



THE UNIVERSITY OF
MEMPHIS®

Herff College of Engineering

2026 SENIOR DESIGN EXPO

FRIDAY, APRIL 24
HERFF ENGINEERING COMPLEX

A word from the dean...

It is a proud and exciting moment for the Herff College of Engineering as we celebrate the achievements of our senior class at the Senior Design Expo.

This event highlights the innovation, creativity and collaboration that define the Herff experience. Each project represents months of dedication, problem-solving and hands-on learning, bringing together the knowledge and skills our students have developed throughout their time here. These capstone experiences are more than final assignments, they are a reflection of our students' ability to think critically, work collaboratively and create solutions that address real-world challenges.

To our graduating seniors, this milestone marks both an ending and a beginning. You have demonstrated the perseverance and ingenuity that will carry you forward as engineers, leaders and innovators. The work you showcase today is a testament to your commitment and to the strong foundation you have built at Herff.

Congratulations on this remarkable achievement. We are proud of you and look forward to all you will accomplish.



Okenwa O.I. Okoli, Ph.D. CEng. CSci. FIMMM
Dean and Professor
Herff College of Engineering

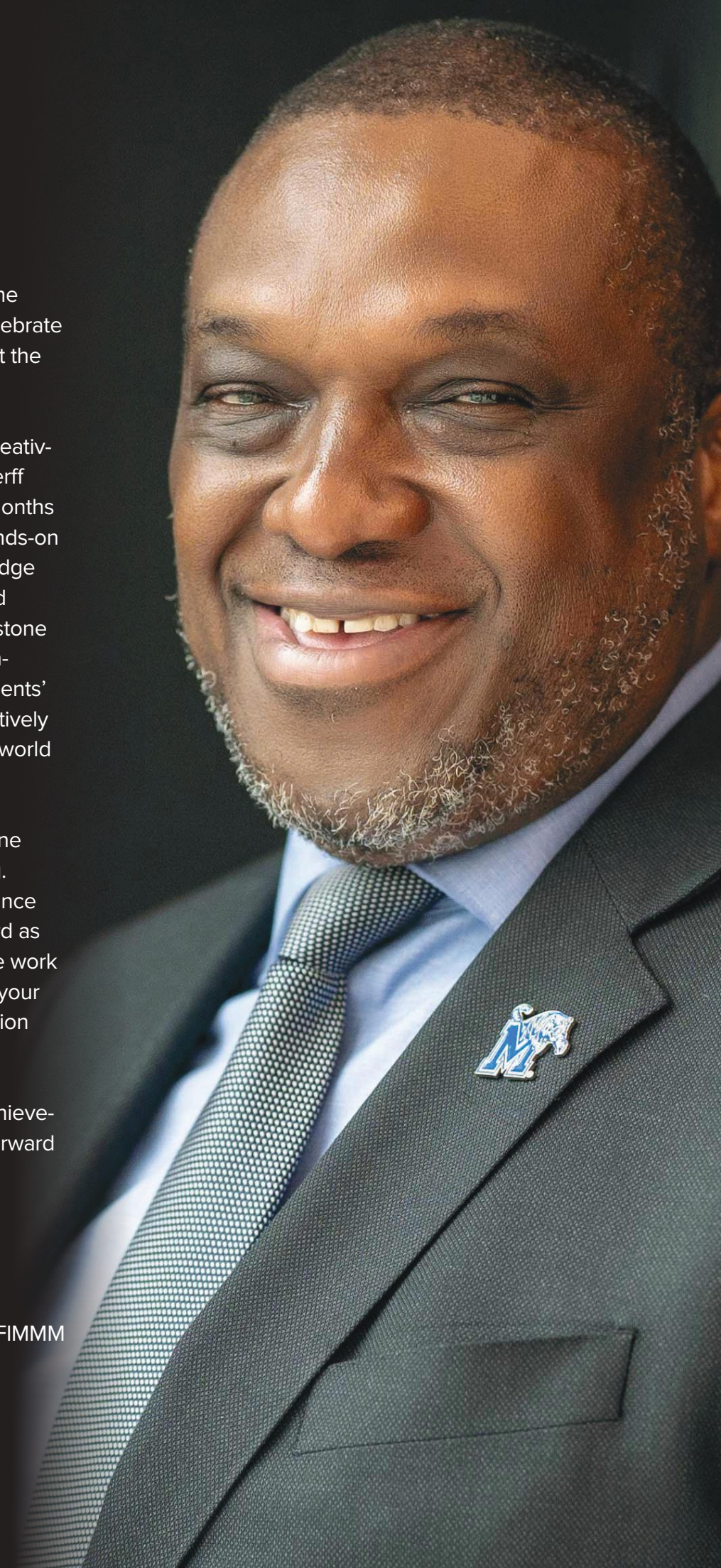


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DESIGN EXPO SCHEDULE

Time	Event	Location(s)
11 a.m. to 1 p.m.	Poster Session	Biomedical Engineering EA, ET Second Floor Breezeway Civil, Construction and Environmental Engineering EA, ES Second Floor Breezeway Electrical and Computer Engineering Technology ES Second Floor Engineering Technology ET Second Floor Mechanical Engineering ERIC Atrium and Second Floor
12 (noon) to 1:30 p.m.	Refreshments	EA Lobby
1:30 to 3:30 p.m.	Concurrent Oral Sessions	ERIC 201/203 ERIC 205 ERIC 207 ES 222 ES 220 ES 218 EA 203
3:30 to 4 p.m.	Closing Reception and Awards Ceremony	EA Lobby and EA 203

EA = Engineering Administration Building
 ES = Engineering Science Building
 ET = Engineering Technology Building
 ERIC = Edwards Research and Innovation Center

CONCURRENT SESSION SCHEDULE

Room	Theme	1:30 p.m.	1:50 p.m.	2:10 p.m.	2:30 p.m.	2:50 p.m.	3:10 p.m.
ES 220	Biomechanical and Biomaterials Design	Optional Adjustable Depth Stop Collar for Cervical Fusion Implant Inserters	Medtronic Depth Stop	ShutEye	Self Cleaning Rongeur	Ocular Tear Sponge	Smart Adapter
ES 218	Fluid Flow Design		Automated Greenhouse	Project Aqua Bot	Stripes & Pipes Automated Solution	Pipe Inner Diameter Spraying Challenge	A Robotic System for Seedling Transplanting
EA 203	Facility Design	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (Capital Design and Engineering)	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (HMAACK)	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (Tigers, Inc.)	Order Location and Warehouse Efficiency Improvement Project	Baptist Hospital Improvement Project	Privacy Screen Kit
ERIC 201/203	Dynamics & Heat Transfer Design	Automated Memphis Zoo Catapult	Prototype-based Catapult	Design and Development of an Automated Zoo Catapult Feeding System	Ultrasonically Enhanced Vacuum with Transducer Assisted Cleaning	Strand Tank Cooling System	Temperature-Responsive Tissue Phantom for Thermal Therapy Experiments
ERIC 205	Robotics & Autonomous Devices	Astro Duck Rescue Robot and UAV	An Autonomous Robotic System for Collecting Astro-ducks on a Lunar Rescue Mission and Re-establishing Antenna Communication with Earth	2025-2026 AIAA Design, Build, Fly	System for Physically Simulating Self-Assembling Electrical Circuits	Mobile Robot	IR Triage Scanner Robot
ERIC 207	Mechanical System Design	Tiger BAJA Frame and Cockpit Integration	Tiger Baja Suspension and Steering System	Universal Pump Test Stand	Design & Build Multi-Door Sliding Testing Apparatus	Johnny A. Seed	A Novel Design of a Bone Screwdriver for Use in Internal Fixation of Long Bone Fractures
ES 222	Signals & Systems Detection Design	AI Lesion Identification System	Cyclist Early Warning System	Automated Pothole Detection and Mapping System	Smart Parking Lot Guidance System	Operation: Defense	

