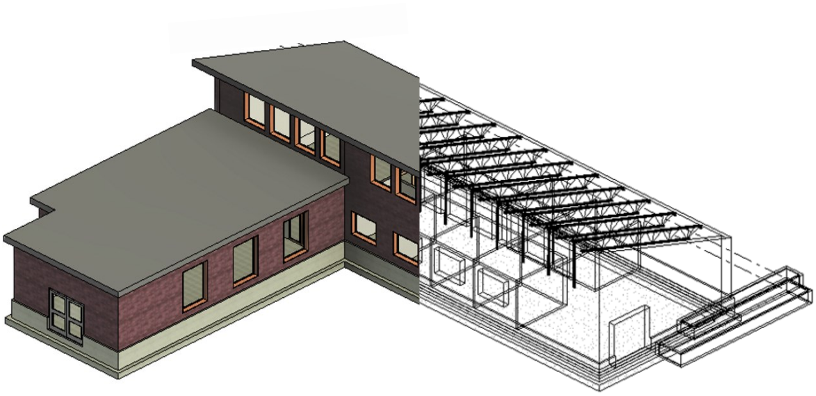
SketchUp of Woodlawn Ave. Double Lights

Team 3: Eco-Expansion

Abbie Parsons, James Poonoosamy

Team 3 is comprised of two Civil and Environmental engineering students. Each member is pursuing a sustainability designation. The Team partnered with the director of the Ecosystem Preserve, Jamie Skillen, to design a theoretical building on Calvin's campus that meets the growing needs of the Preserve. The goals of this project were to design a building that includes additional facilities such as offices, restrooms and community space for students. Throughout the project, Team 3 made sustainability a priority in design. This was achieved by pursuing a LEED certification for the building. LEED stands for Leadership in Energy and Environmental Design and is a green building rating system used to categorize buildings in a framework that prioritizes environmentally friendly construction and design. Some of the sustainable design decisions that Team 3 proposes is a vegetative roof system, runoff management system, insulated windows, energy saving devices, and an overall sustainable long-lasting design and management plan. Sustainable criteria for the building is documented in the *LEED Precertification Worksheet*.

Team 3 wanted to blend the aesthetic and sustainable goals of the building with a structurally and architecturally sound blueprint while staying within budget. Construction plans were produced to illustrate recommended solutions for the Ecosystem preserve. Team 3 hopes that their project can communicate the potential of a LEED Certified building expansion to Calvin's campus that not only meets the given requirements from the client, but also acts as an example of Calvin's mission to be "Agents of Renewal."



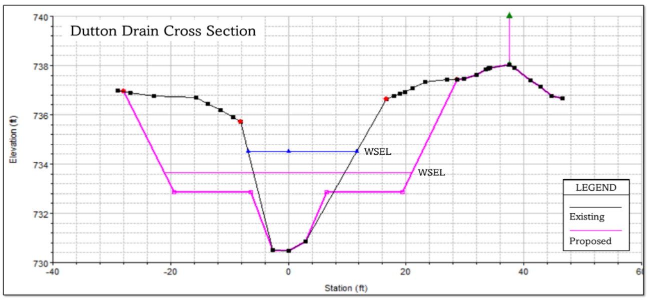
Team 4: Dream Stream Team

Maggie Bentley, McKenna Briggs, and Gannon Olsey

Team 4 is comprised of three Civil and Environmental engineering students. The Team partnered with Dutton Christian School to reconstruct the manmade creek running through their property. Since the creek – known as Dutton Drain – outfalls into Plaster Creek, the Team was able to design under conditions eligible for a grant from the Michigan Department of Environment, Great Lakes, and Energy (EGLE).

Dutton Drain is heavily eroded, resulting in poor water quality and steep banks that are an unsafe space for school children. Furthermore, the Dutton Drain watershed has multiple plans for development, which alters storm runoff entering the Drain. Not only did this project seek to solve the erosion and safety concerns, but proposed designs ensure longevity for the stream in the presence of future development. Moreover, increasing the health of Dutton Drain also benefits Plaster Creek— a Grand Rapids waterway — located downstream.

