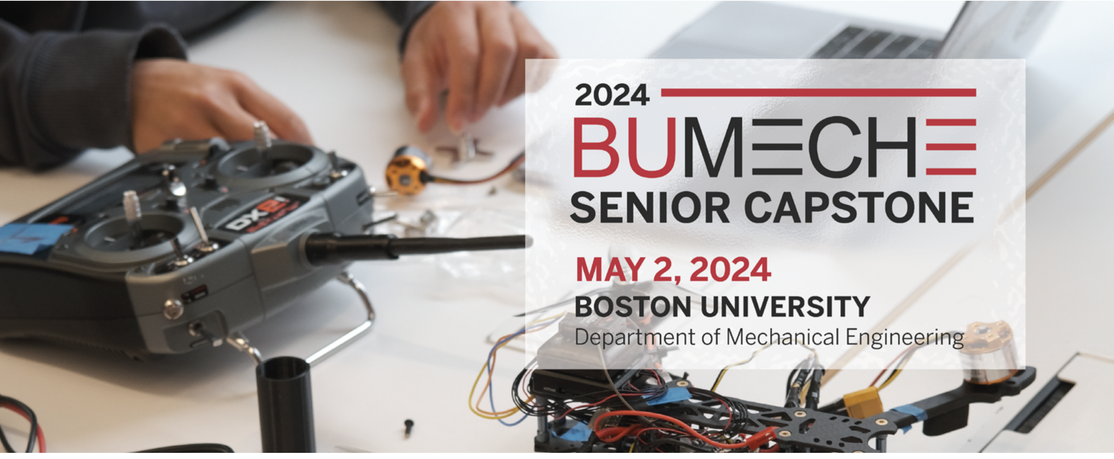


Click here for the Presentation Schedule

Table of Contents

Click on the project name to go to their page.

Letter from the Chair

Welcome to the Mechanical Engineering Senior Capstone Day for the class of 2024!

These Senior Capstone projects are the result of a tremendous amount of work over the past year by our MechE students. The teams leveraged the knowledge they have gained throughout their undergraduate education, using skills from statics, fluid dynamics, electromechanical design, and more, to tackle practical, challenging problems. They went through multiple designs and untold iterations to create novel solutions to meet the needs of their customers.

This year we have 34 projects, covering a wide range of topics in Mechanical Engineering and beyond. Are you excited by the intersection of robotics, environmental monitoring, and education? Then be sure to check out the AquaROVER. Interested in solar-power and heat engines? Then the Supercritical CO2 Brayton Power Cycle project is right up your alley. Have you always wanted a personal aircraft to fly over the Boston traffic jams? The Personal VTOL Commuter Aircraft may be just the thing! The breadth of projects on display this year really showcases that Mechanical Engineering is a discipline impacting so many different areas of our lives.

The projects themselves come from many different sources. We are always excited by the participation of Boston-area companies and are grateful to this year's sponsors, including Formlabs, Senior Metal Bellows, Spinnaker Analytics, and Vibram. We also have projects sponsored by faculty and projects driven by individual student initiatives. We are always looking for new project opportunities and partnerships and invite anyone looking to get involved to contact Professor Tony Linn.

I hope you will enjoy this year's presentations and exhibits. I am extremely proud of what our students have accomplished and look forward to joining you in celebrating their achievements.

Sean B. Andersson
Professor and Chair
Department of Mechanical Engineering

Senior Design Faculty, Staff & GSTs

Anthony Linn
Professor of the Practice

Francis DiBella
Senior Lecturer

Jim Geiger
Lecturer

Thomas Devlin
Lecturer

Annmarie Roth-Haley
Financial Administrator

Ahmad Hedayatzadeh Razavi
GST

Steve Chomyszak
Professor of the Practice and EPIC Director

Tasker Smith
EPIC Senior Shop Manager

Ryan Bakinowsk
EPIC Laboratory Supervisor

Kara Mogensen
EPIC Laboratory Supervisor

Caroline Carbo
EPIC Laboratory Supervisor

Adam Zelny
EPIC Laboratory Supervisor

Eric Hazen
Senior Research Engineer

DBF 3D PRINTED GLIDER

TEAM MEMBERS

Matthew Sorensen
Justin Tran
Ali Eskiocak
Max Honeybone

PROJECT ADVISOR

Jim Geiger

OVERVIEW

Design, build, and test a glider primarily built from 3D printed parts.

THE PROBLEM

The glider must fly for at least 5 seconds. The glider must have a modular design and should easily be reassembled between flights.

THE REQUIREMENTS

The main components of the glider should be 3D printed. The glider must fly within an airspace the size of a football field with maximum height of 30 feet. A propulsion system may be implemented but can only run for a maximum of 5 seconds.

THE SOLUTION

The solution strategy was to design a glider that was highly modular, which enabled multiple test flights per print iteration. Additionally, the different parts of the glider would be connected by an external joint, such as wooden dowels, or pins. Multiple concepts of different designs were pursued concurrently, so as to test various designs experimentally.

THE RESULTS

The final result was a highly modular 3D printed glider with the major print components being the wings, the fuselage, and the empennage. This yielded a small, slender glider with long wings. The wings were designed to be sectioned, so as to increase or decrease the wing span at will. Furthermore, the fuselage resulted in having many wing connection points, so as to move the wings' location at will.

Back to Table of Contents

NASA LEGACY CHALLENGE:
SELF-PILOTED AIRCRAFT FOR CRITICAL RURAL/SUBURBAN NEEDS

TEAM MEMBERS

Cirino Costa
Jordan Marabello
Courtney Lee
Ernesto Rodriguez

PROJECT ADVISOR

Jim Geiger

OVERVIEW

NASA invites students to propose very short takeoff and landing, multi-modal commuter aircraft designs that enable increased throughput of passengers and/or cargo in rural and suburban areas through the use of self-piloting and short takeoff and landing (STOL) technologies.

THE PROBLEM

Operating small commuter aircraft commercially presents economic hurdles in aviation. Serving local, short-range routes with low demand results in small vehicle sizes. Cutting these routes risks isolating remote communities. High operational costs stem from low utilization, frequent takeoffs, landings, and limited seating. Essential Air Services program subsidies ensure access for remote areas. These aircraft, usually under CFR Part 135, carry up to nine passengers or 7,500 pounds of cargo, also used for air cargo and potential autonomous flight adoption.

THE REQUIREMENTS

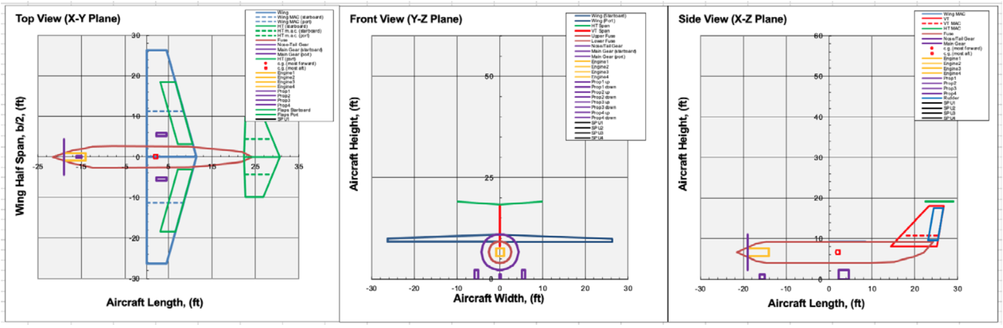
The aircraft is designed with a mission profile of a maximum range of 500nm, max speed of 250KIAS below 10,000ft, takeoff/landing field length of 250ft (goal), and life cycle cost of no more than $2.00/seat-mile. Passenger configuration: passenger weight calculated at 220lbs, accommodations for two pilots.Cargo configuration: payload capacity of at least 2,000lbs.

THE SOLUTION

Taking into account our design drivers, aerodynamics, and safety, our solution is a fixed-gear, high-wing, single engine turboprop STOL aircraft. The aircraft features advanced flap systems to assist with the small field requirements for the air taxi, as well as substantial improvements in weight reduction via the use of composites. With the incorporation of self-piloting technology, the aircraft can be configured with hardware in the cockpit for autonomous flight operations.

THE RESULTS

Our civil utility aircraft weighs in at approximately 8,500lbs and falls in between the objective and threshold values of the design requirements. Upon economical analysis, cargo missions were prioritized to optimize revenue and utilization. Our aircraft design is competitive compared to existing civil utility aircraft in the industry as we have the advantage of advanced autonomous technology. The final design deliverable will include performance specifications and an economical analysis.



Back to Table of Contents

AUTONOMOUS GOOSE CHASER

TEAM MEMBERS

Spencer Twyman
Charlotte Duan
Kim Yeung
Andrew Morrisey

PROJECT ADVISOR

Anthony Linn

OVERVIEW

An autonomous, goose chaser drone to ward off pesky geese from Boston's recreational, outdoor spaces.

THE PROBLEM

The prevalence of geese in urban environments poses a multifaceted challenge that necessitates effective mitigation strategies. Geese, often drawn to cities, inhabit public recreational outdoor spaces, causing disturbances and hinderances. Their presence results in unsanitary conditions, as fecal matter can accumulate quickly. This poses health risks and diminishes quality of life. The need to address the unwelcome presence of geese in public spaces is paramount to the well-being of communities.

THE REQUIREMENTS

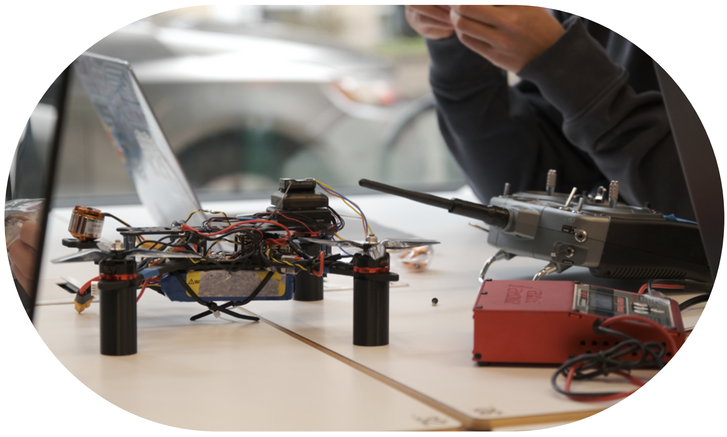
This robot should successfully drive the goose from the designated area via some method of deterrent. Secondly, the device must be autonomous, meaning it does not require human controls to function regularly. The device should be able to activate, search for target geese, execute the deterrent, and deactivate automatically. Lastly, the device should be able to autonomously navigate a designated area without interfering with existing objects like trees and fences.

THE SOLUTION

Our solution is an autonomous drone with an onboard image recognition system that identifies geese, orients towards them, and herds them off a prescribed area.

THE RESULTS

A functioning image recognition system, a new drone with increased frame strength and increased load capacity, and an onboard computer capable of fully autonomous flight.



Back to Table of Contents

TERRAROVER

TEAM MEMBERS
Dana Bulakh
Christian Urteaga
Jingshuo Li
Marcus Wachira
Ani Pulake

PROJECT ADVISOR
Anthony Linn

SPONSOR The GLOBE team and AREN project team at NASA

OVERVIEW
A remote controlled rover dedicated to measuring urban heat island environmental data intended for use by middle school and high school students.

THE PROBLEM

The GLOBE team and AREN project team at NASA have a problem with the lack of information about thermal mapping, wind speed and direction that the rover can provide, and the durability and maneuverability of the rover.