Biomedical

Civil, Construction and Environmental

Electrical and Computer

Engineering Technology

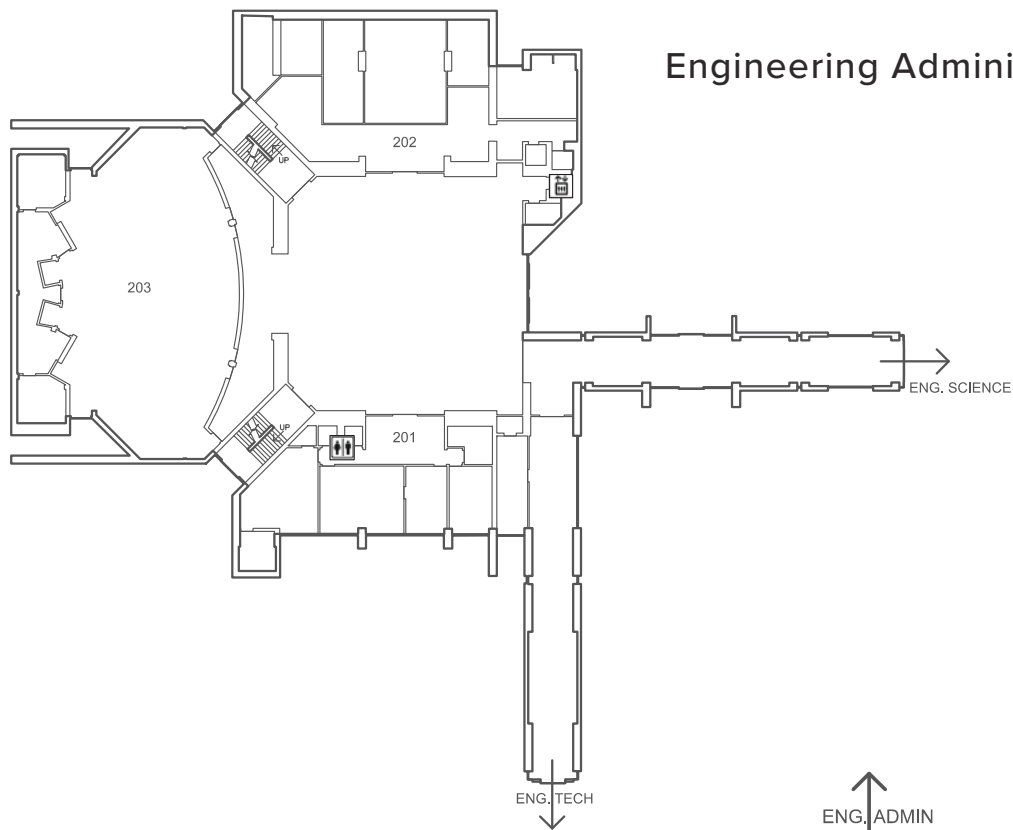
Mechanical

ORAL SESSION SCHEDULE

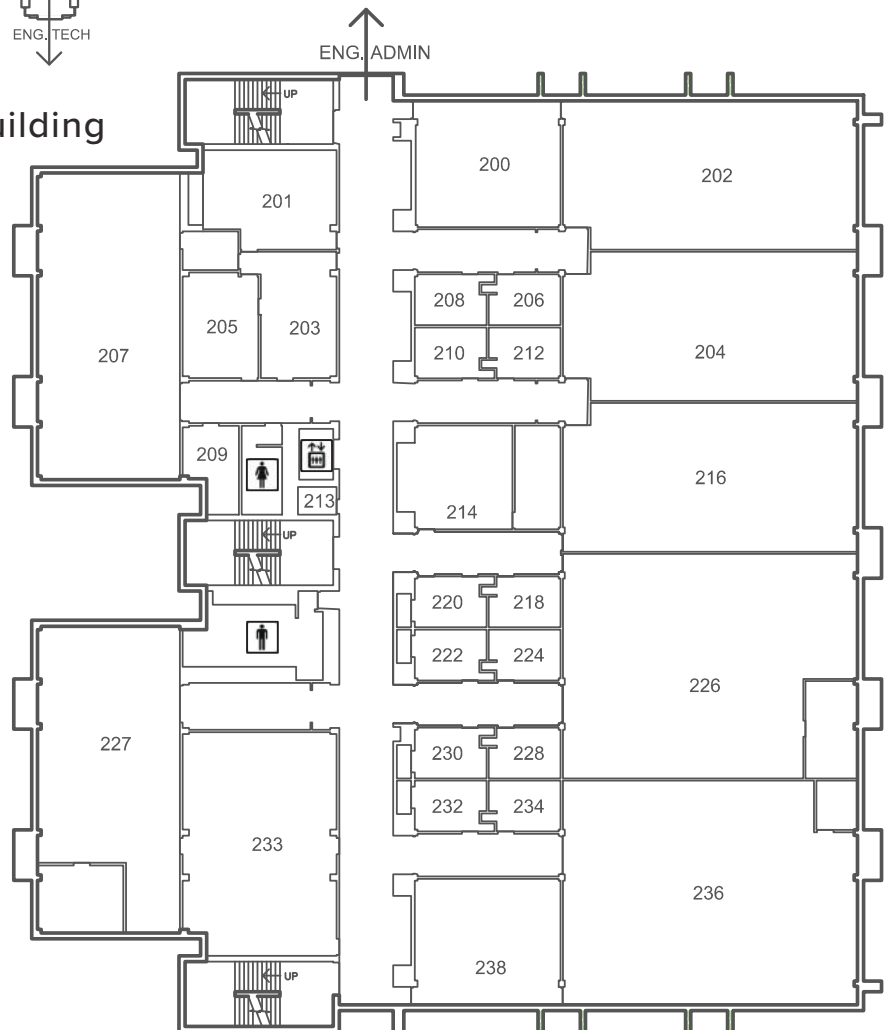
Session Theme: Dynamics & Heat Transfer Design			Room: ERIC 201/203
Time	Department	Project	Abstract
1:30pm	Engineering Technology	Automated Memphis Zoo Catapult	Page 33
1:50pm	Engineering Technology	Prototype-based Catapult	Page 35
2:10pm	Engineering Technology	Design and Development of an Automated Zoo Catapult Feeding System	Page 34
2:30pm	Mechanical	Ultrasonically Enhanced Vacuum with Transducer Assisted Cleaning	Page 42
2:50pm	Mechanical	Strand Tank Cooling System	Page 45
3:10pm	Biomedical	Temperature-Responsive Tissue Phantom for Thermal Therapy Experiments	Page 12
Session Theme: Robotics & Autonomous Devices			Room: ERIC 205
Time	Department	Project	Abstract
1:30pm	Electrical and Computer	Astro Duck Rescue Robot and UAV	Page 28
1:50pm	Electrical and Computer	An Autonomous Robotic System for Collecting Astro-ducks on a Lunar Rescue Mission and Re-establishing Antenna Communication with Earth	Page 29
2:10pm	Mechanical	2025-2026 AIAA Design, Build, Fly	Page 43
2:30pm	Electrical and Computer	System for Physically Simulating Self-Assembling Electrical Circuits	Page 23
2:50pm	Engineering Technology	Mobile Robot	Page 37
3:10pm	Electrical and Computer	IR Triage Scanner Robot	Page 21
Session Theme: Mechanical System Design			Room: ERIC 207
Time	Department	Project	Abstract
1:30pm	Mechanical	Tiger BAJA Frame and Cockpit Integration	Page 44
1:50pm	Mechanical	Tiger BAJA Suspension and Steering System	Page 54
2:10pm	Mechanical	Universal Pump Test Stand	Page 49
2:30pm	Mechanical	Design & Build Multi-Door Sliding Testing Apparatus	Page 48
2:50pm	Mechanical	Johnny A. Seed	Page 46
3:10pm	Mechanical	A Novel Design of a Bone Screwdriver for Use in Internal Fixation of Long Bone Fractures	Page 47
Session Theme: Signals & Systems Detection Design			Room: ES 222
Time	Department	Project	Abstract
1:30pm	Electrical and Computer	AI Lesion Identification System	Page 24
1:50pm	Electrical and Computer	Cyclist Early Warning System	Page 26
2:10pm	Electrical and Computer	Automated Pothole Detection and Mapping System	Page 22
2:30pm	Electrical and Computer	Smart Parking Lot Guidance System	Page 20
2:50pm	Electrical and Computer	Operation: Defense	Page 27

Session Theme: Biomechanical & Biomaterials Design			Room: ES 220
Time	Department	Project	Abstract
1:30pm	Biomedical	Optional Adjustable Depth Stop Collar for Cervical Fusion Implant Inserters	Page 6
1:50pm	Mechanical	Medtronic Depth Stop	Page 53
2:10pm	Biomedical	ShutEye	Page 14
2:30pm	Biomedical	Self Cleaning Rongeur	Page 13
2:50pm	Biomedical	Ocular Tear Sponge	Page 11
3:10pm	Mechanical	Smart Adapter	Page 52
Session Theme: Fluid Flow Design			Room: ES 218
Time	Department	Project	Abstract
1:50pm	Engineering Technology	Automated Greenhouse	Page 32
2:10pm	Engineering Technology	Project Aqua Bot	Page 38
2:30pm	Engineering Technology	Stripes and Pipes	Page 39
2:50pm	Mechanical	Pipe Inner Diameter Spraying Challenge	Page 50
3:10pm	Electrical and Computer	A Robotic System for Seedling Transplanting	Page 25
Session Theme: Facility Design			Room: EA 203
Time	Department	Project	Abstract
1:30pm	Civil, Construction and Environmental	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (Capital Design and Engineering)	Page 16
1:50pm	Civil, Construction and Environmental	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (HMAACK)	Page 17
2:10pm	Civil, Construction and Environmental	Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis (Tigers, Inc.)	Page 18
2:30pm	Engineering Technology	Order Location and Warehouse Efficiency Improvement Project	Page 40
2:50pm	Engineering Technology	Baptist Hospital Improvement Project	Page 36
3:10pm	Mechanical Engineering	Privacy Screen Kit	Page 51

ENGINEERING COMPLEX SECOND FLOOR MAPS

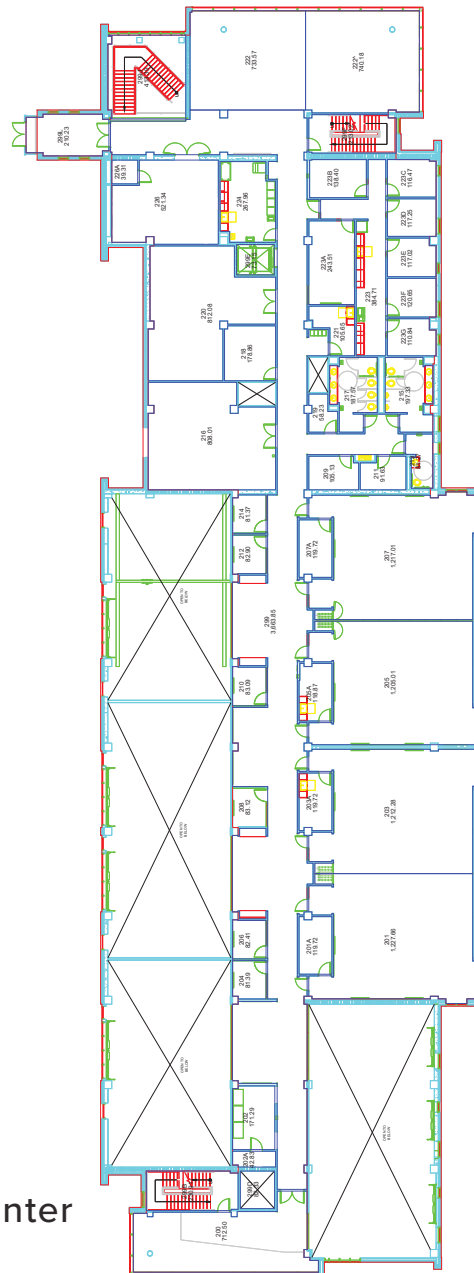


Engineering Technology Building





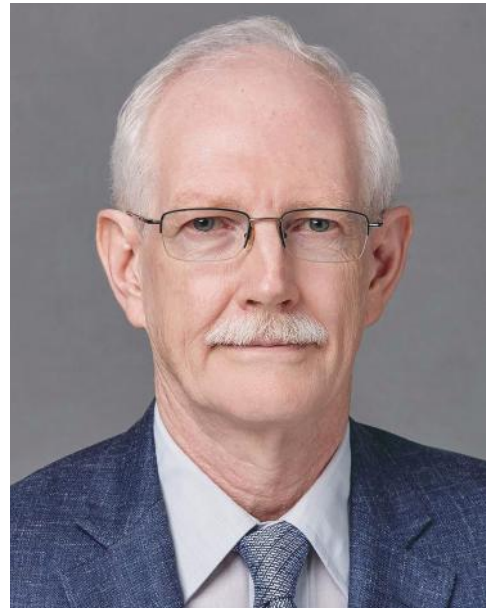
Engineering Science Building



Edwards Research and Innovation Center

Biomedical ENGINEERING

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119B Engineering Technology

Optional Adjustable Depth Stop Collar for Cervical Fusion Implant Inserters



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Project Type

Industry Sponsored

Client

Medtronic

Client Mentors

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Team: CerviStop

Anterior cervical discectomy and fusion is a common spinal procedure in which an interbody cage is inserted into the cervical spine to restore disc height and promote fusion. During implantation, surgeons rely primarily on visual and tactile feedback to control insertion depth. Over-insertion of the implant can result in serious complications, including posterior cortical breach, neural irritation, and potential spinal cord damage. Current cervical depth stop instruments are typically permanently integrated into the inserter and do not provide an optional, adjustable mechanism that allows surgeons to use depth limitation at their discretion.