To fix the issues plaguing Dutton Drain, understanding what water will do after a storm in the present and future was paramount. Therefore, Team 4 completed an extensive hydrologic study of the Dutton Drain watershed to quantify volumes of water in the creek after a storm. The hydrologic study guided the Dream Stream Team's decision to reconstruct Dutton Drain into flood benches, providing excess volume for stormwater while also bolstering erosion resistance and ensuring safety for school children via native vegetation and shallow banks. Construction plans were produced for the final design and will be handed off to the Kent County Drain Commission, Plaster Creek Stewards, and EGLE for review. Assuming submitted plans are complete, implementation of the final design is scheduled for Summer/Fall of 2024. Team 4 hopes that their project will foster a sense of stewardship and environmental education within the community.



Team 5: The Sand-Witch

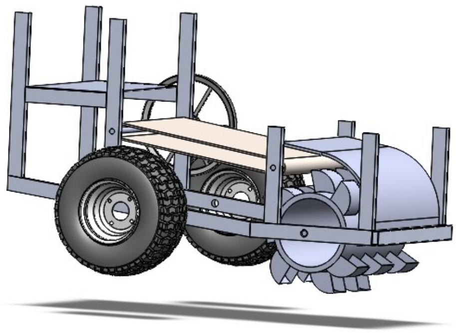
Owen Kalsbeek, Stephen Langerak, Ryan Medema, Zachary Rozendal

Beaches are one of nature's most beautiful and accessible settings. Unfortunately, they are also among the most impacted environments by pollution and littering. Therefore, these places ought to be kept clean and safe for both humans and wildlife.

Team 5 consists of four Mechanical Engineers. The team is aimed toward designing and creating a machine for cleaning up trash on our beaches here in Michigan.

The Sand-Witch harnesses power from an 48 V e-bike battery and 1000 W brushless DC motor to turn a scooped drum, as well as wheels to assist in pulling the device along the sand. The scoops on the drum have holes that are small enough to be in line with the team's design specifications of cleaning trash as small as a cigarette butt. Each scoop can pick up about 50 cubic inches of sand and throws trash onto a conveyor belt while dumping the excess sand. The trash from the conveyor is then carried to a receptacle which stores the trash until it is ready to be dumped.

This machine would be the perfect tool for private beach owners, as well as small-scale DNR use and even beach volleyball courts. Despite being about 5 feet long and almost 3 feet wide, it would still be one of the smallest beach-cleaning machines on the market and therefore is perfect for small-scale use like the examples above. The current model built by Team 5 is simply a prototype due to limits in cost. However, the potential is there for the Sand-Witch to be a small, cheap, and environmentally friendly alternative to beach cleaners, specifically in West Michigan.



Team 6: Bike Team

David Visser, Luke Penning, Nora TerBeek, Ally Gauss, Panashe Makuvaro

Team 6 is composed of five Mechanical Engineering students.

The team was inspired by a cyclist who has polydactylism, Heidi, to design a bicycle for a user who faces challenges of a similar nature.

They have designed and built a bicycle for users with limited to no function of their left hand and or arm. There are two main categories of modifications: electrical/mechanical and biomechanical. The electrical/ mechanical portion of the design incorporates gear shifting, turn signals and braking electronically controlled by a centralized Arduino. For biomechanical modifications, the team designed a more comfortable handlebar that provides additional support for the user's hands and forearms. The modified handlebars have also been placed closer to the user's torso to allow for a more upright posture; lessening the weight on the hands and forearms allows the user to be more balanced.

Through this design, the team hopes to deliver a more comfortable and safer bike ride that the targeted user can enjoy. Team 6 hopes that their project will foster a sense of justice and promote the importance of care when it comes to designing for those with disabilities.