THE REQUIREMENTS

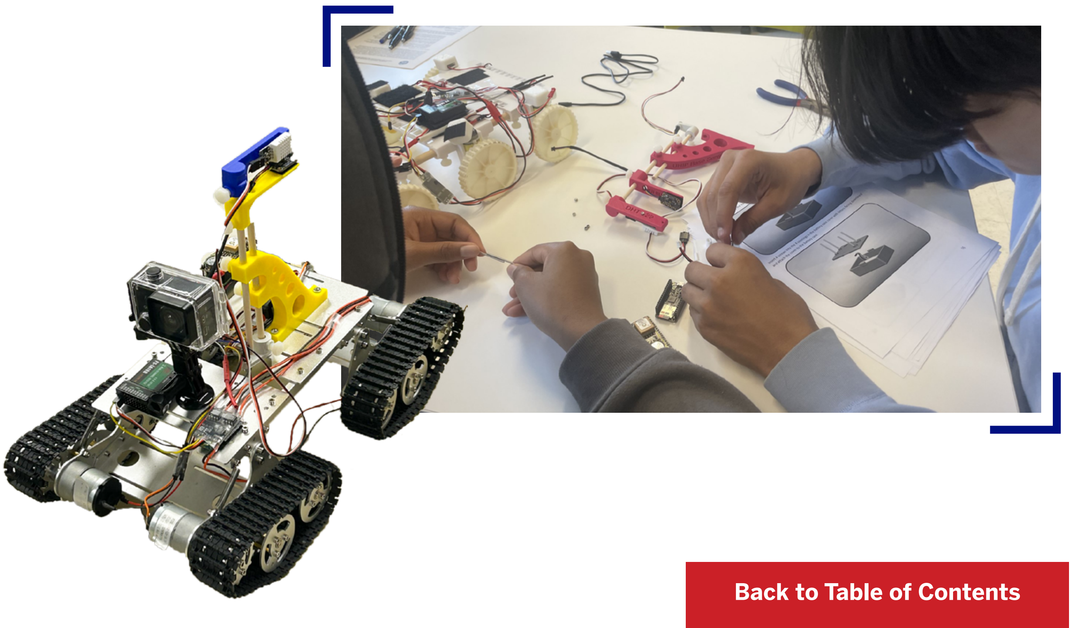
- Usability
- Durability
- Affordability
- Reusable
- Reasonable operations time
- Reasonable Size and Weight
- Has needed sensors

THE SOLUTION

We have multiple solution strategies that address our problem: this includes updating the chassis, adding new sensors, and creating a manual to assemble the sensor pack. We updated the chassis by purchasing a pre-manufactured kit and integrated the components from the old rover. The additional sensors include a wind speed sensor and a thermal camera. The sensor manual was created and built upon previous TerraROVER manuals.

THE RESULTS

The new rover had upgraded speed and mobility due to the updated chassis, which included, but is not limited to, driving down stairs, ramps, over tall grass, mulch, and plants. A focus group consisting of K-12 students found that using the new sensor manual made the process of building the rover easy and educational, with them finishing assembly in 30 minutes.



Back to Table of Contents

AQUAROVER

TEAM MEMBERS

Weinuo Lin
Fahim Rabbi
Natalie Menon
Lorenzo Moriche Koukouchkina
Samuel Haley

PROJECT ADVISOR

Anthony Linn

SPONSOR NASA and Wayne RESA

OVERVIEW

AquaROVER, a collaborative project with NASA and Wayne RESA, aims to develop an autonomous sailing vehicle capable of environmental data collection to enhance K-12 students' engineering curriculum.

THE PROBLEM

The AquaROVER project aims to enhance efficiency in sailboat design by integrating autonomy while prioritizing wind propulsion and ease of assembly. It addresses the demand for accessible methods of gathering water quality metrics while offering hands-on educational opportunities for K-12 students.

THE REQUIREMENTS

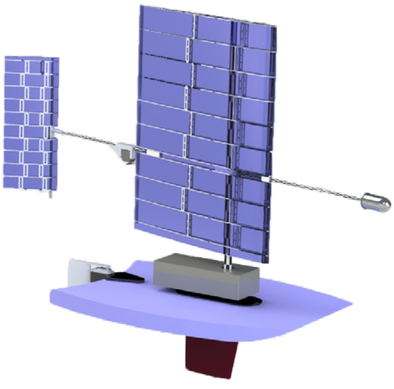
The requirements encompass achieving autonomy in sailing while relying solely on wind propulsion. Engineering constraints involve prioritizing weight reduction and structural stability while adhering to manufacturing and operational constraints. Additionally, ease of assembly and control were crucial objectives aimed at enhancing educational experiences.

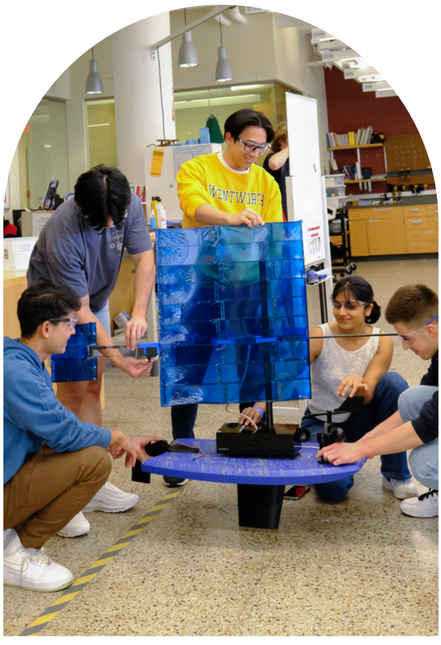
THE SOLUTION

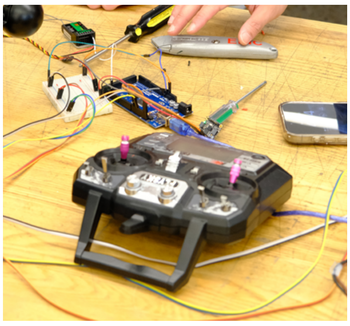
Our solution strategy prioritized weight reduction and structural stability while informing the design using airfoil simulations and sailor consultations, optimizing our sail for efficiency and lift. Moreover, the automation algorithm took inspiration from sailing expertise and preliminary testing.

THE RESULTS

AquaROVER successfully transitioned to wind propulsion with its innovative wing design, enhancing sail lift and minimizing drag. The solid sail and elevator, fine-tuned through simulations, optimized wind capture, while the keel and rudder ensured stability and precise steering. With its autonomous sailing and educational mission, AquaRover lays a solid foundation for future developments.







Back to Table of Contents

SENIOR METAL BELLOWS

TEAM MEMBERS

James Huang
John Carr
David Montana
Stedmon Sweeney

PROJECT ADVISOR
Anthony Linn

SPONSOR Senior Metal Bellows

OVERVIEW
A automated system that is designed to orient, inspect, and stack parts for a downstream automation processes.

THE PROBLEM

Senior Metal Bellows needs a system to orient small diaphragms and stack them on an arbor.

THE REQUIREMENTS

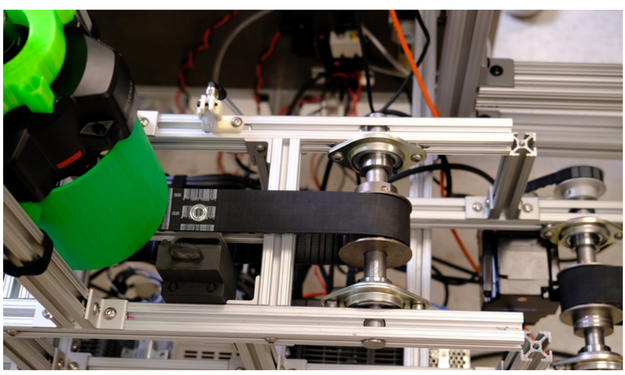
- Accommodates all parts throughout size range.
- Mounted camera for viewing top of diaphragm.
- Mounted camera for viewing bottom of diaphragm.
- Fits in envelope determined by on-site visit.
- 90% successful diaphragm stack rate.
- Easy set-up for operator – provide technical documentation.
- Slug removal method.
- Method to bypass system.
- BOM + Electrical Diagram + Preventative Maintenance + Consumable List.

THE SOLUTION

Complete overhaul of the powertrain system. Improved previous parts of last year's group, and created new parts through multiple design iterations to accommodate diaphragm sizes and to better the stacking rate. Created a bypass system, and improved the pathway from the stamping machine to the conveyor belt. Overall box frame size was rearranged to fit within the envelope presented by the customer.

THE RESULTS

Improved motor function and conveyor belt movement. Smooth flow of diaphragms of all size ranges. A working manual bypass, upgraded sorter, and improved diaphragm stacking rate. Upgraded box frame that is lighter, smaller and more transportable. Easy to use controls with little to no learning curve for overall system use.



Back to Table of Contents

AIR POLLUTION MONITORS
FOR BOSTON BLUEBIKES

TEAM MEMBERS
Sofiya Filippova
K. Raina Tung
Luisa DiLorenzo
Maya Lobel
Leon Long

PROJECT ADVISOR
Anthony Linn

SPONSOR Computational Energy Lab at Boston University

OVERVIEW
This project consists of the design and fabrication of several cost effective, weatherproof, unobtrusive air pollution monitors in the form of small enclosures that are able to be mounted on Bluebikes across Boston, and separately, the design of data receiving stations for wireless data transmission.

THE PROBLEM

Air pollution is extremely harmful to the environment and human health. Existing government-operated air pollution monitors are expensive and thus not densely scattered. Although existing monitoring systems can give insight into general air pollution trends, they do not accurately represent local, neighborhood-level air pollution in Boston. It is important to collect local air pollution data to understand how air pollution effects may vary between neighborhoods with different socioeconomic status.

THE REQUIREMENTS

The device must collect particulate matter, CO2, NOx, methane, temperature, humidity, and GPS data. The device must fit comfortably under the basket of the bike, be securely mounted, unobtrusive to the rider, theft-proof, and shock-proof. The device must allow for air to enter the enclosure and flow over the sensors while simultaneously being weather-resistant. The data collected by the device must be regularly transmitted to a receiving station.

THE SOLUTION

Our final design is a compact and powerful air quality sensor package that is mounted unobtrusively underneath the basket of Bluebikes and collects the desired ground-level pollution data. Air pollution sensors are soldered onto a printed circuit board which is housed in a NEMA 4x rated enclosure with weather resistant protection and ventilation for airflow. The collected data is wirelessly transmitted via LoRaWAN protocol and stored in the AWS database.

THE RESULTS

We were able to collect preliminary data with our prototype to evaluate our design. The collected data has a resolution of less than one city block, allowing us to identify sources of air pollution as the bike moves through the city and understand local pollution trends. We hope to leverage our data as a tool for positive change for Boston's air pollution landscape.

Back to Table of Contents

3D PRINTER

TEAM MEMBERS

Sihan Zheng
Rachel Gardiner
Victoria Ledezma
Noa Dienes
Michael Barany

PROJECT ADVISOR
Anthony Linn

OVERVIEW
Our goal is to design and prototype a working cartesian FDM 3D Printer.

THE PROBLEM

There is a need for a larger 3D printer at BU, so our team is designing and building an FDM printer that has the potential to be expanded to even larger sizes. Our vision is that a future capstone group will take advantage of our printer's modularity and make it bigger. The current electronics can support the higher voltage needs of bigger motors and a larger heated bed.

THE REQUIREMENTS

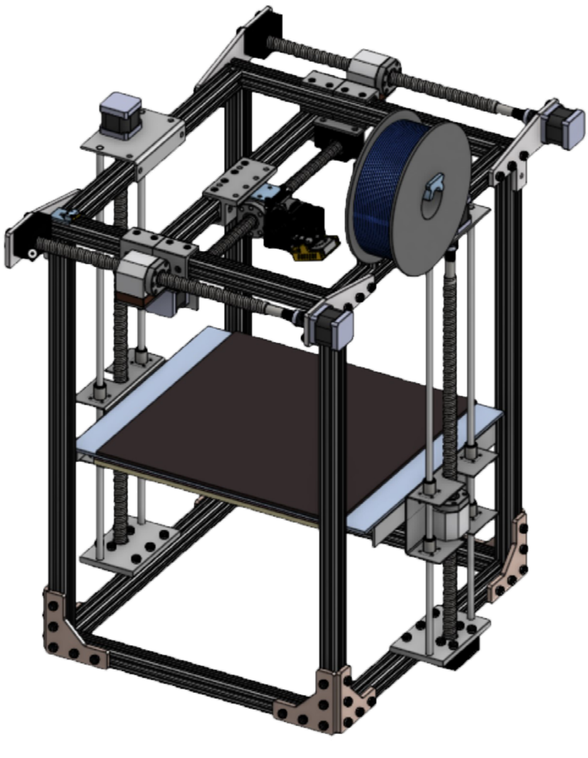
The requirements are print accuracy, print time, and build volume. The printed parts should not warp and should be accurate to the 3D model, along with being printed in a reasonable amount of time depending on the part volume.

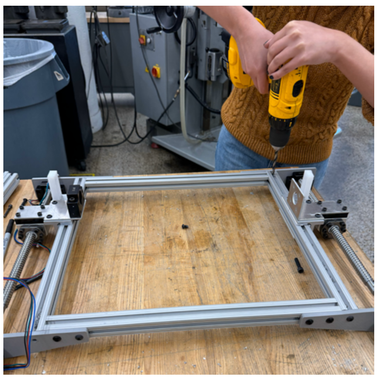
THE SOLUTION

We designed and built a 3D printer with scalability in mind, knowing that various BU teams and clubs may need large 3D printed parts. The modular design allows for longer aluminum extrusions, ball screws, and a heated bed to replace the current ones in order to increase the build volume. Additionally, an open-source software was used for optimal compatibility with potential modifications.