This senior design project addresses the need for a method that enables orthopedic surgeons and neurosurgeons to selectively apply depth control while maintaining safe insertion limitations during cervical procedures. The proposed solution is an optional adjustable depth stop collar attachment designed for compatibility with existing cervical cage inserters. The device consists of a small circular tube with a bottom cutout that mounts onto the inserter shaft and is secured using two screws. A rigid bar attached to the top of the collar extends forward and contacts the anterior cervical vertebra during insertion, physically preventing over-advancement of the implant.

The design process incorporated objectives trees, functional decomposition, morphological analysis, and structured concept selection to evaluate alternative mechanisms. Engineering requirements were defined for dimensional tolerances, resistance to mallet impactation forces, fatigue strength, sterilization compatibility, corrosion resistance, and repeatable accuracy. Verification testing included dimensional

inspection, impactation force evaluation, and mechanical stability assessments. A formal failure mode and effects analysis was conducted to evaluate hazards related to device use, mechanical integrity, aging, and sterilization.

The final design provides a removable and reliable method to enhance surgeon control and improve safety and precision during cervical fusion surgery.

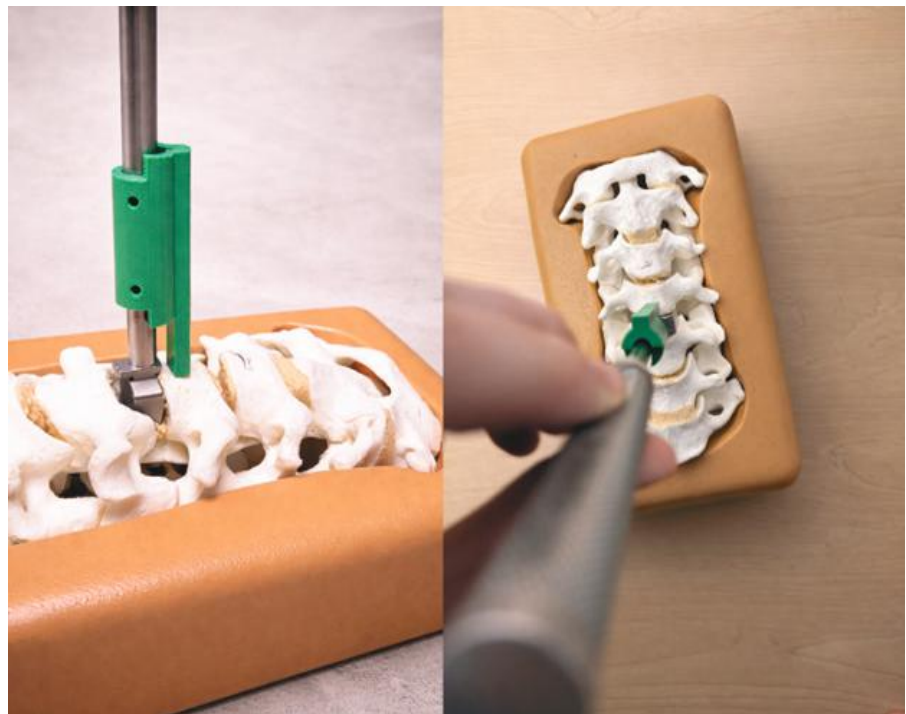


Figure 1. Adjustable depth stop collar prototype mounted on cervical trial to physically limit implant insertion depth.

Ocular Tear Sponge



Team Members

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Faculty Mentor

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Dr. John L. Williams

Project Type

Research Based

Client

Independent

Team: EyeSpy

Recent advances in medical research have seen the use of various biological markers such as proteins, genes, and metabolites to effectively diagnose, prognose, and treat a wide variety of diseases to great success. This has created an interest in obtaining biomarker samples for laboratory analysis.

The tear film of the eye is a minimally invasive source of biomarkers that contains thousands of proteins that act as indicators of ocular health, but due to a lack of standardized sampling there is little to no consistency when researchers compare samples obtained from this very limited sample source.

For further progress to be made in this emerging research field, a way to address the lack of standardized tear sampling for healthcare staff to improve the reliability of protein biomarker analysis is needed.

Upon reviewing a variety of currently used sampling methods, it was determined that ideal solutions would be comfortable for both the

patient and healthcare staff, easy to use with minimal training, collect samples in under five minutes, and have the ability to store at least 7 μ L of fluid to ensure the maximum sample volume could be collected.

Solutions should also be biocompatible, hypoallergenic, and reproduceable. With these design requirements in mind, several designs were created and iterated upon until a solution that satisfied the requirements was developed.

This led to the creation of the ocular tear sponge, a device designed to be placed in the lower portion of the eye for a short period of time to absorb tears directly from the tear film.

This design seeks to standardize the collection and storage of tear samples for protein biomarker analysis, providing consistent and reliable results that will aid in the diagnosis, prognosis, and treatment of eye diseases to improve ocular health worldwide.



Ocular Tear Sponge

Temperature-Responsive Tissue Phantom for Thermal Therapy Experiments



Team Members

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Project Type

Internal

Client

Herff College of Engineering

Team: Phantom

Thermal therapies play a key role in modern medicine, particularly in the treatment of brain cancer and in supporting various surgical procedures. However, achieving precise temperature control within living tissue remains challenging due to the human body's thermoregulatory systems, especially temperature-dependent blood perfusion.

These nonlinear perfusion responses make it difficult to accurately predict tissue behavior during thermal treatments. Traditionally, animal models have been used to study these effects, but they present technical limitations, high costs, variability, and ethical concerns. With the NIH urging scientists to reduce dependence on animal testing, there is a growing need for physiologically relevant *in vitro* models that better replicate human tissue response.

In response to this need, a temperature-responsive tissue phantom was developed to simulate the thermal and mechanical characteristics of brain tissue containing an embedded tumor. The phantom is constructed using a modular mold system that allows the tumor geometry and dimensions to be easily adjusted for different experimental configurations. A capillary alignment system is integrated within the mold to ensure precise and repeatable positioning of perfusion channels throughout the phantom.

The phantom incorporates an active vascular flow network that circulates a rheologically representative working fluid to mimic temperature-dependent blood perfusion. A manifold consolidates the individual capillary outlets into a single tube, enabling streamlined connection to the perfusion pump and controlled fluid delivery. The system is designed to dynamically adjust flow conditions in response to thermal inputs, enabling more realistic simulation of *in vivo* thermoregulation during therapy. Additionally, the phantom is compact, bench-scale, and compatible with standard laboratory environments.

This platform provides a controllable, repeatable, and ethically responsible alternative to animal-based experimentation. By enabling accurate testing and refinement of thermal therapy technologies, the system supports improved treatment planning, device validation, and innovation in cancer research while reducing reliance on animal models.

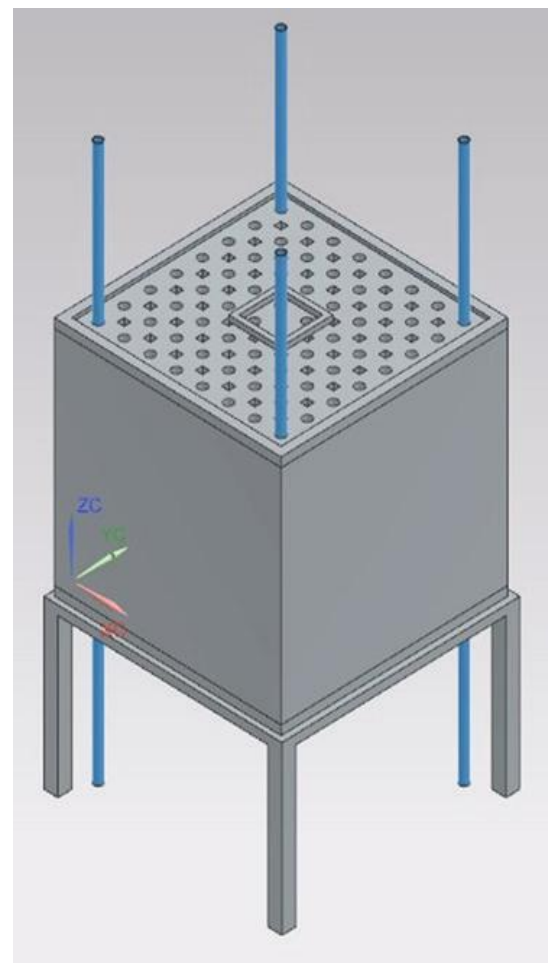


Figure 1: Model of capillary aligner/mold system. Silicone tubes are inserted into the mold to be embedded into place in the tissue.