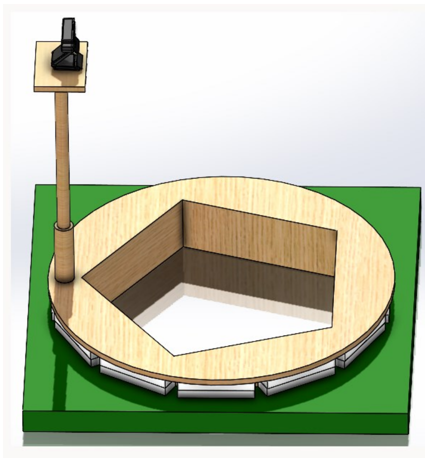
Team 7: Turret Titans

Mitchell Cook, Brayden Raches, Jared Skaggs, Hayden White

Team 7, the Turret Titans, consists of four Mechanical engineering students. Turret Titans worked to create a safer and more protected alternative method to controlling and operating a military turret. Through removing the need for turret operators to be on top of military vehicles such as a HUMVEE, we aim to not only protect and save the lives of turret operators but also enhance situational awareness and integrate new technology into a military application.

Central to the system is an elevated camera with a 120-degree field of view, allowing the operator a wide range of sight without having to rotate the turret. Additionally, a second camera is fastened with the ability to utilize the weapon sight to allow for more precision. The ability to toggle between both cameras allows for a heightened sense of situational awareness. The camera system works in tandem with a virtual reality headset, an Oculus 2, allowing for the operator a heightened sense of situational awareness.

Control of the turret is simplified through the use of a joystick paired with a button allocated to the firing mechanism. Simplicity is key given operation of this system will likely be in high-stress situations. The movement of the system is managed through two motors, one controlling the elevation of the weapon and the other controlling the rotation of the weapon.



Integrating cutting-edge technology and military applications allows for the increased safety of the operator, removing them from direct exposure in combat situations.

Team 8: Ready Recovery

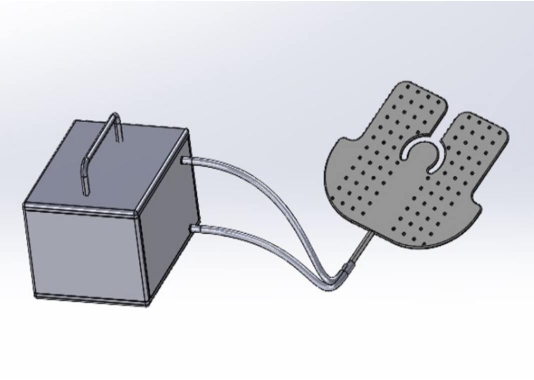
Stuart Johnston, Caleb Gaffner,

Micah VanDeBurg, Kyle VanDusen

Team 8 comprises four mechanical engineering students. The goal of team Ready Recovery is to develop a 3-in-1 muscle recovery device for the athletic training staff and student athletes at Calvin University. The device will be a more convenient and cheaper alternative mode of recovery for all athletes to be utilized before or after intense exercise.

The team is designing and building a recovery device that can provide multiple recovery methods including heating, cooling, and compression therapy to the user. Currently, individual recovery systems are expensive and only provide one or two modes of recovery. In addition, they require the manual addition of ice by the Calvin Sports Medicine staff to provide cooling capabilities, which limits portability and convenience. Our system will be electrically powered and utilize a single working fluid that can be manipulated to switch between hot and cold temperatures, simulating heating and cooling aspects of contrast therapy. A separate pressurized air stream will be used to provide compression for the user to stimulate blood flow and improve muscle recovery.

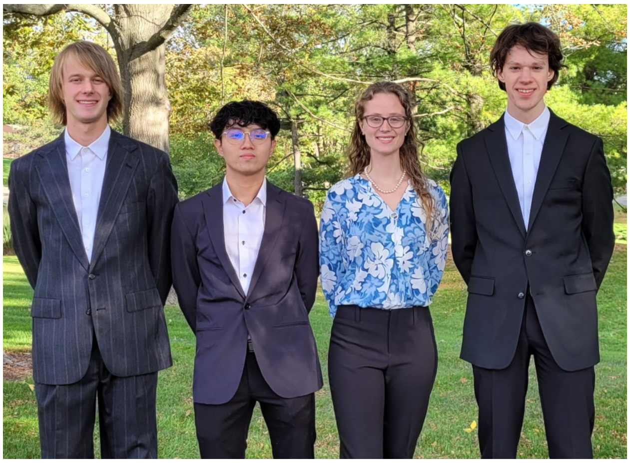
The bottom right picture shows a rendering of the Ready Recovery system which is composed of a mechanical hub and universal recovery sleeve. At the heart of the mechanical hub are multiple thermoelectric Peltier devices—used to provide electrical heating and cooling. As electrical current passes through the device, water will be heated or cooled to desired temperatures and pumped to the recovery sleeve.