THE RESULTS

We prototyped an FDM (fused deposition modeling) 3D printer with a build volume of 350mm x 350mm x 400mm. The printer operates in Cartesian coordinates, with the nozzle moving in the X and Y directions and the bed moving in the Z direction. The linear motion is driven by stepper motors and ball screws. The nozzle extrudes PLA filament onto a heated bed to build desired parts.

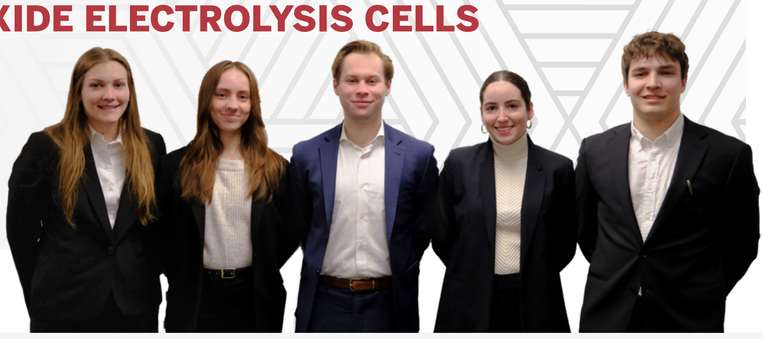




Back to Table of Contents

MODELING HYDROGEN PRODUCTION
FROM SOLID OXIDE ELECTROLYSIS CELLS

TEAM MEMBERS
Hanna Schlegel
Amanda Baumann
Harrison Peairs
Melissa Sierra
Yaroslav Sakharov



PROJECT ADVISOR
Francis DiBella

OVERVIEW
Modeling solid oxide electrolysis and running simulations with varying novel geometries and operating conditions to assess the costs and benefits of each design.

THE PROBLEM

As the threat of global warming continues to worsen, there is an increasing need for low carbon fuel. One of the most promising options is green hydrogen from solid oxide electrolysis (SOE), which is produced when electrolysis is powered by a renewable energy source at a high temperature. Current SOE cells are inefficient, degrade quickly, and have low surface area to volume ratios.

THE REQUIREMENTS

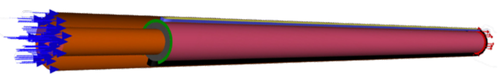
The electrolysis reaction, splitting water into hydrogen and oxygen, requires less energy at higher operating temperatures. In order to achieve these higher efficiencies, the electrodes and electrolyte must be solids that can withstand temperatures upwards of 700°C. These components must also have very specific material properties to allow the complex electrochemistry to occur. Larger cells yield more hydrogen, but ceramic components are limited in size due to their brittle nature.

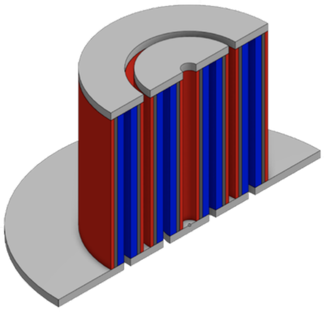
THE SOLUTION

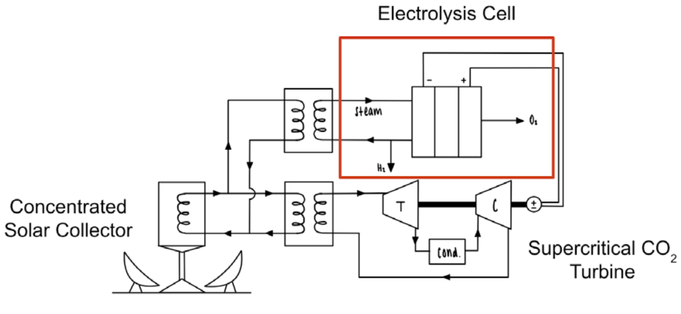
To improve efficiency of green hydrogen production, new SOEC designs that increase hydrogen production per unit volume were proposed. Multiple computational models were used to simulate and evaluate the novel designs. Material properties and operating conditions were informed by an extensive literature review. The simulations assessed each design's performance and efficiency, considering factors like electrode geometry, temperature, and pressure.

THE RESULTS

The various computational models of the novel designs produced similar results. Simulations revealed promising improvements in efficiency and hydrogen production rates compared to traditional SOEC designs,and achieved higher hydrogen production per unit volume. These models were also validated against current cell performance from literature. Further analysis will refine the models, which should then be tested experimentally. These designs could pave the way for more efficient and sustainable hydrogen production.







Back to Table of Contents

SUPERCRITICAL CO2 BRAYTON POWER CYCLE

TEAM MEMBERS

Noah Taniguchi
Chase Fukuda
Andres O'Connell
Christopher Lambert

PROJECT ADVISOR

Francis DiBella

OVERVIEW

Develop a sCO2 cycle that is powered by concentrated solar collectors to provide electric power for a high temperature steam electrolyzer within the constraints of available commercial systems.

THE PROBLEM

The use of sCO2 allows for power generation in a smaller form factor than steam turbines due to the higher working density of sCO2. Traditional power plants utilizing steam turbines often create a high volume of emissions with low efficiencies, which sCO2turbines can improve to generate cleaner and cheaper energy for consumers and energy businesses. Creating a renewable-based alternative that is more compact, efficient, and cost-effective could change the power generation landscape throughout the United States.

THE REQUIREMENTS

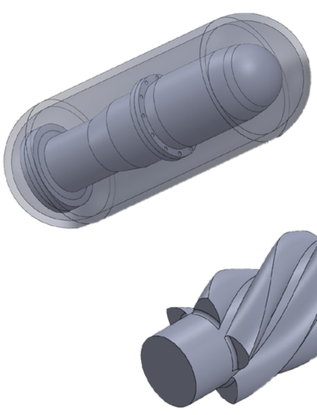
Deliverables include a conceptual design of a closed-loop Brayton Cycle with sCO2 as the working fluid. The power cycle will receive the required thermal energy input from a solar collector and produce at least 5kW of net electrical power for a high temperature electrolyzer. This sCO2 Brayton cycle must be compatible with the steam flow rates from the solar array as well as to the electrolyzer. The compressor and expander must be of "reasonable" size so as to be used in a classroom setting to demonstrate a small-scale power cycle.

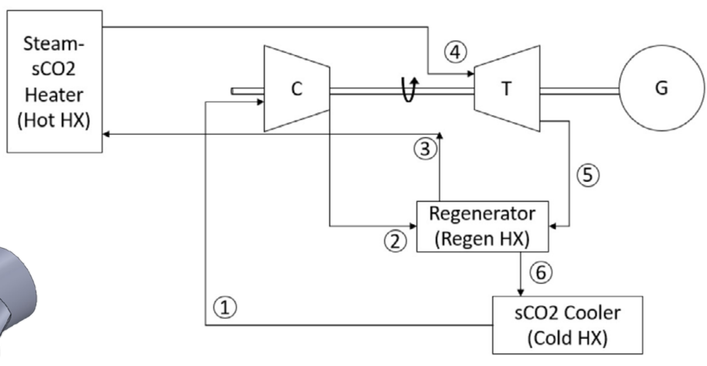
THE SOLUTION

Thermodynamic cycle analysis was performed to determine necessary heat exchanger sizes, fluid mass flow rates, and optimal compressor and expander designs. Stress and heat transfer analysis was performed to account for the high temperature and pressure requirements of the system. These calculations informed the selection of a compressor that currently exists on the market.

THE RESULTS

Alterations are included in a conceptual CAD redesign of the compressor and turbine. Both housings will be replaced with a new material, and the turbine will be housed by a double hull with cooling water flow in the annulus. These will be equipped with thrust bearings to account for the high operating pressures within ASME specified design and safety factors.



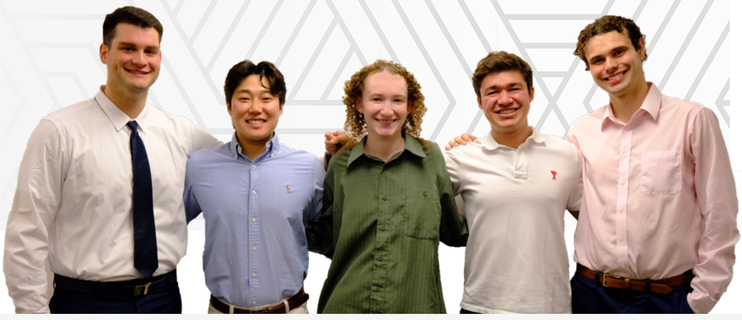


Back to Table of Contents

TRACKING SOLAR COLLECTOR

TEAM MEMBERS

Jack Mingo
Chris Shin
Ella Cicone
Daniel Piedrahita
Winston Davis



PROJECT ADVISOR

Anthony Linn

OVERVIEW

This project aims to develop a tracking solar collector system utilizing mylar-based mirror panels to concentrate solar radiation onto a heat exchange unit, facilitated by a dual-axis kinematic system for autonomous mirror position adjustment, ultimately generating thermal energy to complement other projects in driving high-temperature electrolysis or powering supercritical CO2 turbine generation for sustainable energy solutions.

THE PROBLEM

This project is aligned with sustainable energy initiatives. Harnessing solar thermal energy will fuel a high-temperature hydrogen electrolysis cell and a supercritical CO2 turbine generator, generating significant renewable energy. Our tracking solar collector concentrates solar radiation, facilitating energy production. Furthermore, this method avoids the need for rare earth metals, reducing costs and simplifying maintenance, thus promoting the wider adoption of renewable energy solutions.

THE REQUIREMENTS

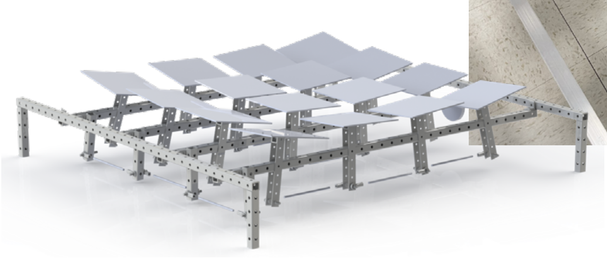
This project must exhibit a compact footprint suitable for urban settings, utilize inexpensive non-rare earth materials, maintain cost-effectiveness, ease of maintenance, and autonomously adjust mirror positions. Additionally, it should seamlessly integrate with other group's systems to work towards our shared goal of producing clean energy.

THE SOLUTION

A product with minimal complexity was the driving force when making design decisions. A linkage system using two motors allowed dual-axis movement with minimal electronic parts. Using data of the sun's path eliminated the need for sensors. All of this was accomplished using simple materials such as aluminum and mylar.

THE RESULTS

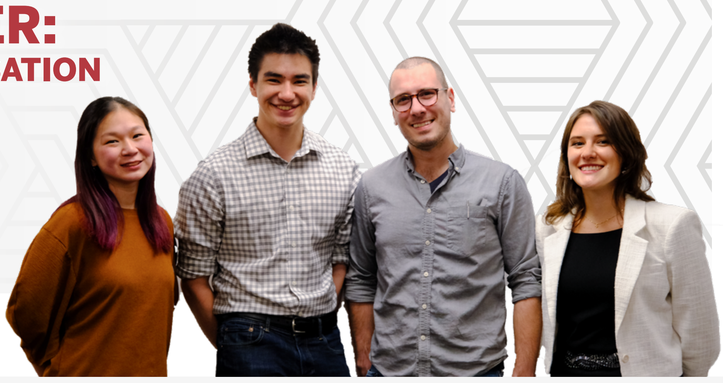
Two important results are the temperature change of the working fluid and dual-axis movement depending on the path of the sun. To measure the temperature difference, a pump was used to move water through a heat exchanger. A thermocouple was placed at the inlet and outlet to determine the efficiency. The second result can be demonstrated by utilizing two motors and existing data on the sun's path.



Back to Table of Contents

VIEWMASTER:
FRICTION VISUALISATION

TEAM MEMBERS
Anya Keller
Mark Higgins
Zack Pinard
Giulia Rigamonti



PROJECT ADVISOR
Anthony Linn

SPONSOR
Professor J. Gregory McDaniel and Professor Enrique Gutierrez-Wing from Boston University in partnership with the Navy

OVERVIEW
Generation of stick slip friction vibration and high resolution motion capture for repeatable studies.