Self-Cleaning Rongeur



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Project Type

Industry-Sponsored

Client

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Team: Rongeur

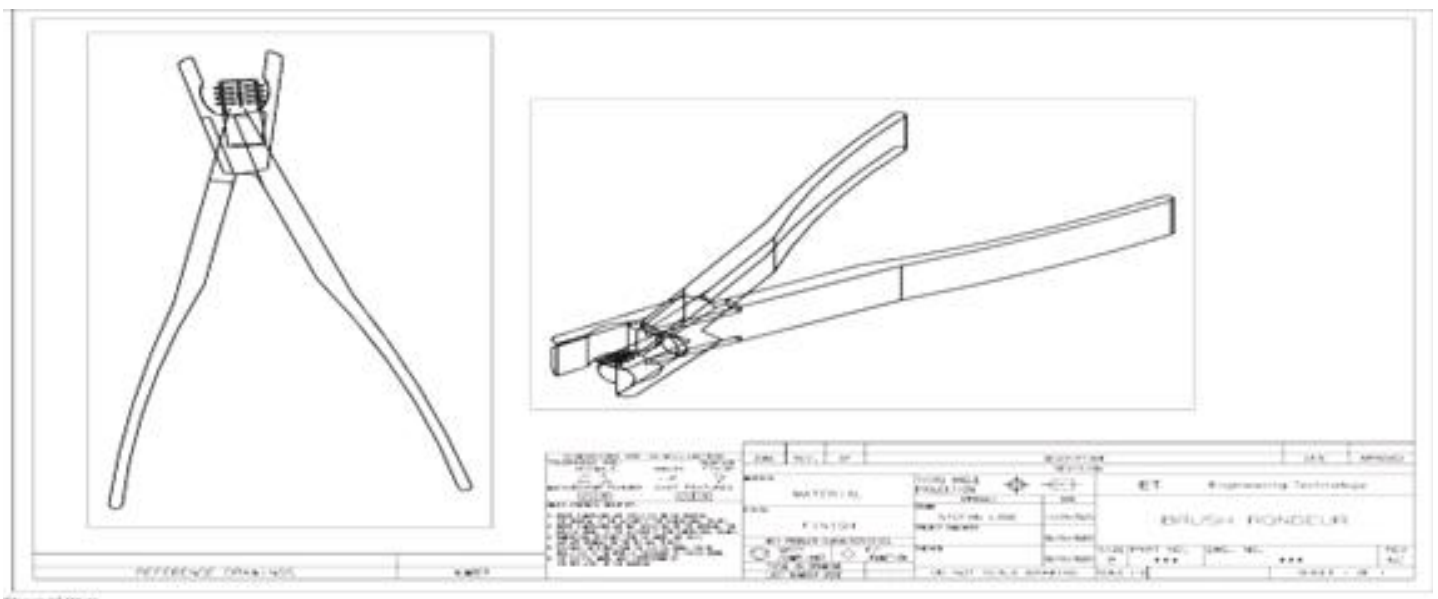
A rongeur is a surgical instrument used to cut bone and tissue during surgical procedures. They require removal from the surgical site after each use for cleaning. This removal poses risks, including misplacement of the surgical site upon reentry, infection from improperly sterilized cleaning materials, and harm to surgeons and/or patients.

This has led to a need for a self-cleaning rongeur or a better cleaning method. The self-cleaning rongeur in this design is a surgical instrument designed to enable a safe and effective procedure without the constant removal of the rongeur at the surgical site, or to at least provide a better means of cleaning.

To design a self-cleaning rongeur that reduces the number of times it is removed from the surgical site, or to develop a better cleaning

method, we introduced three potential design possibilities for a self-cleaning rongeur. These designs consist of an external suction and fluid-flush device, a rongeur with detachable, replaceable jaws, and a rongeur with a brush. After reviewing the pros and cons of each design, the team decided to proceed with the flush and suction device as our final design.

The flush and suction rongeur will be hung over the surgical site, and clean inserted rongeurs will be operated by the surgeon using a pedal. The problem at hand is being able to fit the suction tube on the rongeur without causing blockage of the working site. As a team, we are continuing to build a prototype to test possible solutions for the design we chose.



Drawing of one of the considered designs that uses a rotating brush to clean jaws.



Team Members

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Project Type

Internal

Client

Herff College of Engineering

Exposure keratopathy, or corneal damage, is a common and preventable complication in patients who experience incomplete eyelid closure, or lagophthalmos, due to unconsciousness, sedation, facial nerve dysfunction, or critical illness. If left untreated, it can lead to discomfort, infection, or permanent vision impairment often resulting from disruption of the tear film.

Current solutions – including medical taping, eye covers, moisture chambers, and surgical interventions such as tarsorrhaphies – often prevent medication administration, impede monitoring, create cosmetic or comfort concerns, and further irritate the periocular area.

The objective of this project was to design a safe, effective, user-friendly, and clinically applicable device capable of temporarily closing the eyelid while still allowing healthcare professionals controlled access to the eye for assessment and treatment.

The design process followed a structured methodology that included needs specification, ranking of objectives, and iterative concept evaluation using three rounds of Pugh analysis. Key constraints included ensuring biocompatibility and hypoallergenic materials, maintaining

functionality within the limited anatomical area of the upper eyelid, operating reliably under normal physiological temperature conditions, allowing eye medication instillation without device removal, and meeting requirements for comfort, usability, and affordability in clinical environments. Performance specifications further required reliable eyelid closure force, low-trauma skin adhesion, rapid application, and unobstructed manual access to the eye.

The final selected design, the weighted tape/patch, incorporates a thin hypoallergenic adhesive strip with an embedded tantalum weight that gently maintains eyelid closure using a passive gravitational force mechanism. This concept was chosen due to its simplicity, manufacturability, and strong potential for clinical use compared to more complex magnetic or temperature-dependent alternatives.

The resulting device provides an accessible and practical method for reducing the incidence of exposure keratopathy, improving patient safety and comfort, and supporting both patient convenience and workflow efficiency across diverse healthcare settings.



CAD Model of Weighted Tape with Encapsulated Tantalum

Civil, Construction and Environmental ENGINEERING

Faculty Advisor



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Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis



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Professor Ian Engstrom

Project Type

Industry Sponsored

Client

Baptist Memorial Hospital-
Memphis

Team: Capital Design and Engineering

This project includes the strategic planning and design of a temperature-controlled storage facility aimed at optimizing the operations of Baptist Memorial Health Care's East Campus. The hospital is currently experiencing limitations in its capacity for climate-sensitive storage, which leads to operation inefficiencies within the campus. The goal of this design effort is to create a cost-effective, structurally sound, energy efficient storage facility that adheres to all applicable standards while seamlessly integrating with the existing campus infrastructure.

The envisioned facility will feature a structural steel frame equipped with an insulated wall and roof system, specifically designed to sustain stable interior temperature conditions throughout the year. Key design constraints include site limitations within an existing employee

parking lot, compliance with local zoning regulations, considerations for stormwater management, and budgetary constraints. The design approach involves the selection of structural steel members, foundation sizing utilizing a mat foundation, and civil site modifications that include drainage and traffic adjustments.

Deliverables will consist of a structural framing layout, foundation design calculations, site civil analysis, traffic reconfiguration, and construction cost estimation. The final design will yield a scalable storage solution that improves hospital logistics. This project exemplifies the applications of structural, geotechnical, water resources, transportation, and construction management principles within a practical healthcare infrastructure context.

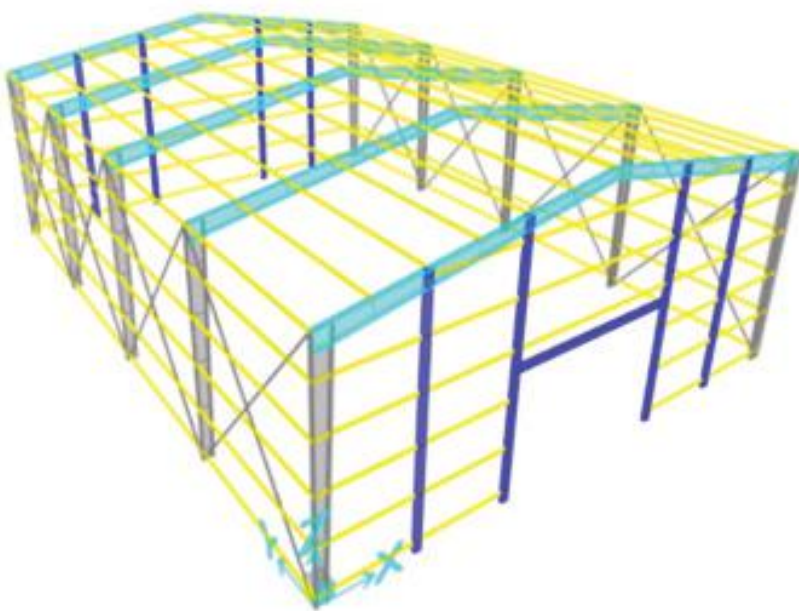


Figure 1. Three-dimensional structural framing model showing primary frames, secondary members, and lateral bracing system for the proposed storage facility.

Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis



Team Members

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Faculty Mentor

Professor Ian Engstrom

Project Type

Industry Sponsored

Client

Baptist Memorial Hospital-
Memphis

Team: HMAACK

This project includes the consultation and design of a ground-up addition of a 3,000 square foot temperature-controlled storage building within the employee parking lot at Baptist Memorial Hospital East. This building will mitigate additional storage needs of the hospital, including old hospital beds and other equipment.

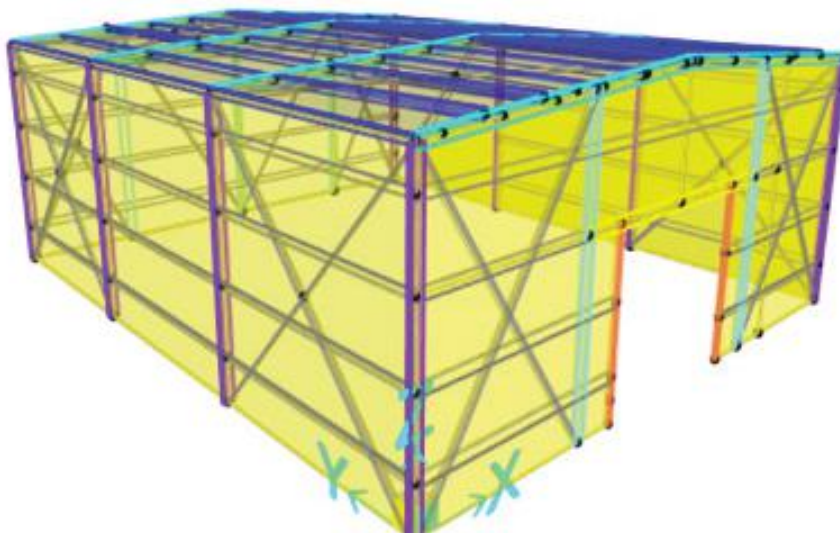
The design scope of this project involves demolition planning, utility rerouting, structural and foundation design, site planning, grading and drainage improvements, erosion control planning and phasing, traffic control and parking adjustments, paving design, and interior layout.