Team 9: PiggyWrap Pro

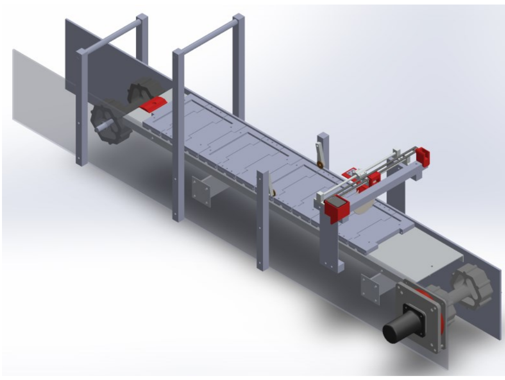
Nathan Zylstra, Tyler Nguyen,

Samantha Bush, David Schmurr



South Olive Christian School strives to provide a Christian education at an affordable price. Their annual Pigs-in-a-Blanket (PIBS) fundraiser helps them achieve this by using the profits from the sales to lower tuition costs. However, due to recent inflation and increase in demand, the school volunteers making the appetizers can't keep up. This is where a 2022-2023 Senior Design team stepped in to help and created a machine to automate and speed up the assembly process for the PIBS.

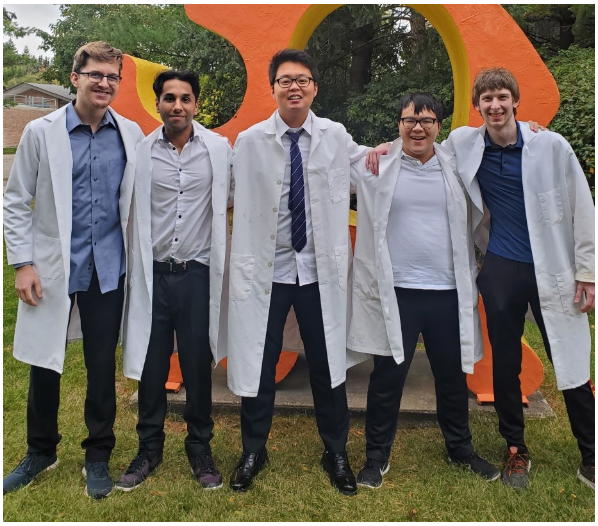
Inspired by this project, Team 9, consisting of three Mechanical engineering students and one Electrical engineering student, created a prototype of an semi-automated packaging machine that would complete the process. This design included a custom conveyor belt with trays sized for the proper amount of PIBS (12) for each package and two rollers to sandwich the appetizers in between two layers of packaging plastic. It also included multiple heating elements used to seal all four sides of the individual packages and a cutting element to divide the connected packages into separated individual packages. A PLC was used to semi-automate the process with the use of a push button to index the conveyor belt and drive the cutting element across the plastic.



The team put together a CAD model as a proof of concept, then went on and created a physical model to showcase the function of the design. Multiple different designs for the conveyor belt trays, heat-sealing element and cutting method were prototyped and tested to ensure desired specifications for the design were met.