THE PROBLEM

The stick-slip vibrations occuring at the friction boundary between two media in relative planar motion is of particular interest to the Navy, but has proven itself a challenge to understand both visually and quantitatively the stick-slip phenomenon occuring directly at the contact interface.

THE REQUIREMENTS

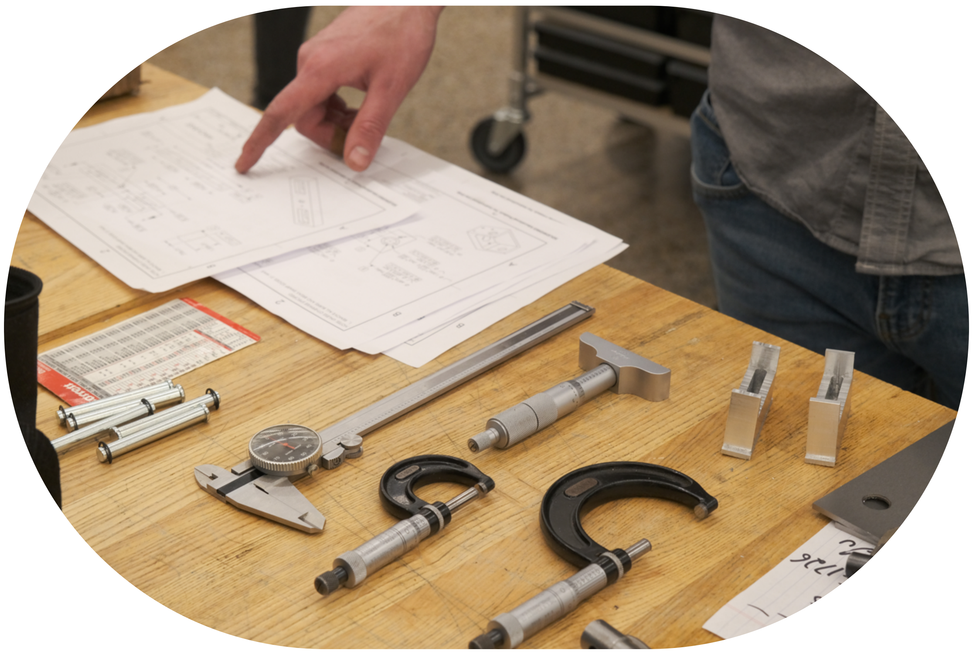
The prototype must be compatible with the Trilion motion capture system. The normal force must be uniform and adjustable as well as the rate of motion. Sensors must capture the force and motion data which can be synchronized with the Trilion data. The studied materials should be swappable. The system should be isolated from external vibration.

THE SOLUTION

Our aim is to deliver a device, compatible with multiple materials, which recreates these vibrations with adjustable normal force and speed parameters and is compatible with the Trilion high-resolution motion capture system.

THE RESULTS

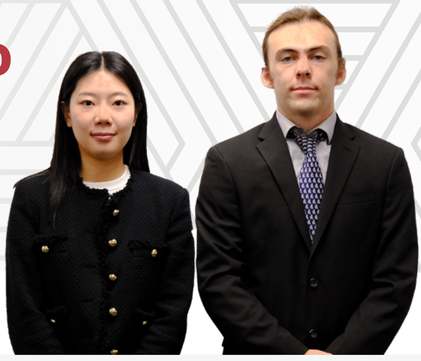
A complete mechanical prototype that has both custom-designed and precision machined components, commercially sourced hardware, and fully synchronized electronics system that outputs and displays the actively applied load and rotation speed alongside the Trilion motion capture system.



Back to Table of Contents

PIUMA: THE NEW WHITEBOARD WRITING UTENSIL

TEAM MEMBERS
Kate Hur
Ethan Dillon



PROJECT ADVISOR
Francis DiBella

OVERVIEW

This project introduces a new non-drying whiteboard writing utensil that has a longer lifespan and reduces waste.

THE PROBLEM

Since the 1990s, whiteboards have seen widespread use, yet users frequently face frustration due to dried out markers, resulting in disruptions, waste, and complaints. Around 400 million markers are discarded annually due to drying out, mainly from being left uncapped for a period of time. Considering that each marker contains approximately 20 grams of plastic, this amounts to 8,000 metric tons of plastic wasted per year.

THE REQUIREMENTS

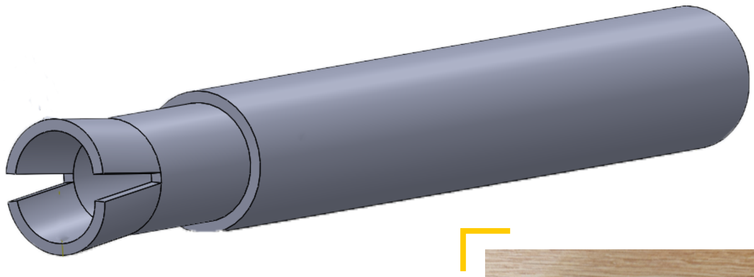
The writing utensil must mark clearly and erase easily from a whiteboard. It must also be comfortable to use: light and ergonomic. It must incorporate a mechanism to prevent drying out, ensuring it lasts at least 150% longer than the current standard.

THE SOLUTION

A mechanism which extrudes a crayon-like wax from an ergonomic grip. The mechanism consists of tongs which grasp the wax when pushed into a wedge by a spring and release and extrude the wax when pressed down by the user's thumb. These pieces were 3D printed using PLA for our prototypes. The wax was purchased from Crayola and reshaped manually.

THE RESULTS

We have designed the utensil theoretically and have since been prototyping. We have been iterating the bending plastic parts to ensure they meet the strength requirements necessary to grasp and release the wax. While manufacturing through 3D printing presents challenges due to its layered construction, we hope to use a scaled up version of our product to demonstrate a robust proof of concept.



Back to Table of Contents

AUTOMATIC MOTORCYCLE KICKSTAND

TEAM MEMBERS

Chanjoo Kim
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Alexander Brown
Kyle Powers

PROJECT ADVISOR

Francis DiBella

OVERVIEW

An automatic, self-deploying kickstand that will stabilize large motorcycles during stops, emergency stops, and speeds under 5 mph, minimizing the physical need to balance the bike which may be difficult for riders with disabilities or limited dexterity.

THE PROBLEM

Touring motorcycles, with their weight exceeding 850 pounds, pose a challenge to riders in maintaining balance when stationary, particularly for older riders, veterans, or individuals with limited dexterity. This can make riding less accessible, forcing some enthusiasts to give up on this lifestyle.

THE REQUIREMENTS

The kickstand must quickly and automatically deploy/retract reliably. It should also be weatherproof, easy to install, cost-effective compared to competitors, and capable of supporting the weight of two riders. Additionally, it needs to feature a kill switch for user control over its operation, have wheels at the bottom for enhanced mobility, and possess an aesthetically pleasing design that maintains a discrete profile.

THE SOLUTION

The goal of the project is to develop a kickstand for a Honda Gold Wing GL1800 that activates at speeds under 5 mph. Further features included a kill switch which enabled riders to disable the kickstand as needed. Powered by the motorcycle's 12V battery, DC motors ensure the kickstand deploys within two seconds. Each kickstand features a wheel at the base, aiding riders in maintaining balance when stopped.

THE RESULTS

The kickstand is integrated with the Gold Wing's frame; not only does this configuration ensure better balance, but it also allows the overall size to be more compact. Operation is governed by a sensor that interprets the bike's speed and sends signals to an Arduino, which is programmed to deploy the kickstand at speeds under 5 mph. This allows for enhanced safety and balance during stops and slow speeds.

Back to Table of Contents

PERSONAL VTOL COMMUTER AIRCRAFT

TEAM MEMBERS

Amaryllis Wiltz
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Tom Armstard
Jenny Zhao

PROJECT ADVISOR

Jim Geiger

OVERVIEW

An economically efficient single-passenger vertical takeoff and landing (VTOL) aircraft design is developed to avert commuting traffic inconveniences.

THE PROBLEM

Traffic congestion, limited roadways, and maintenance delays severely affect current means of commuting. Many commuters find themselves dedicating an entire workday's worth of time to commuting each week. Moving closer to work is often not feasible due to the high housing costs in urban areas or the scarcity of available housing options. Therefore, we need to develop conceptual designs for a flight vehicle capable of serving as a commuter aircraft.

THE REQUIREMENTS

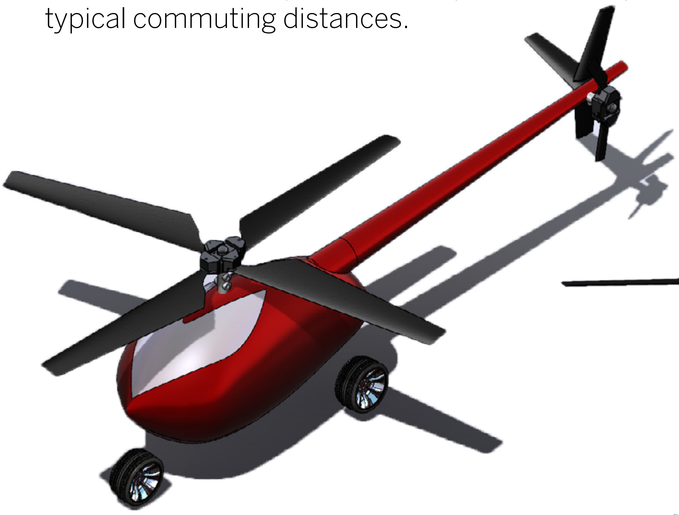
The design is required to take off and land vertically, fly a two way trip with a total distance of 100 nautical miles, drive for under 3 miles in a parking garage, and park in an average parking space. Our solution must be as simple and lightweight as possible while abiding to the mission and constraints.

THE SOLUTION

To reach a final design decision, we went through a multitude of benchmarking. This included researching VTOL aircraft to base our design on and to build off of. In addition, we made pugh matrices and trade studies to better compare two of our best designs and downselect to one design.

THE RESULTS

Following numerous design iterations exploring various VTOL configurations, we concluded that a single main rotor helicopter best aligns with the customer requirements. The single main rotor design is a small, lightweight, and fast conventional helicopter that is capable of transporting a single person through typical commuting distances.



Front View

Side View

Back to Table of Contents

MORPHING SAIL

TEAM MEMBERS

Nashr El Auliya
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Filip Springer
Nathan Smith
Gilbert Tohme

PROJECT ADVISOR

Anthony Linn,
Jim Geiger

OVERVIEW

A morphing sail system for cargo ships employs adjustable sail structures capable of dynamically changing shape and orientation to harness wind energy efficiently, enhancing propulsion and reducing fuel consumption.

THE PROBLEM

The morphing sail system addresses the challenge of reducing carbon emissions in maritime transportation by providing an innovative solution that harnesses wind power to supplement traditional propulsion methods on cargo ships. By optimizing the utilization of renewable energy sources, this technology aims to significantly decrease reliance on fossil fuels, thereby mitigating environmental impact and promoting sustainability in the shipping industry.

THE REQUIREMENTS

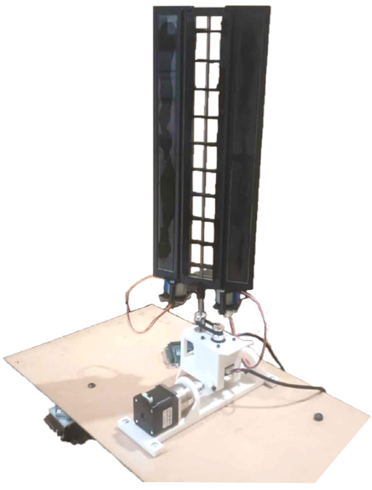
The system must be fully automated to independently adjust sail trim according to external conditions, capable of complete folding to facilitate cargo loading and unloading, and capable of propelling the boat solely through wind power.

THE SOLUTION

The Morphing Sail design dynamically adjusts its camber and angle of attack based on real-time wind conditions to optimize lift for the boat. Using data from sensors such as wind direction, velocity, and temperature sensors, the automation system calculates the most efficient airfoil shape and angle for maximum thrust. Small motors individually control each panel's camber, ensuring precise adjustments to match the changing wind dynamics, yielding enhanced performance and efficiency.