In addition to efficient storage, design will also include 2 bathrooms, a utility sink, an office, a corridor, and a forklift charging facility within the building. Potential challenges to the project include, but are not limited to: cost efficiency, compliance with local and national codes, proximity to sewer lines, sufficient interior layout for forklift turn radius, rerouting parking and traffic during construction, floodplain proximity/constraints, required permits/reviews, net parking loss and maintenance of ADA

requirements, maintaining two emergency entry points, accommodating heavy truck deliveries, limited construction staging area with active lot, geotechnical risks, and necessity of hydraulic and utility rerouting. This project assumes outsourced design for landscaping, architecture, fire protection, mechanical, electrical, plumbing, distributed energy, and telecommunication.

Final deliverables include a full construction document set, including the following pages: existing conditions and demolition plan, utility plan and details, structural design and details, roof framing plan, structural foundation details, foundation plan, erosion control plan phase 1, 2, and details, grading and drainage plan and tables, post-construction runoff plan, site plan, paving plan, and traffic control and circulation plans.

A drainage report will also be provided as a final deliverable. This project offers experience and understanding of the broader world of engineering consultation and design.



3-dimensional rendering of building frame design, featuring a gable frame system composed of rolled wide-flange steel members.

Temperature-Controlled Storage Facility at Baptist Memorial Hospital-Memphis



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Faculty Mentor

Professor Ian Engstrom

Project Type

Industry Sponsored

Client

Baptist Memorial Hospital-
Memphis

Team: Tigers, Inc.

Baptist Memorial Hospital is running out of space to store items such as disaster equipment, older patient beds, and other operational supplies. Existing storage areas are being repurposed to support an expanded Emergency Department, creating the need for additional storage while minimizing impacts to campus activities.

This project delivers the final design for a structurally-sound, temperature-controlled storage facility in the hospital's employee parking lot, along with the parking and circulation improvements needed to maintain safe and efficient access.

The project objectives include providing at least 3,000 square feet of storage space, and approximately 500 square feet of office space. Key constraints include maintaining uninterrupted hospital operations, preserving emergency and service access routes, minimizing loss of

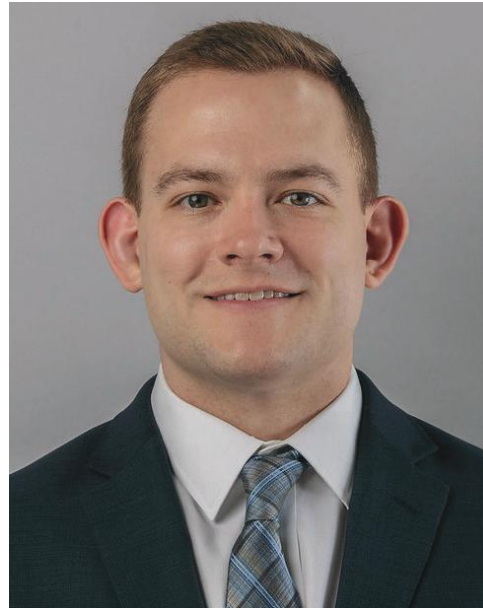
existing parking, and protecting nearby environmental resources such as the Wolf River.

The design approach includes evaluating cost-effective site layout alternatives, developing a building floor plan that provides adequate storage for the facility, and completing the civil and structural engineering design for the selected solution.

Civil design elements address utility coordination, site grading, and a stormwater management plan, along with pavement and striping modifications to improve parking lot circulation. Structural design elements establish the building's primary framing system and foundation to meet strength, serviceability, and constructability requirements. Expected deliverables include a complete set of 100% construction drawings and a final presentation summarizing the design.

Electrical & Computer ENGINEERING

Faculty Advisor



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Smart Parking Lot Guidance System



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Faculty Mentor

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Project Type

Internal

Client

Herff College of Engineering

Team Adman Technologies

This project develops a camera-based smart parking guidance system that reports real-time space availability to drivers and facility staff. In busy parking lots, drivers often circulate to find open spaces, increasing congestion, fuel use, and frustration.

The system's objective is to detect individual parking-space occupancy from an overhead camera view and publish clear availability information through a dashboard, while remaining low-cost and practical to deploy within typical campus power and network constraints.

A roof-mounted camera overlooks the lot, and an edge computing device processes video frames locally. After camera calibration and frame alignment, predefined regions corresponding to parking spaces are analyzed to determine whether a vehicle is present.

Occupancy results are time-stamped, aggregated by zone, and sent to a lightweight backend service that stores updates and exposes them through an application programming interface. A web interface displays

current counts, a lot of maps with open/occupied indicators, and system health information for administrators.

Key engineering considerations include robustness to lighting and weather variations, reduced bandwidth by transmitting compact occupancy data instead of full video, and privacy by avoiding vehicle or person identification. Space regions can be reconfigured for new lots without redesigning hardware, supporting scalability, and maintainability.

The project deliverables include the installed prototype hardware, the full software pipeline (edge processing, backend services, and dashboard), and an evaluation using annotated footage to quantify detection accuracy and update latency. By shortening search time and improving situational awareness, the platform supports smarter parking operations and provides a foundation for future automation and analytics.



Figure 1. Camera-based parking occupancy detection results for the test lot, showing mapped spaces and detected vehicles used to compute real-time availability.

IR Triage Scanner Robot



Team Members

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Mitchell Haggard
Ramses Alvarez
William Lopez

Faculty Mentor

Dr. Aaron Robinson

Project Type

Internal

Client

Herff College of Engineering

Team A.O.N. Innovations

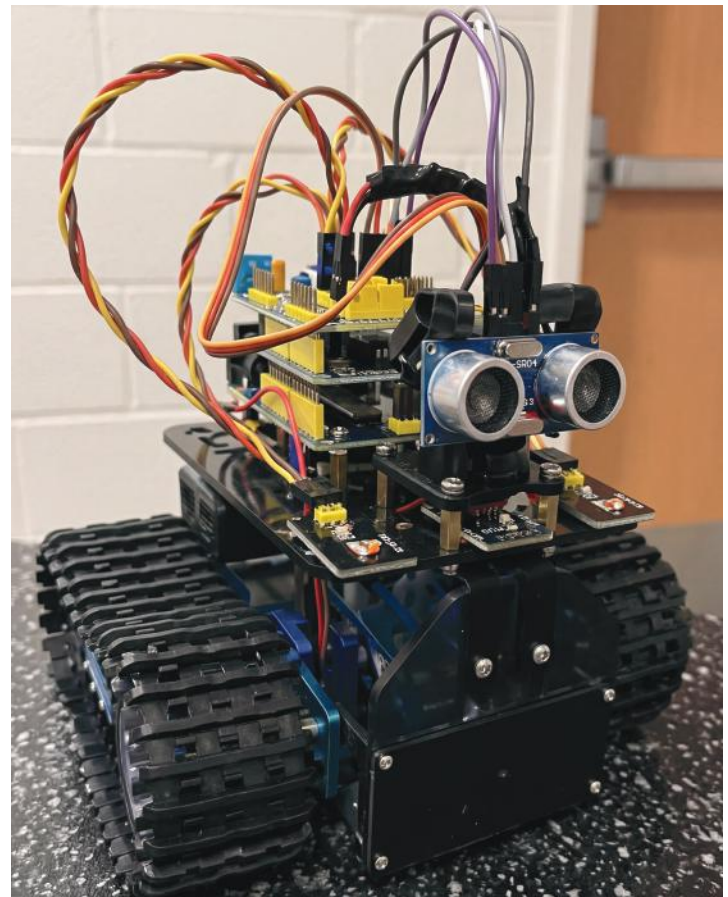
Mass-casualty incidents such as natural disasters, fires, and large accidents require rapid victim assessment to prioritize medical treatment. During these situations, emergency responders often need to enter unstable or hazardous environments to locate and evaluate victims. This process increases the risk of injury to responders and can delay early triage decisions that are critical for saving lives.

The objective of this project is to design and develop a small mobile robotic system capable of assisting responders in performing remote victim assessments during emergency situations. The proposed system allows operators to evaluate victims from a safe distance while maintaining visual and thermal awareness of the environment.

The system is based on a differential-drive mobile robot platform equipped with a thermal camera for infrared imaging and a smartphone for RGB video streaming. The thermal camera enables detection of body heat signatures, while the RGB camera provides standard visual monitoring of the scene. Video data is transmitted to a laptop that is used for system control, processing, and basic data logging. The robot also supports simple triage tagging and the storage of victim information with timestamps.

Several design constraints were considered during development, including reliable remote operation, clear infrared and RGB imaging, lightweight portability, and maintaining a prototype cost below the \$500 project budget. The selected configuration satisfies these requirements while remaining practical for rapid deployment in emergency scenarios.

The IR Triage Scanner Robot is intended to improve the safety of first responders and increase the speed of triage operations by allowing initial victim assessment without requiring personnel to immediately enter hazardous areas.



Automated Pothole Detection and Mapping System



Team Members

Shahzain Kazmi
 Viknesh Sabapathi
 Carlin Webster
 Jaden Kimbro
 Karlee Bates

Faculty Mentor

Dr. Eddie Jacobs

Project Type

Internal

Client

Herff College of Engineering

Team Current Crew

Roadway deterioration caused by potholes presents persistent safety hazards and significant financial costs for drivers and municipalities. Current detection methods rely heavily on manual inspections or citizen reporting systems, which are often slow, inconsistent, and reactive. This project addresses the need for a proactive and automated solution through the development of a Pothole Detection and Mapping System capable of identifying and recording roadway damage in real time while a vehicle is in motion.