Team 10: Auto-Pill

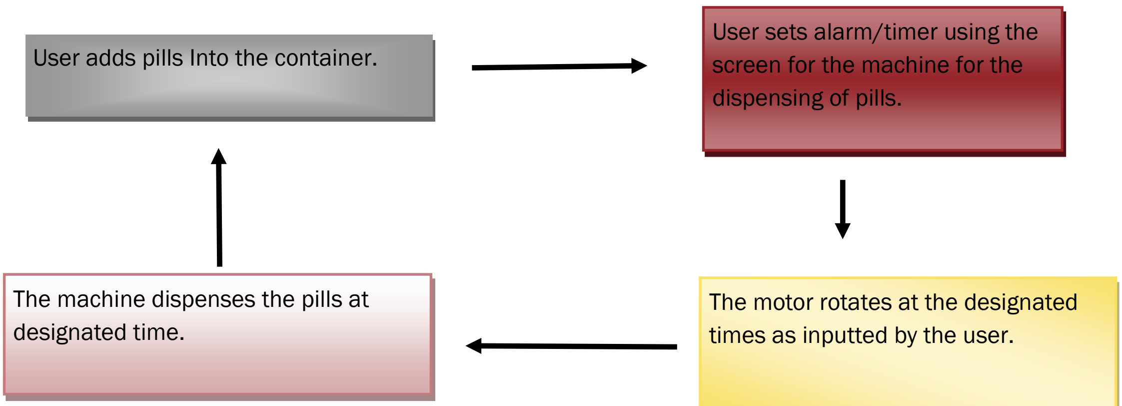
Austin Duimstra, Vardhan Adhikari, Yonggi Kim, Dat Ta, Mark Schultz



Team Auto-Pill is made up of three Mechanical and two Electrical engineering students. Our team has sought to create a solution that helps people who to take their prescribed medications within the designated times. This is a problem for many families, especially if people become more forgetful or take many prescriptions. As we came to recognize this problem, we decided to create a solution for our Senior Design Project.

Our team worked on a project that focuses on providing a better experience to take prescribed medications, without the hassle of having to take out the pill, as well as remembering when to take them. Our project consists of a box-like device that will notify the user when it is time to take their pills. A large button on a touchscreen will be pressed by the user when they are ready to dispense their pills.

How it Works:



Team 11: Full Spectrum Design

Seth DeVries, Daniel Cordeiro, Trent Belote, Joseph Fu

Team 11 consists of two Mechanicals, one Mechatronics and one Electrical engineer. The team developed a running test chassis and prototype pneumatic gear shifting system to be used in the future by Calvin's new FSAE (Formula Society of Automotive Engineers) club.

The FSAE competitions are high-speed races held between various universities. Each team must design, build, and fine-tune miniature Formula One cars where cutting-edge innovation and technology are critical keys to success. Full Spectrum Design (FSD) has designed a pneumatic shifting mechanism for the FSAE car to help achieve this goal. The shifting mechanism is designed and implemented with many generic manufactured parts to allow the FSAE team to modify and adapt the shifting system to their performance needs. Using a high-pressure CO_2 system, a pneumatic double-acting cylinder is actuated by a tap-shifting controller to immediately change gears at the optimal speed and RPM commanded by the driver.

Team 12: VoltRampage Innovations

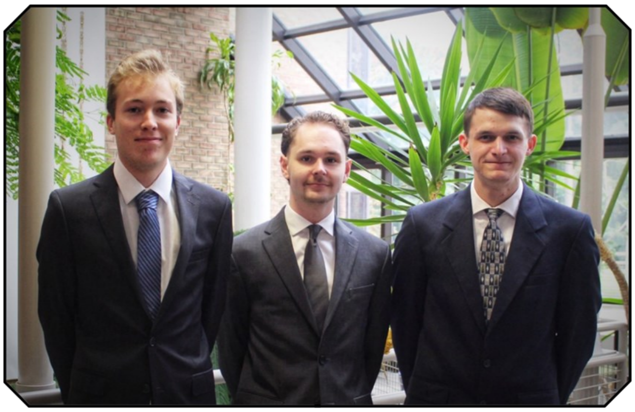
Noah Jarrell, Joe Saldin

In the modern guitar gear industry, guitar players are forced to spend a substantial amount of money to buy quality amplifiers or pedals. This typically involved buying an expensive guitar amplifier and multiple expensive pedals. Current attempts to solve this problem contain large amounts of low-quality effects into a low-quality guitar amp. Thus, there is no simple or cost effective way to dial in a quality guitar tone. To fix this dilemma, VoltRampage Innovations combines the quality of expensive pedal effects into a high-grade guitar amplifier package at an affordable price: the DOOMCaster. This eliminates the need for guitar players to spend needless amounts of money to achieve a certain tone. The DOOMCaster provides a quality, all-in-one portable solution for guitar players.