THE RESULTS

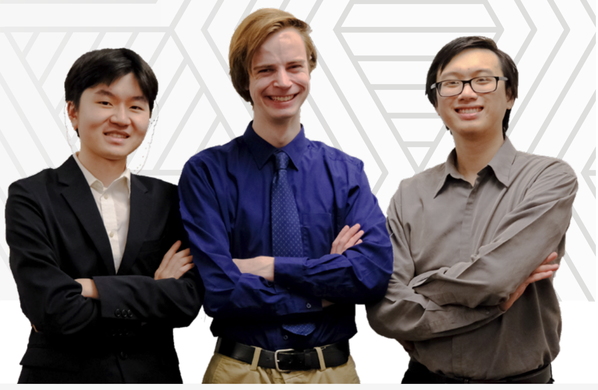
Our preliminary results are promising, confirming the viability of our morphing sail system. We've attached the sail to a testing rig equipped with integrated sensors, allowing us to measure critical metrics such as lift and angle of attack. The collected data from these tests indicate that the sail's performance closely aligns with our theoretical models, demonstrating a consistent and reliable lift across varying wind conditions. This alignment between observed and predicted outcomes is a significant step in validating our design, indicating that our system can efficiently utilize wind power for maritime propulsion. The success of our 1:82 scale model provides a solid foundation for further development and scaling, supporting the project's goal of reducing carbon emissions in cargo shipping.



Back to Table of Contents

GAS TURBINE TURBOCHARGER

TEAM MEMBERS
Nathan Lau
Jason Cruz
Noel Cummings



PROJECT ADVISOR
Francis DiBella

OVERVIEW
Adapting a turbocharger to make a gas turbine engine for a laboratory setting.

THE PROBLEM

Boston University's mechanical engineering professors are currently looking for a way to demonstrate compressible flow principles in a laboratory setting. At the moment, there is no equipment available to provide data for flow analyses of turbo machinery components. The solution presented involves converting an automotive turbocharger into a small, mobile gas turbine engine through the addition of a combustion chamber and other necessary subsystems: oil lubrication, water cooling, instrumentation, etc.

THE REQUIREMENTS

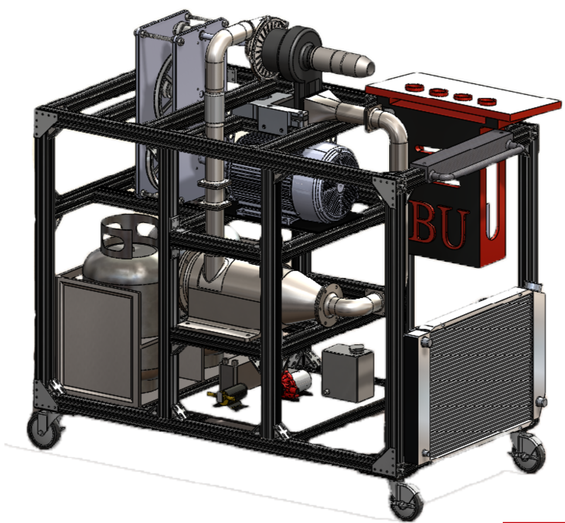
The aim of this project is to demonstrate a gas turbine system as a way to promote engagement with students. The process involves the transformation of an automotive turbocharger into a fully moveable and simple to use gas turbine system that is capable of measuring the pressures, flow rates, temperatures, and speeds of the device. An analytical system will be able to calculate efficiencies and output power to be displayed to the end user.

THE SOLUTION

After extensive research of gas turbine systems, our team designed a test stand that could interface with a turbocharger sourced from a 6.6L Duramax engine. The test stand is made up of the following components: combustion chamber, compressed air starter, oil and water cooling systems, motor/generator and pulley system, data acquisition and instrumentation systems, and a cart to package it all together.

THE RESULTS

We provided a complete CAD assembly and a bill of materials with all the components necessary to build the full system. Our final report includes one-line diagrams of the electrical and cooling systems. A flow simulation of the combustion chamber and a stress analysis of the cart were carried out to verify both designs.



Back to Table of Contents

FETCHFRIEND
AUTOMATIC DOG BALL THROWER

TEAM MEMBERS
Jennifer Perez
Devin Dembrow
Lisa Korver

PROJECT ADVISOR
Thomas Devlin

SPONSOR Professor Kenn Sebesta at Boston University

OVERVIEW
An AI-enhanced, automated and adaptive ball thrower, offering personalized play and solutions for modern dog owners.

THE PROBLEM

The FetchFriend addresses the challenge of balancing a pet's need for playtime with an owner's busy schedule and physical limitations. Professor Kenneth Sebesta and his lively dog Aka face this dilemma, as Aka loves to play fetch for hours while Professor Sebesta navigates a hectic agenda and frequent tennis elbow. This innovative device provides an adaptive, engaging fetch experience while ensuring safety for both the pet and owner.

THE REQUIREMENTS

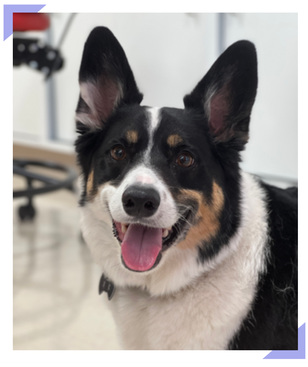
Our primary goal is to keep the dog, Aka, engaged by adapting to his behavior. The device should be portable, and the function should be simple. It should be able to throw the ball about 10-20 feet in an indoor or outdoor environment. There should also be safety features to ensure the dog will not be injured.

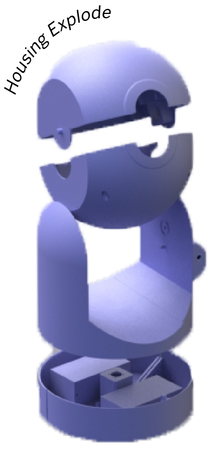
THE SOLUTION

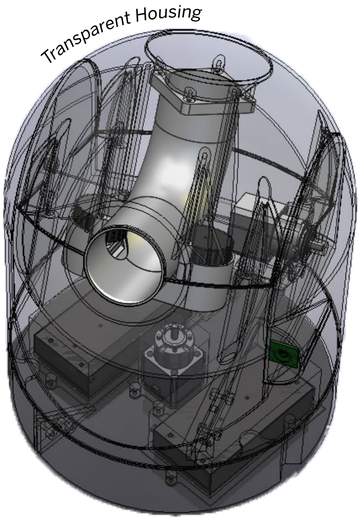
The design of this product can be largely broken down to three subsystems: a vision system that is adapted from a simple object detection machine learning model that tracks where the dog is, a physical ball launch system driven by a pair of high RPM DC motors, and launch controls for variable pitch and yaw that change the angle of throw based on the output of the vision system.

THE RESULTS

We have designed and created a prototype of the FetchFriend thrower, which is able to track the dog and launch a ball at different angles and distances. The prototype is remotely controlled by a computer and we have created a mockup of an app to allow users to interact with the device.







Back to Table of Contents

SCOOTAIR

TEAM MEMBERS

Armaan Vasowalla
Thomas Simmons
James Sinchi
Ethan Jonah Vernon
Paolo Ison Limcaoco

PROJECT ADVISOR

Thomas Devlin

SPONSOR Professor Kenn Sebesta at Boston University

OVERVIEW

We created a light-weight, compact push scooter capable of fitting inside tight compartments.

THE PROBLEM

Professor Sebesta is an aviation enthusiast who flies a STEMME S-6 motorglider. Although he is able to fly to local airfields, there is a lack of transportation to travel from the airfield to the adjacent town. This “last mile” problem can be solved with a scooter. However, there is no scooter available in the market that fits Sebesta’s requirements.

THE REQUIREMENTS

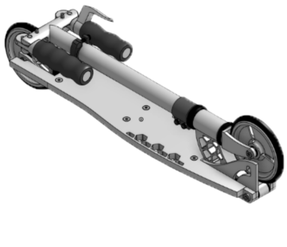
We were tasked to create a compact scooter capable of fitting into the storage compartment of the STEMME S-6 motorglider and holding the weight of a 200 lb rider. The storage compartment is measured at 30.15” x 8.25” x 11.75” (LxWxH), with an opening of 16.25” x 6.50”, the compartment also has a maximum weight limit of 44 lbs. We had to create a custom scooter that fit these specifications solely with the manufacturing capabilities of EPIC.

THE SOLUTION

The team created sub-assemblies of each structural component to ensure, through FEA, that they would meet load-bearing specifications. A comprehensive CAD assembly was created to act as a form & function model to ensure that the total dimensions of the scooter were within the dimensional specifications given by the project SPONSOR.

THE RESULTS

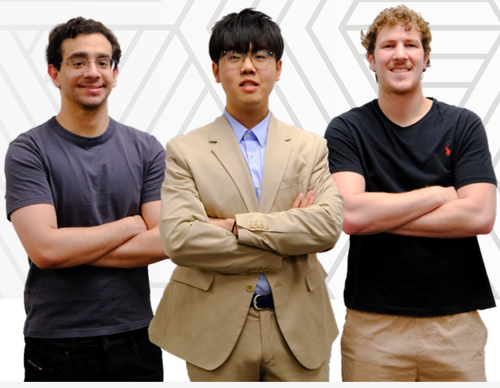
Once the CAD models were used to confirm that all of the structural and dimensional specifications were met with the comprehensive design, manufacturing on the sub-assemblies began. Through a combination of additive and traditional manufacturing processes, a physical 1:1 model of the scooter was created.



Back to Table of Contents

ALLOSTATIC STANDING

TEAM MEMBERS
Muhammed Aldandany
Frangui Wang
Tariq Alhalabi



PROJECT ADVISOR
Francis DiBella

SPONSOR Dr. Vipul Chitalia at BU Medical Lab

OVERVIEW

Our project's primary objective is to develop a prototype system for inducing allostatic load (stress) in rodents. This system will be used by the pharmaceutical industry for pre-clinical research, mirroring human conditions.

THE PROBLEM

The goal is to create a prototype system to induce allostatic load (chronic stress) in rodents for pre-clinical research, addressing the lack of animal models that effectively simulate the human condition of chronic stress. This will aid in understanding disease progression and developing therapeutic interventions, providing invaluable data on physiological changes and mechanisms associated with chronic stress, in collaboration with Dr. Vipul Chitalia at the BU School of Medicine.

THE REQUIREMENTS

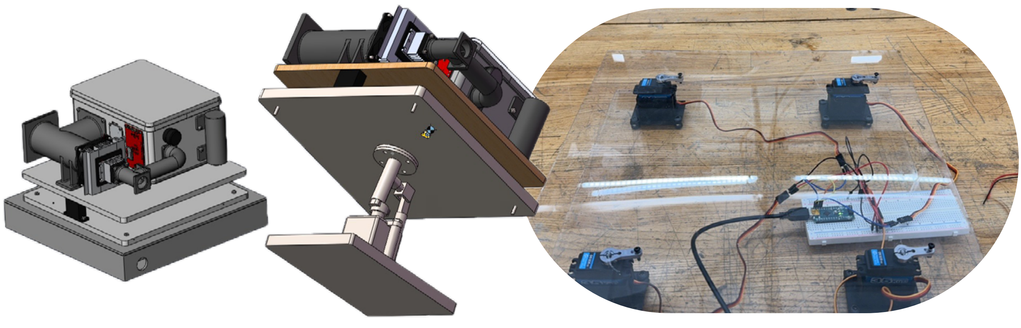
The system must reliably induce allostatic load in rodents, simulating chronic human stress conditions. It requires ethical design considerations, reproducibility across different labs, and the ability to measure stress-related physiological changes. Principal constraints include ensuring animal welfare, maintaining cost-effectiveness, and adhering to regulatory standards for pre-clinical research. Collaboration with experts in the field, such as Dr. Vipul Chitalia, is essential for guidance and validation.

THE SOLUTION

The solution strategy involves designing a prototype system to induce allostatic load in rodents by simulating stress conditions through mechanical and environmental stressors like shaking, tilting, noise, and variable lighting. This system integrates various components such as a shaker table, axial board with stepper motor, and environmental controls within a cage, allowing precise manipulation of conditions to mimic chronic stress, crucial for pre-clinical research in pharmaceutical development.

THE RESULTS

The construction of the prototype cage is in action, incorporating mechanical and environmental controls designed to induce stress in rodents. The cage features a shaker table for physical stimulation, along with adjustable lighting and sound systems to mimic environmental stressors. This setup allows for precise manipulation of stress variables, essential for studying the impact of chronic stress in a controlled, replicable manner suitable for pre-clinical research.