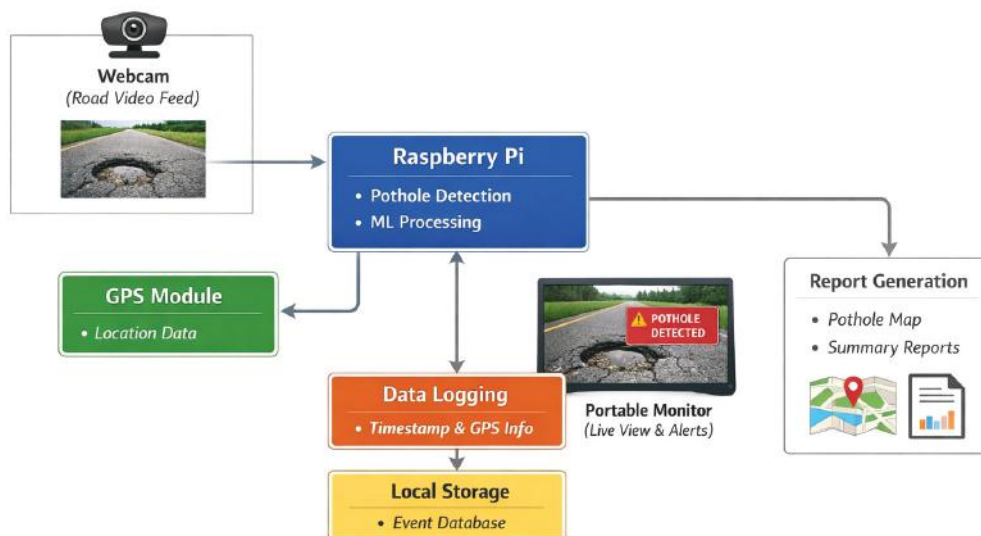
The primary objectives of the project are to accurately detect potholes under varying road, lighting, and weather conditions; automatically log their geographic coordinates and timestamps; and display the collected data on an accessible digital mapping interface for maintenance personnel. Key design constraints include maintaining low implementation cost, ensuring minimal driver interaction, operating

reliably during vehicle motion, enabling simple installation across different vehicle types, and supporting future scalability.

The system was developed with a strong emphasis on autonomy, simplicity, and non-intrusive operation. The goal was to create a device that functions automatically in the background without requiring driver input or interfering with normal driving. The design prioritizes seamless vehicle integration, dependable performance in real-world conditions, and efficient data collection and organization.

The expected outcome is a functional prototype that autonomously detects potholes, associates each event with precise geographic coordinates, and compiles the information into a structured digital map and database. By enabling continuous, vehicle-based roadway monitoring, the system supports data-driven maintenance planning, more efficient resource allocation, and improved roadway safety.

Pothole Detection and Reporting System



System for Physically Simulating Self-Assembling Electrical Circuits



Team Members

Logan Sheppard
Sara Howell
Braxton Quillin
Tyler Ross

Faculty Mentor

Dr. Russell Deaton

Project Type

Internal

Client

Herff College of Engineering

Team Delta Development

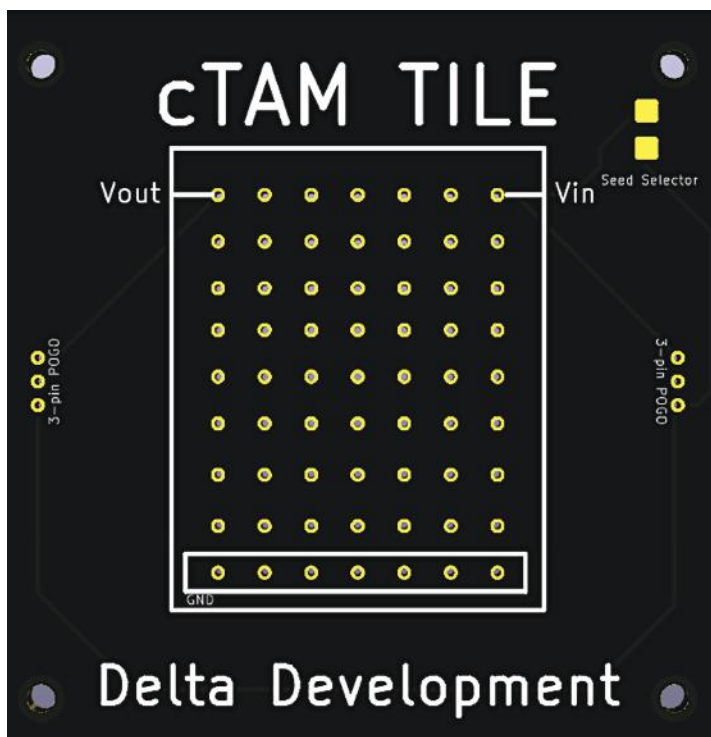
Biological growth is a complex phenomenon that occurs autonomously in nature. Simulations have been developed to increase understanding by representing this process through the lens of circuit theory. Delta Development aims to bring this research from digital simulation to physical design as a proof of concept.

At the University of Memphis, Doctor Russel Deaton of the Electrical Engineering department is spearheading research into self-assembling circuits. Taking inspiration from aTAM (abstract tile assembly model)

research, Dr. Deaton's team is developing cTAM (circuit tile assembly model). The purpose of cTAM is to replicate growth behavior autonomously using circuitry. In the scope of this project, a user-defined threshold voltage will act as the growth stimulus.

This will dictate the amount that the circuit needs to grow. The seed circuit is the first tile in the chain, directly connected to the voltage supply. The voltage of the tile, referred to as its tip potential, will be measured and compared to the threshold voltage. The controller will autonomously attach a circuit tile to the seed circuit if the last circuit's tip potential is higher than the threshold voltage.

The customizable circuit tiles will have varying impedances, causing a decrease in tip potential after each attachment. When growth stimulus is present, the controller will use a motor to push the circuit tile far enough to trigger a magnetic connection. This process will continue to build a chain of circuit tiles until the tip potential is less than the threshold voltage, at which time growth will cease. Successful design of a physical model will provide a basis for future applications in understanding and simulating growth.



Render of PCB used to represent a cTAM tile.

AI Lesion Identification System



Team Members

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Patrick Brayden O'Briant
Drake Watters
Brian Dunn
Benjamin Borwick

Faculty Mentor

Dr. Aaron Robinson

Project Type

Industry Sponsored

Client

Dr. Joe Greer,
Good Health Institute

Team Five Guys

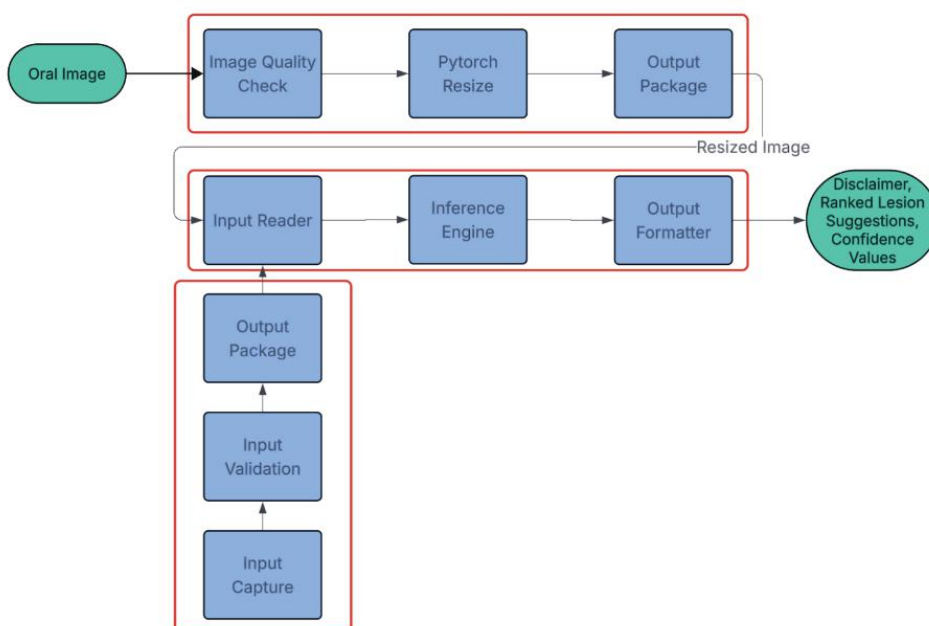
Medical and dental practitioners often encounter oral lesions that are difficult to identify during routine examinations. Some lesions are small or visually subtle, which increases the risk of delayed diagnosis and treatment. This project addresses the need for a rapid decision support tool that assists practitioners in identifying oral lesions from clinical images.

The objective is to develop an artificial intelligence-based lesion recognition system that analyzes an oral image and returns the three most likely lesion categories to support differential diagnosis. The system must achieve at least 85 percent classification accuracy and return results within two seconds to avoid interrupting clinical workflow. The design must also accept common dental image formats, provide

confidence scores for predictions, and maintain patient privacy and data security.

The proposed approach uses a fine-tuned machine learning model trained on a curated dataset of oral lesion images. The model processes the image and optional descriptive parameters provided by the practitioner. A locally deployed system running on a workstation in the dental office performs the analysis. This architecture reduces network dependence, protects patient data, and enables fast inference.

The expected deliverable is a prototype lesion recognition application capable of assisting practitioners with preliminary lesion identification. This system aims to improve diagnostic efficiency and support earlier detection of potentially harmful oral conditions.