To present a viable solution, VoltRampage Innovations took a detailed design approach to achieve the desired outcome. This involved the use of simulation software to design the circuits and confirm functionality before manufacturing the physical circuits. Our final prototype consists of a working guitar amplifier with three built-in effects. The user has the ability to turn on or off any of the effects to change the sound of the guitar. The amplifier and effects also include multiple volume and tone adjustment knobs to customize the tone of the guitar. Most importantly, all knobs on the DOOMCaster go to **11**.

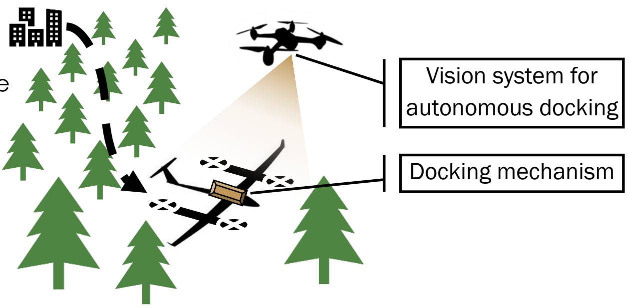
Team 13: Tandem Scout

Jacob Vanden Bosch, Caleb Shippy, Caleb Clark



Tandem Scout is a compact and agile quadcopter capable of autonomous docking and undocking with Team 14's Tandem Ranger (quadplane host-ship) via a smart vision system. Paired with the host-ship, Tandem Scout extends mission life, as none of its power is expended during transit to or from the point of interest. While docked, it can also be charged by the host. Upon detachment from the host-ship, it seamlessly transitions into first-person view (FPV) mode, granting operators an immersive, perspective. Outfitted with cameras, it is well equipped to collect high-resolution spatial data. Along with Team 14, this Tandem drone system is capable of long range, high resolution imagery.

The quadcopter will accomplish this by communicating with the flight controller on the quadplane via flight controllers running ArduPilot firmware; combined with Mission Planner software autonomous flight is possible. Both flight controllers communicate via radio with a ground control station computer that relays information between the two vehicles. During deployment, the quadcopter will be released and will move away from the quadplane autonomously. Then, it will descend toward its target before switching to a manual flight mode. After completing its mission, it will enter its reattachment stage and navigate towards the quadplane's GPS coordinates. The GPS will get the quadcopter close enough to the quadplane that the quadcopter will be able to use a vision system to navigate slowly and safely to the quadplane. A fiducial marker that provides 3D positioning information to a vision system will be used in conjunction with the vision system for the final stages of reattachment with magnetic feet and a mechanical docking system. These integrated systems make the quadcopter ideal for environmental stewardship applications like forest management, wildlife tracking, search and rescue, and geographic exploration.