Back to Table of Contents

AUTOMATED MOLD MAKING

TEAM MEMBERS
Stanley Sebastian Salim
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Stanley Peng
Daylin Javier Aguasvivas
Catherine Joh

PROJECT ADVISOR
Thomas Devlin

SPONSOR Vibram Corp.

OVERVIEW

We are providing Vibram–an international corporation that manufactures millions of custom shoe soles–with a process to manufacture their shoe outsole and midsole molds, using state of the art additive manufacturing technology, at competitive costs and lead times.

THE PROBLEM

Vibram is looking to develop an in-house facility to manufacture hard molds with their compression molding process. Currently, molds are outsourced from other countries, resulting in high costs and long lead times when a new show size or design is created or modified. Vibram is looking for alternative processes in an effort to shorten lead times and be more resilient to a volatile market.

THE REQUIREMENTS

The solution process should not exceed $6,000 per mold in costs and two months in total manufacturing and shipping lead times. The process should also preserve the resolution of essential design details and the mold must be able to withstand the mechanical and thermal stresses imposed by the molding presses.

THE SOLUTION

Of the mold making processes currently available on the market, the most viable solution to produce hard tooling molds is to utilize binder jetting technology to 3D print the negative of the mold in sand, then to be casted in metal. Considering the gross costs, total lead times, material constraints, and design limitations, this method proved to be the most optimal.

THE RESULTS

We narrowed down two foundries utilizing our proposed solution—one with a higher cost and shorter lead time, and another capable of casting in a more desirable metal, but with a longer lead time. Vibram approved of our presented plan and ordered a sample mold from the former foundry, with plans to order from the latter down the line.

Back to Table of Contents

BATCHING OF RUBBER COMPOUNDS

TEAM MEMBERS

Ethan Feldman
Stefan Scornavacca
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Hanxiao (James) Zhang
Salem Adda-Berkane

PROJECT ADVISOR

Thomas Devlin

SPONSOR Vibram Corp.

OVERVIEW

Our project aims to enhance batching accuracy for Vibram's rubber compounds through a magnetic latch and LED system, minimizing errors while maintaining human involvement and adaptability. manufacturing technology, at competitive costs and lead times.

THE PROBLEM

We address Vibram's issue of high error rates in manual batching, resulting in significant material waste and financial loss, by implementing a magnetic latch and LED system to streamline material usage and prevent errors.

THE REQUIREMENTS

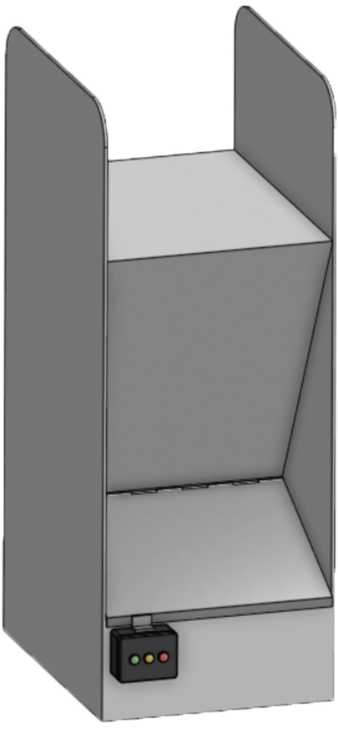
The solution must reduce error margin to 1% or less, cost less than $100,000, maintain or improve batching efficiency, be adaptable to current recipes, minimize human error, and not require full automation.

THE SOLUTION

The approach aims to minimize the incorrect selection of materials or their respective quantities in the batching of rubber compounds for Vibram. The group is implementing a magnetic latch and LED system to indicate material selection status, utilizing outsourced parts for cost-effectiveness and repeatable manufacturability.

THE RESULTS

The efficacy of the solution is being tested at Vibram's facility, evaluating its impact on batching efficiency and error reduction. This hands-on approach will provide valuable feedback for refining the system and optimizing its performance. The group aims to reduce material selection error by 95% or more.



Back to Table of Contents

IMPROVED SOLAR PROPULSION SYSTEM

TEAM MEMBERS

Valentin Trujillo
Amanee Vazquez
Paul Ferrer
Anton Garcia-Abril Beca
Kyebaek Jun

PROJECT ADVISOR

Jim Geiger

OVERVIEW

Our proof-of-concept project aims to deliver a new rechargeable LiPo battery system that aims to extend operation longevity of the applied vehicle, using solar cells and a dual battery switching mechanism.

THE PROBLEM

Unmanned systems, such as drones and rovers, are limited in their operation time due to the lack of battery life. As the industry for unmanned system grows, the question of battery performance remains in question.

THE REQUIREMENTS

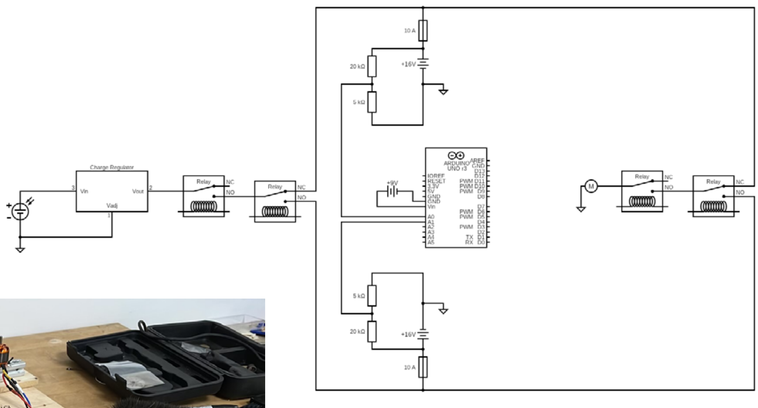
Our team's main objective for this project was to deliver a working system while minimizing volume, weight and maximizing energy capacity, operational time.

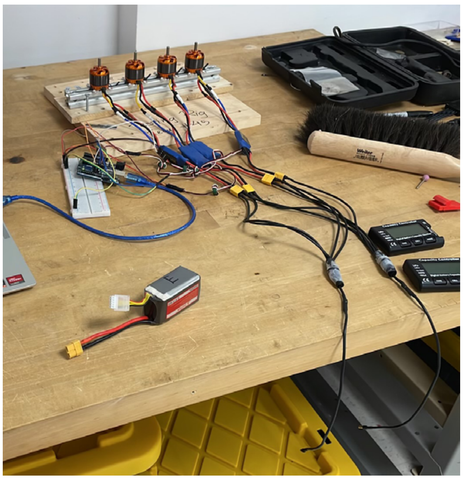
THE SOLUTION

In order to increase the operation time of unmanned vehicles, our team is proposing a new LiPo dual battery propulsion system that uses solar cells to charge one battery while the other discharges. Once the discharging battery is depleted to a certain level, the system "switches" and the discharged battery receives charge from the solar cell while the charged battery then powers the load.

THE RESULTS

With our new propulsion system concept, the unmanned vehicle industry can see major improvements in operation time. Our system is a proof-of-concept project and will serve as a milestone for further innovation that will hopefully become a useful asset for the unmanned vehicle battery industry.





Back to Table of Contents

MASKLESS PHOTOLITHOGRAPHY MACHINE

TEAM MEMBERS

Alejandro Mercardo
Abby Harris
Dani Nadira
Do Hyun Park
David Ospina

PROJECT ADVISOR

Anthony Linn

OVERVIEW

A more affordable, accessible maskless photolithography equipment targeting students who wish to get entry-level, hands-on experience on micro/nanofabrication for their personal projects or research in a home cleanroom, or school laboratory environment.

THE PROBLEM

Photolithography, a semiconductor fabrication technology, enables the precise transfer of intricate patterns onto a substrate, enabling the fabrication of miniaturized electronic components and devices. Typically used to pattern out the Integrated Circuit designs on silicon wafers, photolithography is also used in various applications, including microelectromechanical systems (MEMS), Lab-on-a-chip devices, and metasurfaces. Fabrications of these devices rely heavily on commercial mask aligners that are expensive and inaccessible. We propose to conduct our senior design project to create a more affordable, accessible maskless photolithography equipment.

THE REQUIREMENTS

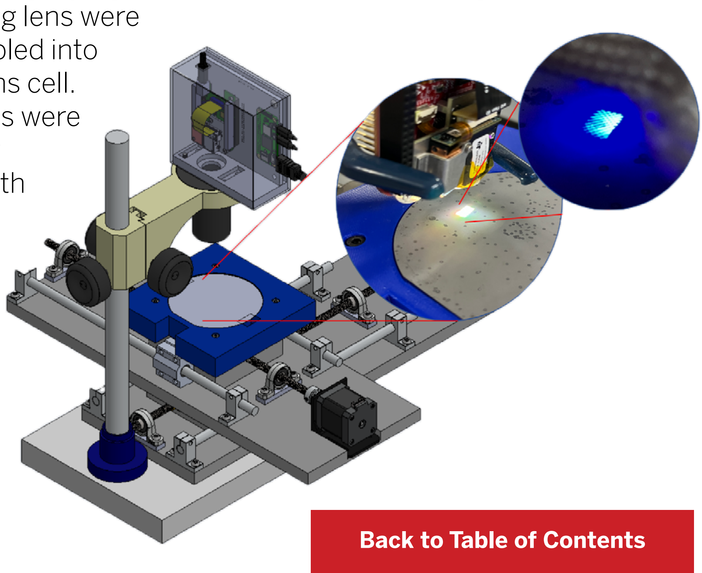
Create a functioning prototype that allows maskless photolithography in micro dimension resolution. With low cost, user intuitive programs.

THE SOLUTION

Maskless Photolithography Machine using optical projection technique using a digital micrometer device (DMD). A DMD consists of an array of up to millions of individual mirrors, which can replace the hard masks in conventional lithography. Compared to conventional mask lithography, this “flexible” mask can change the image of the layer generated instantaneously. DMD-based maskless lithography is low cost and the image of the whole layer is generated at once, making it a much faster process. With the advancement of DMD-based lithography, a submicron structure has been achieved, showing the potential for nanoscale structures to be constructed using this inexpensive and efficient method.

THE RESULTS

Three major components of the project are mechanical design, optical alignment, and software. A mechanical stage was produced allow the wafer to move in x-y motion. This allows the lithography machine to “step and repeat” the generated pattern for numerous time. Optical alignment is another key factor. While we rely on DMD to generate an user input image, we wish to shrink this image to micron level features by using the magnifying lens in reverse. The focal length of both DMD projector and the magnifying lens were carefully tuned, and assembled into one optical engine with a lens cell. Lastly, software components were needed to drive the stepper motor and communicate with the DMD projector.



Back to Table of Contents

SMART MEOW:
AN AUTOMATIC RFID ENABLED CAT FEEDER

TEAM MEMBERS
Sam Fogelberg
Daniel Juweid
Rosie Speidel

PROJECT ADVISOR
Thomas Devlin

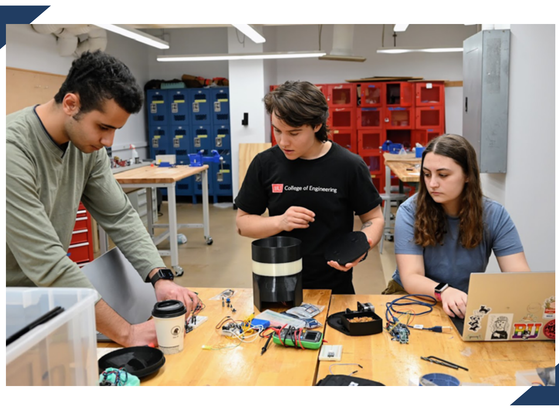
OVERVIEW
Smart Meow revolutionizes meal times as an automatic, RFID-enabled cat feeder, seamlessly integrating existing technology to create an innovative new product, ensuring hassle-free feeding for feline companions.

THE PROBLEM
Microchip-enabled cat feeders allow pet owners to cater to individual dietary requirements, deter food theft among multiple pets, and assist in weight management. However, current products remain inaccessible to many due to cost. By reducing cost and increasing value, Smart Meow is making microchip-enabled cat feeders accessible to all. Smart Meow dispenses precise food portions and minimizes the need for frequent refills.

THE REQUIREMENTS
The requirements for Smart Meow were to create a device that identifies a particular cat using RFID, prevents other animals from eating the food, automatically dispenses dry cat food at certain time intervals, is compact, can hold a minimum of a week's worth of food, and can be cleaned easily.