A Robotic System for Seedling Transplanting



Team Members

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Abner Fernandez
Angel Armenta
Lucas Poloni

Faculty Mentor

Dr. Mohammadreza Davoodi

Project Type

Internal

Client

Herff College of Engineering

Team Agri Bot Prime

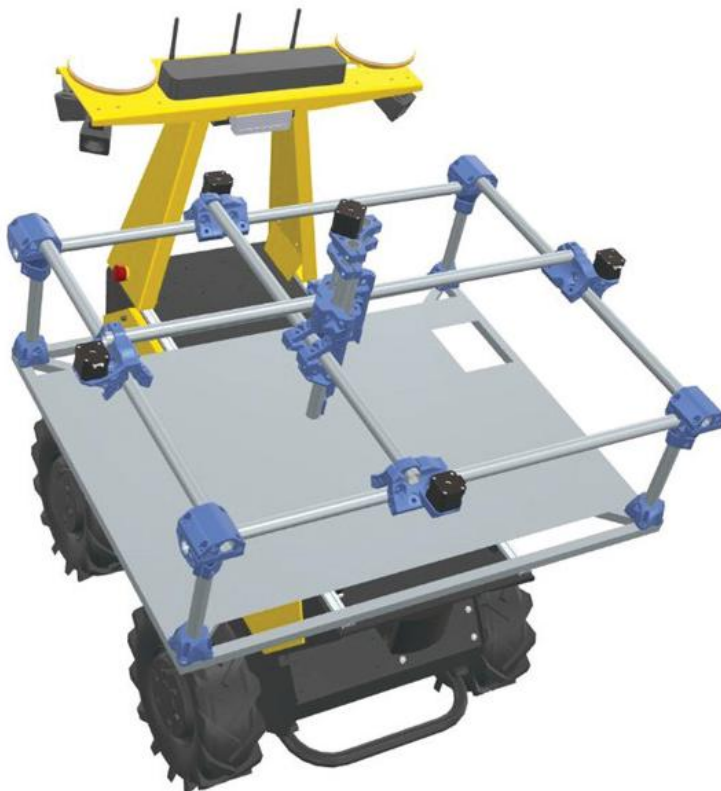
Agri Bot Prime is an autonomous seedling planting system designed to assist agricultural operations by automating the process of transplanting seedlings into soil. The system is intended to be mounted on a Husky unmanned ground vehicle (UGV) and combines navigation, manipulation, and soil preparation mechanisms to perform a complete planting cycle. The project focuses on the design and integration of electromechanical subsystems that coordinate seedling handling, soil

preparation, and stabilization of the planted seedling. By automating these steps, the system aims to improve planting efficiency and reduce the amount of manual labor required in agricultural environments.

The system receives power from an external 24-volt DC source and navigation commands that guide the robot along a planting route. Seedlings are manually loaded into a tray mounted on the robot. A gantry-based positioning system moves a gripper mechanism along three axes to retrieve individual seedlings from the tray and transfer them to the planting mechanism. The planting subsystem prepares the soil by creating a cavity of appropriate depth before the seedling is placed into the ground. After placement, a tamping mechanism compacts the surrounding soil around the seedling to help ensure stability and proper root contact with the soil.

Control of the system is coordinated by a microcontroller-based architecture that sequences the actions of each subsystem. The microcontroller processes navigation data, sensor feedback, and subsystem status signals to execute a complete planting cycle. Stepper motor drivers control the gantry positioning system, while state machines manage the behavior of the gripping, injection, and tamping subsystems. The system software is organized into layered modules that separate hardware drivers, control logic, and application-level coordination.

Agri Bot Prime demonstrates a modular and scalable approach to agricultural automation. By integrating robotic manipulation with soil preparation and stabilization processes, the system provides a prototype platform for automated field planting and illustrates how robotic technologies can support future precision agriculture applications.



Cyclist Early Warning System



Team Members

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Tyler McAdams
Isaiah Triplett
Andre Doyle
Sahid Castor

Faculty Mentor

Dr. Aaron Robinson

Project Type

Internal

Client

Herff College of
Engineering

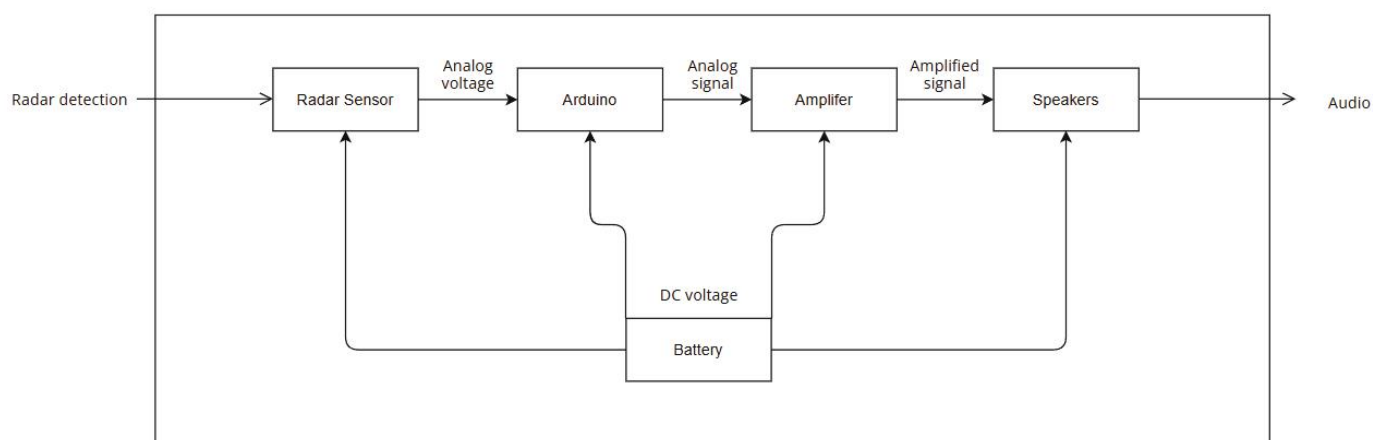
Team Live and Grounded

Cyclists riding in American bike lanes face significant safety risks due to approaching vehicles from behind. Limited rear visibility and delayed reaction time increase the likelihood of accidents. This project addresses that problem through the development of a compact and easy to install early warning system designed to improve cyclist awareness and response time. The goal of the system is to enhance rider confidence and safety without requiring the cyclist to divert attention from the road ahead.

The proposed device mounts directly to the bicycle without restricting rider movement or interfering with locomotion. It is designed to detect vehicles approaching from approximately 30 feet both behind the cyclist and to the sides in order to provide enough time for a proper reaction.

The system prioritizes timely detection and clear communication so that riders can make safer decisions in real-world traffic conditions.

The selected concept utilizes radar technology for vehicle detection, as it provides greater accuracy and reliability when compared to ultrasonic technology, while staying more cost-effective than lidar alternatives. The system components will be housed in a durable plastic enclosure with a secure clamping mechanism for attachment to the bicycle. The primary alert mechanism will be an audible warning delivered through an onboard speaker, ensuring clear and immediate feedback to the rider. The final design emphasizes affordability, durability, and ease of integration so that it can serve as a practical safety enhancement for everyday cyclists.



Operation: Defense



Team Members

Gerrell Ahkim Dabbs
Joshua Martin
David Jerome Adaway
Roger Vincent Filcek II

Faculty Mentor

Dr. Eddie Jacobs

Project Type

Internal

Client

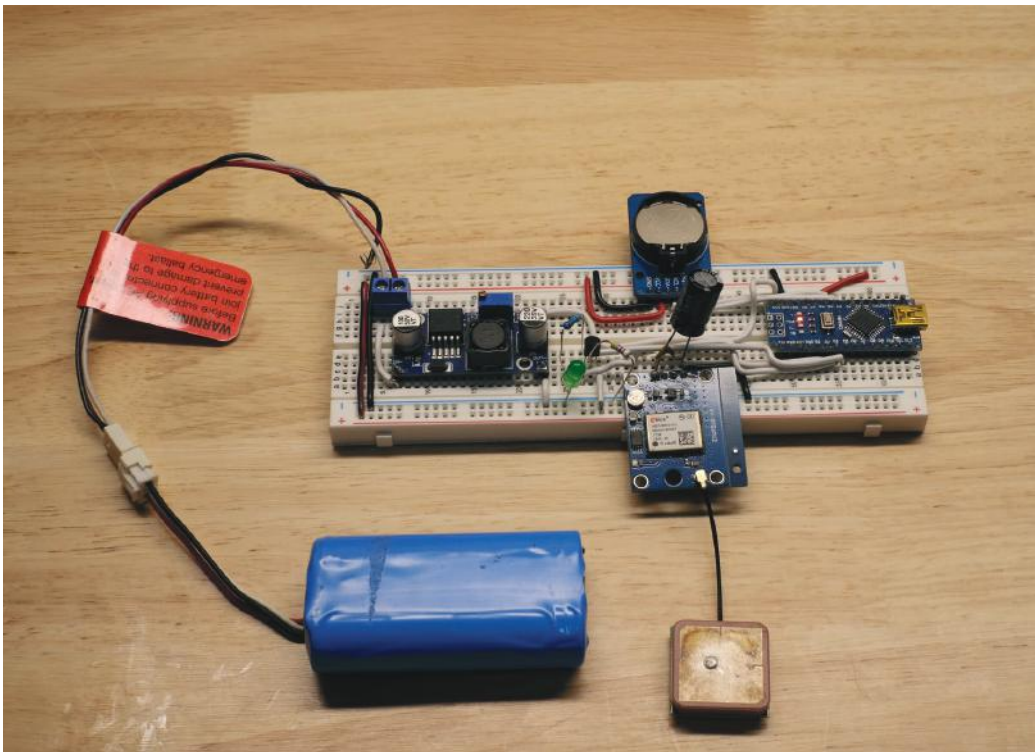
Herff College of
Engineering

The project seeks to create a system of nodes which possess the capability of detecting drones through a combination of signal processing and microcontroller design. This is to solve the problem of the usage of drones for illegal tasks such as smuggling, aircraft inception, and other similar issues.

A common issue in detection systems is how expensive they are, in addition to detection methods causing variable issues. Even with an array of methods, there is not a singular method which solves the issue of generalized detection.

As such, an improvement that can be made in the domain of drone detection systems is the reduction of cost. To this point, there are systems that rely on more common or affordable technology, such as cellphones, to make a network for the task.

Creating a system that is cost-effective relies on being able to extract a wealth of information even in the most general cases, something that digital signal processing enables. To this end, the system uses acoustics, radio communication, and signal processing techniques to accomplish this task.



The requirements of the system are that the system will be able to detect the presence of drones and estimate their locations. Additionally, the system should have some security against interference and some resilience to nodes breaking, along with efficient data processing, long-range functionality, and the ability to transmit to host in uncontrolled environments. The system also allows the node data to become interfaceable through a web application. The complete project creates a easily integrable system for drone detection for any user.

*Drone Sensing Node
Prototype featuring a GPS
Module and Power Supply*

Astro Duck Rescue Robot and UAV



Team Members

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Alexandria Pride
Emma Ronai
Alexis Luna

Faculty Mentor

Dr. Mohammadreza Davoodi

Project Type

Internal

Client

Herff College of Engineering

Team Astro Duck

The Astro Duck Rescue Robot and UAV project addresses a simulated lunar disaster set in the year 2075, where a meteor strike has disabled communication between Earth and the moon. The primary objective is to develop a fully autonomous robotic system with a micro Unmanned Aerial Vehicle (UAV) capable of locating and rescuing “Astro-Ducks” stranded on the lunar surface. To succeed, the system must navigate a complex environment, restore power to four distinct antennas by completing physical tasks (such as button presses and crank rotations), and transmit vital color-coded data to “Earth” via infrared communication.