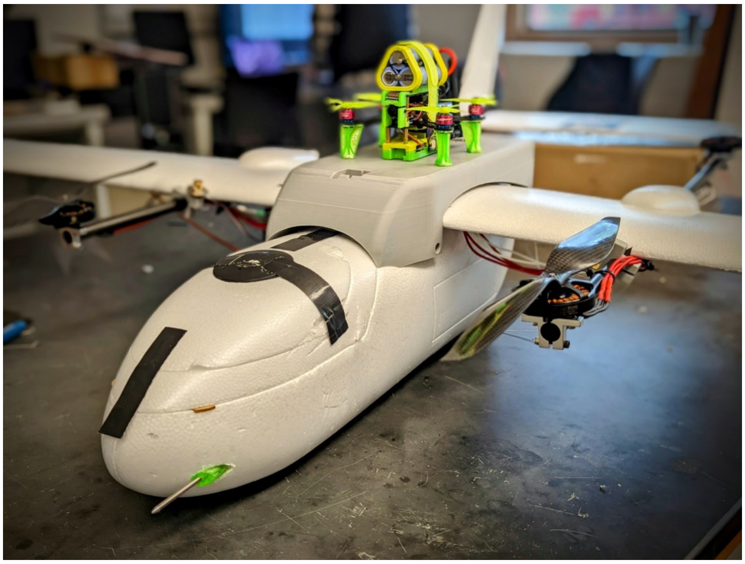


Team 14: Tandem Ranger

Kyle Borror, Cole Rettstatt, Mikayla Bindon, Luke Jensen

Tandem Ranger, designed for range, functions as a dedicated mission support platform such as aerial reconnaissance yet is capable of autonomous docking and undocking with Team 13's Tandem Scout. It is configured to transport a payload, such as a quadcopter, and equipped with sensors tailored to specific use cases.

Upon reaching its destination, the Ranger offers two distinct operational modes. If the terrain permits, it may gently land and deploy the quadcopter, conserving battery power. Alternatively, the Ranger may assume a higher vantage point, circling above the designated area to provide an extended view of the surrounding area. Where continuous surveillance is required, the Ranger may operate autonomously, scanning the environment to relay crucial data to its operators. To further save power for the Scout, the Ranger charges the Scout when it is docked on the Ranger.



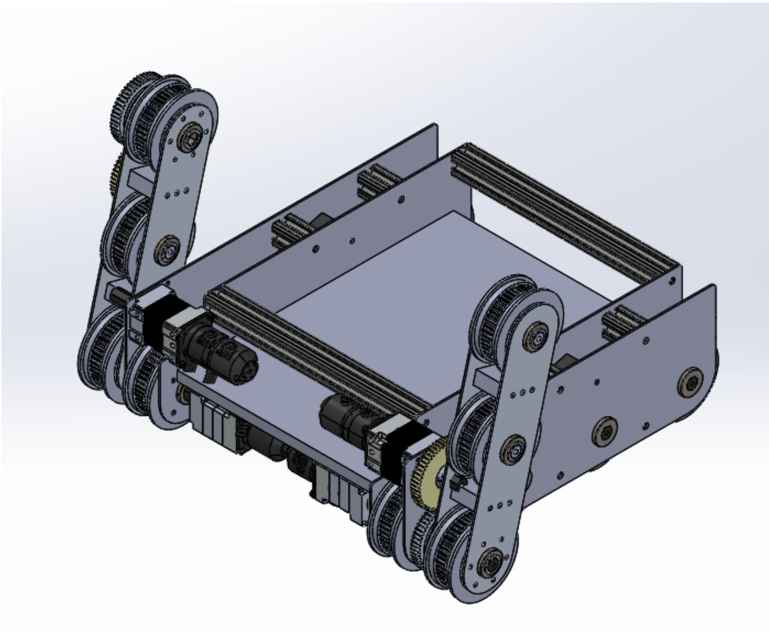
Team 15: ProFound

Forrest Peterson, David Conhoff,

Matthew Walstra, Sam Mennega

Earthquakes trap people inside collapsed buildings. Rescuing people quickly is critical for increasing earthquake survival. Current strategies include local and international rescue teams with dogs, imaging, and microphones. To improve rescues, teams need to search quickly deep into rubble.

Researchers are improving robots because robots can explore more dangerous and smaller areas than people. These robots augment existing solutions by finding trapped people faster and deeper inside collapsed buildings. Our team is designing a cost-effective robot solution to traverse earthquake rubble. The design includes the mechanical motion systems integrated with the electrical and software controls.