THE SOLUTION
SmartMeow utilizes a hopper-like reservoir to store the kibble. It's then funneled through an opening and dispensed into a rotating compartment until it falls through the shoot into the bowl. A stepper motor drives the rack and pinion system to move the bowl in and out. There are three buttons on the front which are used for both programming the settings and manually dispensing and opening the drawer.

THE RESULTS
SmartMeow is a successful proof of concept – it is a compact, cheap, and user-friendly automated cat feeder which dispenses food and opens and closes. One difficulty that we did run into was the integration of the RFID chip-reader with our mechanical design. In order to get the correct range, we would need to custom-design the antenna. This could easily be done but was out of the scope of our project (as well as our budget). If we were to continue with the project, this would be a key focus of ours.



Back to Table of Contents

NASA BLUE SKIES COMPETITION:
DEPLOYABLE UNMANNED AERIAL SYSTEM TO DETECT AND MAP VOLCANIC ASH CLOUDS

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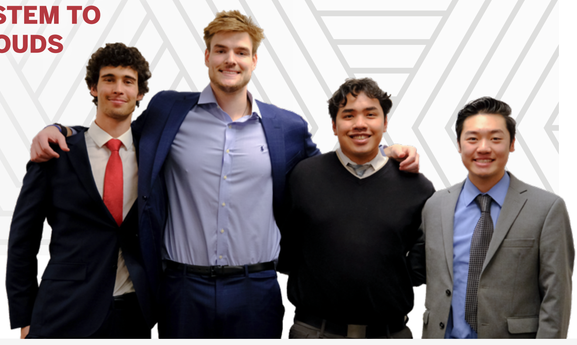


PROJECT ADVISOR
Jim Geiger

SPONSOR
NASA's 2024 Gateways to Blue Skies Competition: Advancing Aviation for Natural Disasters

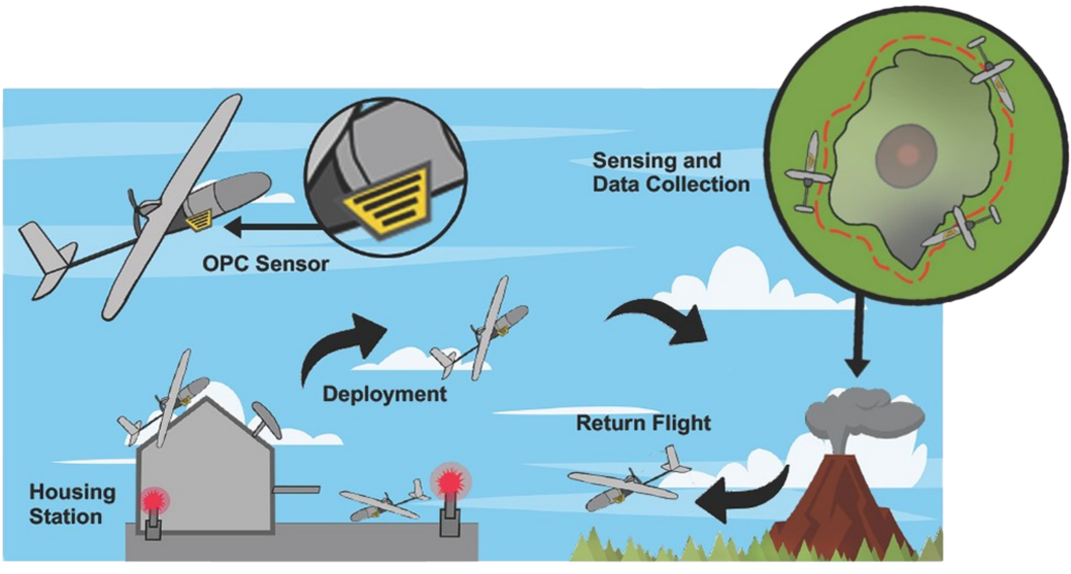
OVERVIEW
Our project was part of the NASA Blue Skies Competition that aimed at improving the forecasting methods of ash clouds originating for volcanic eruptions.

THE PROBLEM
Improving the collections of inital enviromental parameters to provide to the forcasting model, to make it more accurate, reducing amount of closed airspae and sending alerts to people that could be in the immediate path of the ash cloud.

THE REQUIREMENTS
The requirements of the project, was that we had to design an aviation system that could be implemented by 2035, with technology not currently developed or used effectively. We had to ensure that we could rationalize our choice in picking which natural disaster area to focus in, and had to ensure that our system had a detailed con ops that descibed all components and how they work.

THE SOLUTION
Brainstormed and designed an Autonomous Unmanned Aerial System (UAS) to detect Volcanic eruptions and deploy a fleet of drones to collect real-time data. This data is used to improve the accuracy of the current ash cloud prediction algorithm (Ash3d), which uses estimated initial parameters of the eruption, leading to inaccurate predictions. This improvement will allow accurate predictions which allow for more efficient travel through airspace while the ash cloud disperses.

THE RESULTS
This project was our submission for NASA: Gateway to BlueSkies, a nationwide competition with the goal of producing novel, feasible innovations related to aviation, with a specific focus on Natural Disasters. Our idea was one of eight teams to be selected to participate in the finals selection forum, which will take place at the Ames Research Center in Mountain View, CA in late May. Wish us luck!



Back to Table of Contents

NASA BLUE SKIES COMPETITION:

RECOVER (RAPID EVALUATION, COORDINATION, OBSERVATION, VERIFICATION & ENVIRONMENTAL REPORTING)

TEAM MEMBERS

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PROJECT ADVISOR

Anthony Linn

SPONSOR

NASA's 2024 Gateways to Blue Skies Competition: Advancing Aviation for Natural Disasters

OVERVIEW

Our project proposes RECOVER (Rapid Evaluation, Coordination, Observation, Verification & Environmental Reporting), an unmanned aerial vehicle swarm system designed to assess damage and monitor the spread of debris and water contamination to aid in flood recovery.

THE PROBLEM

As climate change escalates natural disasters worldwide, the need for innovation in aviation for disaster response becomes more critical. Many aviation-based solutions used in disaster management are outdated, presenting significant opportunities to enhance existing systems or introduce new technological applications.

THE REQUIREMENTS

The 2024 Gateways to Blue Skies Competition requirements were to conceptualize and propose an aviation system, feasible and viable by 2035, for one phase of management in a specific natural disaster, aiming to improve capabilities. This involved identifying a practical use-case, developing a concept of operations, conducting a risk analysis, and outlining a deployment strategy.

THE SOLUTION

Our team performed an in-depth analysis of disaster management phases, pinpointing areas for improvement in flood recovery. We developed RECOVER (Rapid Coordination, Evaluation, Verification, and Environmental Reporting), a system merging traditional methods like drone surveying with cutting-edge technologies including hybrid-FSO communications and rapid bacteria detection devices. RECOVER employs drones for detailed site surveys, integrating debris mapping and water quality analysis. After drafting a full operational plan and risk mitigation strategies, we refined our system based on stakeholder feedback.

THE RESULTS

Selected as a finalist for the 2024 NASA Gateways to Blue Skies competition, our system, RECOVER, can survey 80 square miles in 4 hours to detect flood hazards and implement early health risk mitigations. According to FEMA, the US Coast Guard, US Geological Survey, and water quality analysts, RECOVER will reduce government expenses and personnel strain by aiding rapid damage assessments and water quality monitoring.

Back to Table of Contents

ENERGY TRANSITION ROADMAP

TEAM MEMBERS

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PROJECT ADVISOR

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OVERVIEW

A roadmap projecting the United States' shift away from predominantly fossil fuel-based energy resources by evaluating the prospective renewable alternatives.

THE PROBLEM

Fossil fuels are finite resources that we are exploiting at an unsustainable rate and account for 80% of global energy generation. Renewable energy sources offer a sustainable future for energy production. Consequently, sooner or later a transition towards alternative sources will be necessary. Assessing the current path and opportunities that exist to accelerate the transition is paramount to avoid a future disaster where energy demand is too great for energy supply.

THE REQUIREMENTS

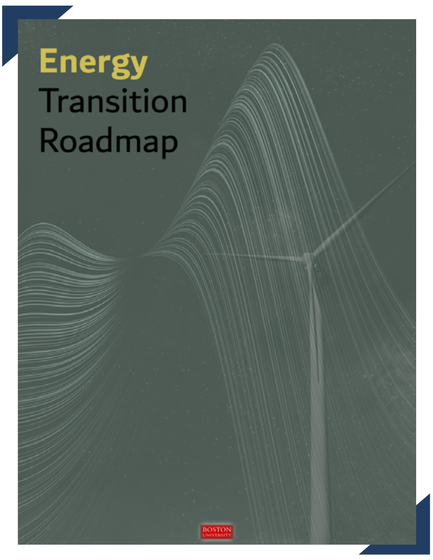
Energy transition roadmap centered around the United States. Analysis focused primarily on solar and wind energy, however, nuclear and hydropower are considered. The projections extend annually until 2050.

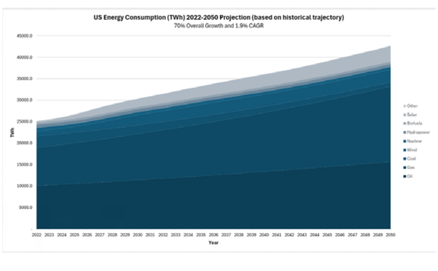
THE SOLUTION

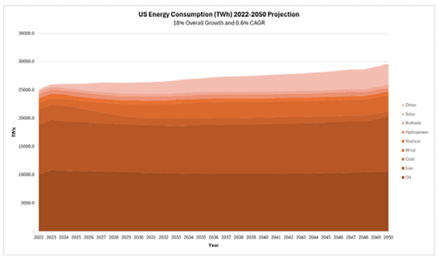
Our methodology consisted of using other energy transition roadmaps to assess the current energy transition path in the US, potential opportunities or overestimations to show future mismatch in energy demand to supply. A scaling method was used in our research analysis of relevant technologies to evaluate their adoption potential. These scores and their qualitative implications justify our projections for each technology, as described in the written section of the report.

THE RESULTS

The U.S. relies on fossil fuels for 86% of energy consumption (as of 2022); and most of the world remains at around 80%. However, the resource reserves are not infinite, and alternative energy sources are necessary. In the U.S., solar and wind energy are expected to grow at a rapid pace, accounting for 16-20% of all energy consumed by 2050, but not enough to offload our dependence of fossil fuels.







Back to Table of Contents

WHITEBOARD INTELLIGENT AND PROGRAMMABLE ERASING ROBOT (WIPER)

TEAM MEMBERS

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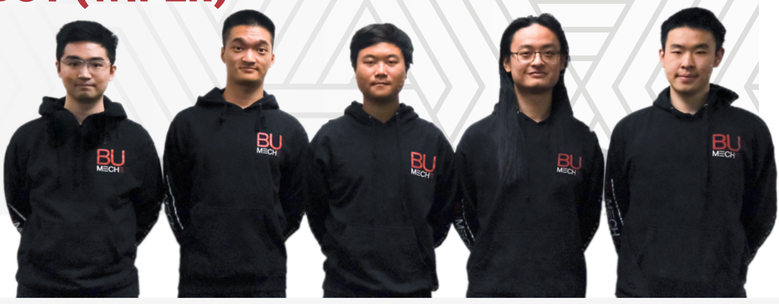


PROJECT ADVISOR

Francis DiBella

OVERVIEW

An automatic whiteboard cleaning robot that cleans whiteboard after use.

THE PROBLEM

Lecturers and staff face the challenge of efficiently cleaning whiteboards during and after class, as erasing is time-consuming and disruptive. An automatic cleaning solution at the CDS building is required.

THE REQUIREMENTS

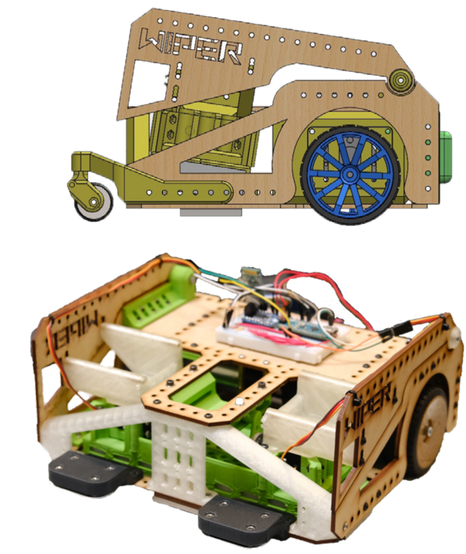
- Must clean dry erase markers
- Has safety protection for human
- Must have enough battery capacity for multiple-board cleaning
- Must have replaceable power supply
- Must clean by selected sections
- Must be able to localize and plan path
- Must be easy to operate
- Must avoid obstacles
- Require minimum and smart calibration and maintenance

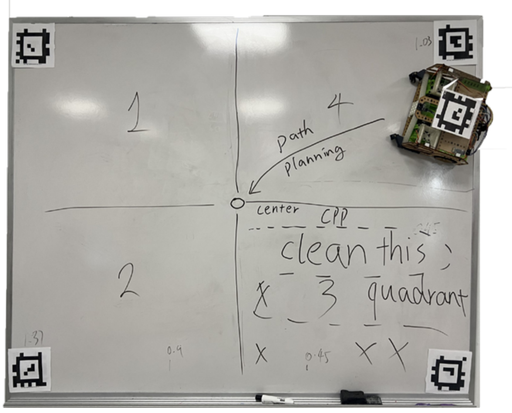
THE SOLUTION

Surveys and interviews were conducted to gather use cases and requirements, as well as DOE to determine specific design parameters. Employing a blend of hardware and software tools—including CAD design, 3D printing, laser cutting, Arduino, PID control, wireless communication, computer vision, path and coverage path planning—WIPER fulfilled the demands of the design criteria: To design a robot that cleans autonomously per user's selection with effective cleaning outcomes.

THE RESULTS

WIPER is a dual layer, dual motor driven robot that is magnetically attached to the whiteboard with replaceable erasers that can be levitated. The system includes a depth camera to track WIPER's location. It is simple to use: the user can select one of the four quarters of the whiteboard on the PC, and WIPER will automatically drive to the locations and erase the selected area with its sweeps.





Back to Table of Contents

NITRO BUDDY

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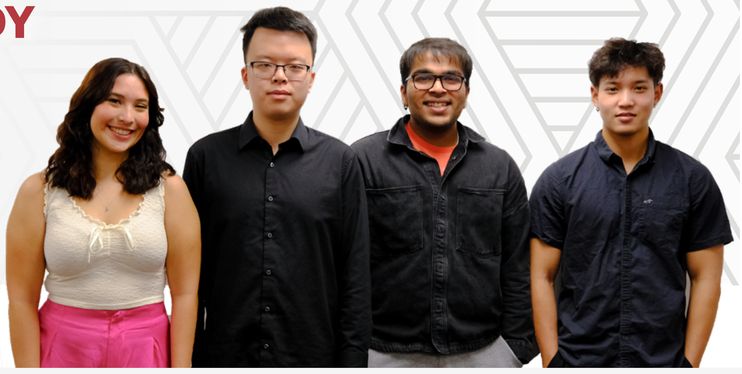


PROJECT ADVISOR

Anthony Linn

SPONSOR Formlabs

OVERVIEW

To develop a stand alone machine that is responsible for filtering out oxygen, and other compounds from the exhaust gas from the printer so that the exhaust is 99% pure nitrogen and then inject it back into the printer.

THE PROBLEM

Find a way to inject enriched nitrogen air into the printer, without using compressed air. This printer uses materials that are sensitive to oxygen degeneration, so to ensure best quality products are printed nitrogen enriched air is injected into the printer, currently this is being done using a nitrogen generator which requires a large air compressor and does not focus on the gas inside the printer.

THE REQUIREMENTS

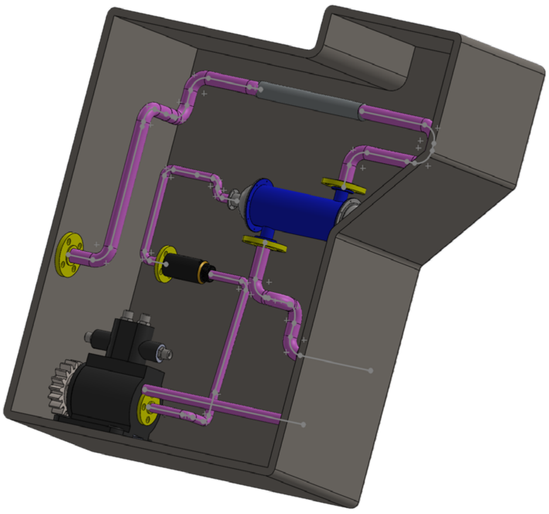
Create a stand alone gas processing unit the size of a standard mini fridge, can be plugged into a 120V outlet, does not require compressed air and is compatible with the FormLabs Fuse 1 printer. The gas processing unit would use exhaust air from the printer and filter out all unwanted chemicals and compounds leaving the air 99% nitrogen, then this nitrogen air would be injected back into the printer.

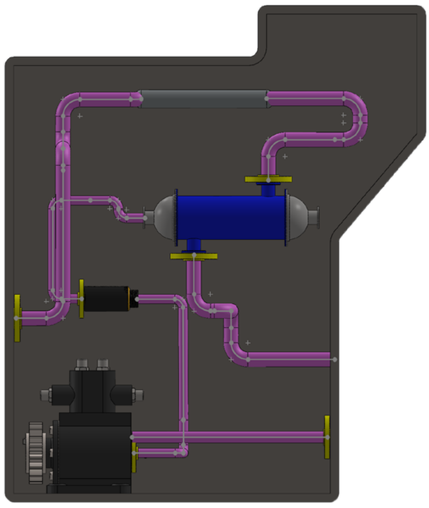
THE SOLUTION

Our group approached a solution by researching different methods that would ensure the 99% nitrogen purity. We researched methods such as: Air Separation Module (ASM), Pressure Swing Adsorption (PSA), carbon molecular sieve, and the Nitrobreeze from Holtec Industries. In researching these we compared the price, size and efficiency of the components.

THE RESULTS

While there was not enough time to complete a functioning prototype we were able to to create a theoretical model and package of the components that would be used that satisfies all of the requirements for the Nitro Buddy. In this model we decided that the package would include a compressor, a filter, such as the carbon molecular sieve, heat exchanger, and the air separation module.





Back to Table of Contents

HEAT MAPPING THE URETEROSCOPIC LASER LITHOTRIPSY PROCESS

TEAM MEMBERS
Jacob Garrett

PROJECT ADVISOR
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SPONSOR BU Fluid Lab

OVERVIEW
I am investigating how heat is diffused during a minimally invasive kidney stone removal procedure.

THE PROBLEM

Ureteroscopic laser lithotripsy is an endoscopic procedure used to break up kidney stones performed around 300,000 times per year. While it is a safe and common procedure, there is a limited knowledge base as to how heat is diffused in the actual kidney stone. The aim of this project is to bridge this knowledge gap by combining experimental and computational approaches.

THE REQUIREMENTS

Design and implement an experimental setup to observe heat diffusion when a laser is fired at a phantom kidney stone.

THE SOLUTION

COMSOL Multiphysics simulations were constructed to gain intuition into the heating process. Analytic solutions from scientific literature were utilized to verify these results. These results were then compared to experiments carried out using a medical grade laser and phantom kidney stones.

THE RESULTS

This system enables medical professionals to gain a base understanding of the physics behind this procedure. Improvements to the simulated conditions and more systematic experiments will yield even better results that can further inform clinicians.

Back to Table of Contents

MECHANICAL CATHETER
FOR THE REMOVAL OF CLOTS AND BLOOD FROM THE BLADDER

TEAM MEMBERS

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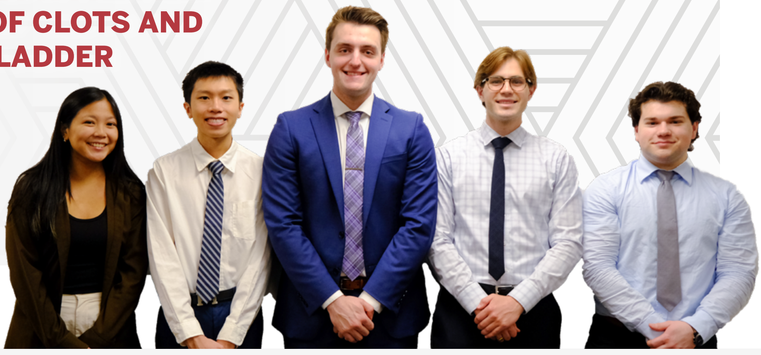


PROJECT ADVISOR

Anthony Linn

SPONSORS Brian Eisner MD and Graham Lieberman MD

OVERVIEW

We were tasked with the creation of a device to facilitate the removal of blood clots from the bladder in a more efficient manner than current methodologies.

THE PROBLEM

Urologists have long been faced with the issue of low success rates when removing blood clots in patients' bladders using currently available minimally invasive methods. If left untreated, these clots can prevent urination and cause problems leading to kidney failure and surgical intervention. This is a problem that affects a large number of patients as well as physicians for whom the current procedure is time and labor intensive.

THE REQUIREMENTS

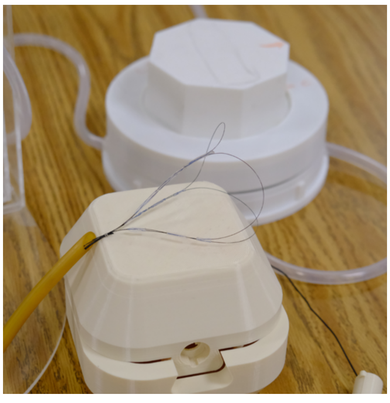
For this device we were tasked with removing clots from bladders faster and more effectively than current methodologies, all while ensuring that patient discomfort is minimized, no physical damage is done to the patients bladder, and the device is sterile, disposable, and portable. The cost per procedure must also be under $200 and use less than 5 liters of fluid.

THE SOLUTION

Our team approached the removal of blood clots from the bladder from two distinct directions. One, breaking up the clots via a mechanical catheter mechanism that functions by drawing nitinol wire through the clots. Two, an automated device that replicates the steps found in the current standard of care, repeatedly irrigating and suctioning the bladder with saline, with minimal physician effort.

THE RESULTS

The device that facilitated irrigation worked as intended in semi-automating the process of irrigating our simulated bladder as well as making this process more efficient than it initially was via hand irrigation. Likewise, with the additional application of the emulsification system, the overall process became much more streamlined than it initially was as the broken simulated blood clots were able to more easily be removed from the bladder.



Back to Table of Contents

INTERDISCIPLINARY TEAM

PIZZAIR:
PIZZA DELIVERY DRONE

SPONSOR

Spinnaker Analytics

TEAM MEMBERS

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Yafei Chen
Usman Jalil

ABSTRACT

In response to the persistent challenges of pizza delivery, we present an innovative solution to overcome these obstacles and redefine pizza delivery. The current reliance on human drivers results in delays and cold pizzas for customers. Our solution, “Pizzair,” is an AI-enabled, fully autonomous pizza delivery drone. This drone ensures fast, cost-effective, and hot pizza delivery within a 10-minute radius of a pizza restaurant. The drone is equipped with a specialized harness to securely deliver the pizza while maintaining its temperature. Pizzair’s autonomous navigation system, enabled by cutting-edge machine learning techniques, ensures timely and safe delivery, even during peak demand or difficult conditions. Pizzair is intended to transform the pizza delivery industry, drastically improving customer experiences and optimizing delivery operations.

Back to Table of Contents

INTERDISCIPLINARY TEAM

MOSS WHEELCHAIR

SPONSOR

Professor Osama AlShaykh

TEAM MEMBERS

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Norbert Malik

ABSTRACT

Around 1% of the world's population needs wheelchairs, but a basic wheelchair cannot meet everyone's needs and expectations. Therefore, we are proposing to build a Modular Open Source Smart (MOSS) Wheelchair in which engineers will be able to create modules for a user's wheelchair as needed. For our project, we will implement three modules while also creating an open-source website for easy access to our modules. The first module introduces a 3D-printed robotic arm implemented with servo motors for precision in movement and manipulation. The second module features navigation, where we employ computer vision. This algorithm facilitates advanced real-time object detection and recognition, allowing the wheelchair to navigate its environment intelligently. The third module tackles obstacle detection and avoidance, utilizing the outputs of computer vision to intricately control the motors and electronics responsible for wheel movement and robotic arm functionality. Using computer vision will allow our wheelchair system to gain an enhanced ability to interpret its surroundings, offering users a more sophisticated and adaptive mobility solution. Through this comprehensive approach, we aim to redefine wheelchair capabilities and foster inclusivity while providing users with customizable, state-of-the-art mobility solutions.

Back to Table of Contents