Team 16: Kombrewcha

David Harris, Michael Lanning, Ben Nymeyer, Zachary Swart, Carter Vande Vegte

The rising popularity of kombucha has led to significant costs for avid consumers, with yearly spending on store-bought bottles often exceeding $900. While some turn to homebrewing for cost-effectiveness, traditional methods lack consistency and require substantial time and effort. To address these issues, a time -efficient homebrewing solution is proposed, focusing on consistency in these key factors: acidity, sweetness, and carbonation. Maintaining optimal fermentation conditions is crucial for producing quality kombucha. A kombucha maker must regulate temperature to expedite brew time without compromising the health of the SCOBY (Symbiotic culture of bacteria and yeast). Additionally, acidity measurement plays a vital role in flavor and brew status, requiring the device to monitor pH levels through conductivity to determine how acidic the brew is. Sweetness levels are determined by sugar content, with the machine guiding users on the appropriate amount to achieve desired flavor profiles or recipes. Beyond brewing optimizations, the device must meet aesthetic and functional criteria for kitchen integration, accessibility, and ease of cleaning. This design aims to blend seamlessly into modern kitchens while being user-friendly for a broad population of brewers. Ensuring simplicity in operation and maintenance is crucial for widespread adoption. Stop by our table and ask us questions about our machine, or about kombucha in general. Samples will be available in limited supply.

Team 17: The Antibiotic Strikes Back

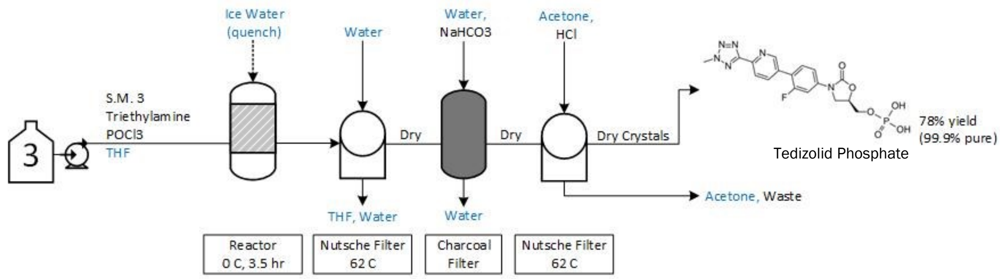
Colton Stonehouse, Netsanet Waal, Adelaide Stonehouse, Daeun Joo, Noah Pehrson

Team 17 is comprised of five Chemical engineering students. The team designed a plant to produce medical grade (99.9 wt%) tedizolid phosphate (TP) (pictured below). TP is a last-resort antibiotic used to treat acute bacterial skin infections. Currently, one gram of TP costs $2600. This plant was designed to significantly reduce the cost, making the antibiotic more accessible to future patients. The plant produces 500 kg of TP per year to treat 410,000 patients a year, or 50% of all US hospitalizations for skin infections, with the flexibility to reach foreign markets.

The process involves three individual reactions steps with subsequent purification stages. The first, second, and third reactions are a Miyaura borylation, a Suzuki coupling, and a phosphorylation, respectively. The process was simulated using SuperPro Designer. The team designed a batch process for its flexibility and its typical use in the pharmaceutical industry. Demonstrating the batch process's flexibility, reactions one and three occur in the same reaction vessel with intermittent cleaning, while reaction twooccurs in a second reactor, since it is the slowest step.

To purify the crude product, the team incorporated multiple Nutsche filters for their ability to filter, wash, and vacuum-dry the product in a single vessel. In the Nutsche filter, the crystallized product is collected into a solid phase (i.e., the filter-cake), while a solvent washes impurity into a liquid phase (i.e., the filtrate). Distillation and charcoal filtration are also used to help achieve 99.9% purity.

Final reaction step for producing tedizolid phosphate.



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Jeremy Van Antwerp

Civil & Environmental Concentration
Leonard De Rooy
Julie Wildschut
David Wunder

Electrical & Computer Concentration
Randall Brouwer
Monica Groenenboom
Mark Michmerhuizen

Mechanical Concentration
Gayle Ermer
Fred Haan
Chris Hartemink
Matthew Heun
Ren Tubergen

Adjunct Faculty
Andrew DeJong
Michael DeVries
Nicole Dyer
Andrea Fryling
Mathew Lomasney
Andrew Jo
Braden Kopenkoskey
Robb Lamer
Rob LaPlaca
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