The design utilizes ROS 2 software for high-level task coordination and state machine logic, running on a Raspberry Pi 4 Model B. The hardware architecture features a multi-sensor suite, including LiDAR and a camera for obstacle detection and environment mapping, alongside custom-built paddle-style effectors for object manipulation. Constraints include a strict 12-inch cubic starting volume, a weight limit of 25 lbs. for the robot, and 250 grams for the UAV. The methodology emphasizes sensor fusion to correlate camera and LiDAR data, ensuring refined environmental awareness during the three-minute mission window.

Beyond the competition, this project demonstrates the integration of autonomous navigation, real-time sensor processing, and multi-agent coordination. The successful implementation provides a blueprint for small-scale search-and-rescue operations in hazardous environments where human intervention is impossible, showcasing the broader impact of autonomous robotics on disaster recovery scenarios.



Robot prototype in arena

An Autonomous Robotic System for Collecting Astro-ducks on a Lunar Rescue Mission and Re-establishing Antenna Communication with Earth



Team Members

Gabriella Heinz
Yaneli Mora
Benjamin Olzera
Haleigh Sisson

Faculty Mentor

Dr. Mohammadreza Davoodi

Project Type

Internal

Client

IEEE, Herff College of Engineering

Team: TigerTronics

The 2026 IEEE SoutheastCon Hardware Competition requires teams to design and build a fully autonomous robot that capable of completing multiple tasks based on structured competition field. The main challenge of this project is to create a reliable robotic system that can detect the official start signal, navigate accurately across the field, interact with physical mechanisms, and complete all required objectives autonomously without intervention.

The TigerTronics team designed an autonomous mecanum drive robot to allow omnidirectional movement for precise positioning and alignment during task execution. The robot is required to collect and transport astro-ducks and complete additional interaction tasks within strict size, time, and power constraints defined by competition rules. These requirements demand accurate navigation, robust sensing, and reliable mechanical interaction mechanisms.

The system uses layered control architecture. A Raspberry Pi

running Robot Operating System 2 along with a teensy 4.1 to manage high level navigation, localization, motor control coordination, and sensor integration. An Arduino microcontroller handles low level task sequencing. Robot localization is achieved using sensor fusion by combining data from inertial measurement units and wheel encoders to estimate position and orientation in real time.

A photodiode detects the official start light signal to initiate the robot. Servo motors, DC motors, and linear solenoids are used to perform mechanical interaction tasks.

The final deliverable is a fully autonomous and competition ready robotic platform capable of completing all required tasks reliably and efficiently. This project integrates embedded systems, sensor integration, control theory, and mechanical design, while providing hands-on experience in multidisciplinary robotic system development.

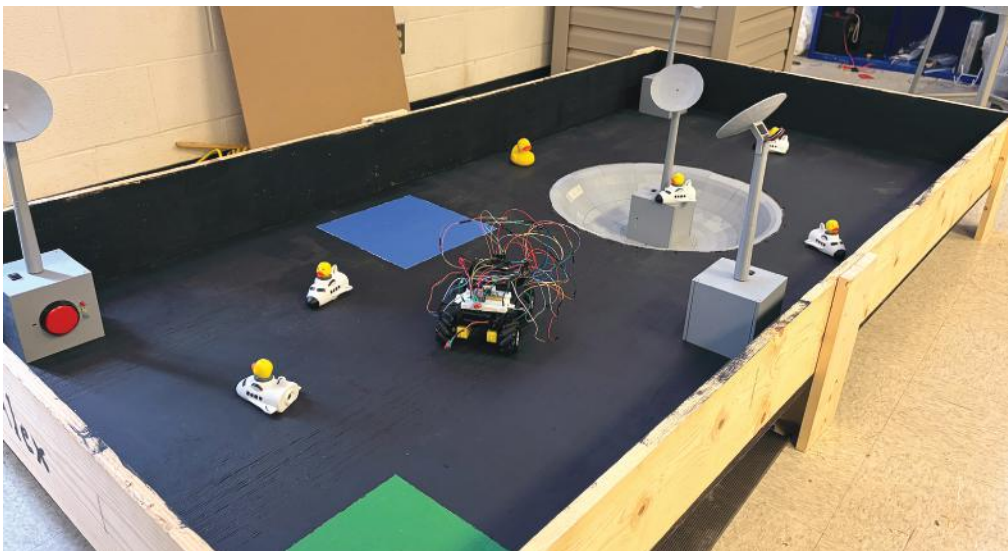
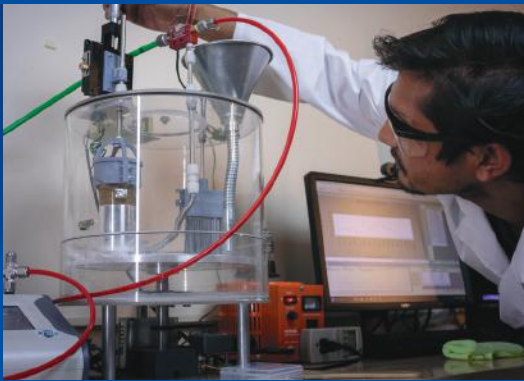
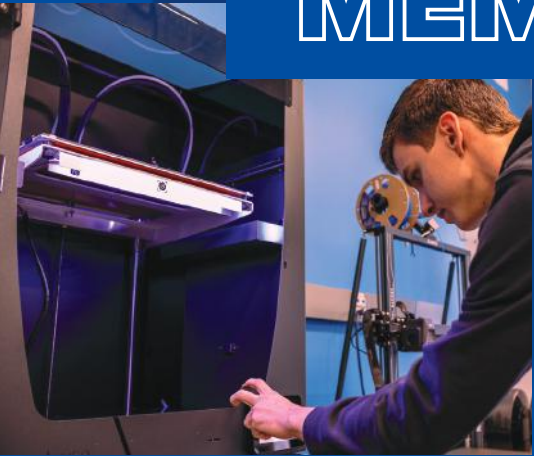


Figure: Robot on Playing Field



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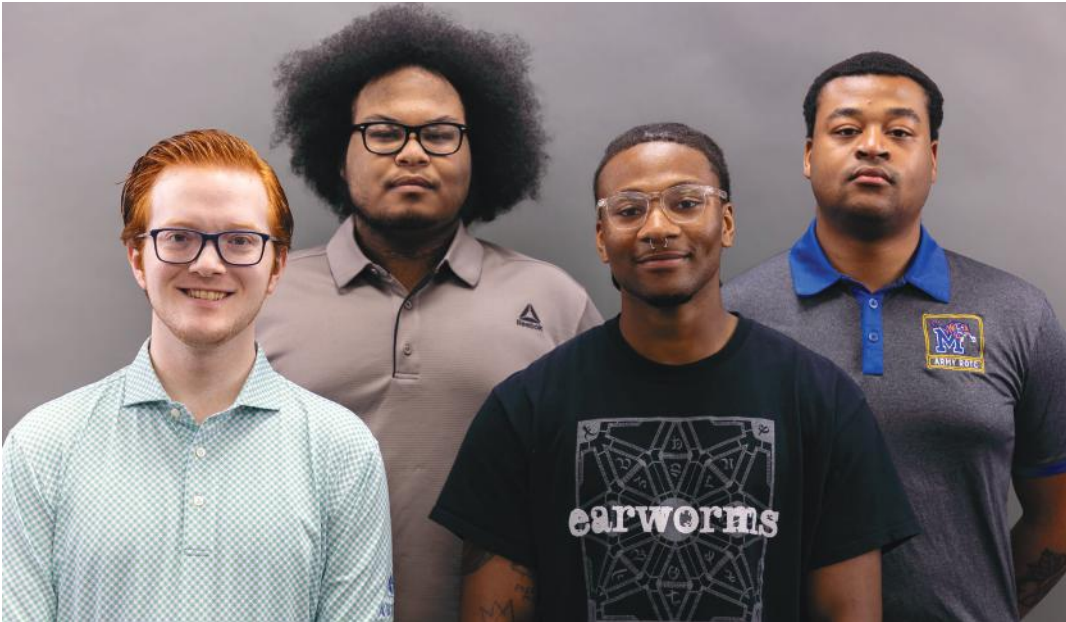
Faculty Advisor



Dr. Kevin Berisso
Associate Professor

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901.678.4300
209 Engineering Technology

Automated Greenhouse



Team Members

Harrison Neal
LaQuinton Calloway
Christian Dennis
Bryant Dixon

Faculty Mentor

Dr. Daniel E Kohn

Project Type

Internal

Client

Herff College of Engineering

Team: Automated Avengers

The Automated Greenhouse Project focuses on designing and constructing a sustainable, automated greenhouse based on clear input-output control architecture. The system continuously monitors environmental parameters such as temperature, humidity, and soil moisture using a network of sensors.

Control logic evaluates these inputs against designated values and executes automated responses. For example, ventilation is activated

when humidity exceeds acceptable levels, cooling systems engage when temperature rises above their setpoints, and irrigation cycles operate on a scheduled or condition-based basis.

This project integrates multiple engineering specialties, including microprocessor systems, manufacturing, network administration, and software development. The microcontroller-based platform interfaces with environmental sensors and controls actuators such as fans, pumps, and valves.

Enclosures are important for protecting electronic components within the greenhouse environment. Network infrastructure and IoT implementation enable secure remote access, data transmission, and system diagnostics. Embedded software manages sensor acquisition, decision-making algorithms, and actuator control, while higher-level software supports user interaction and data visualization.

The system is structured to support energy-efficient operation and integration with renewable power sources, such as solar energy. A modular hardware and software architecture allows for future expansion, including additional grow beds, enhanced sensing capabilities, and more advanced control strategies.

By combining automation, environmental sensing, and sustainable energy practices, the Automated Greenhouse Project reduces manual labor, optimizes resource usage, and maintains consistent growing conditions independent of external weather variability.

The final design demonstrates a scalable, energy-efficient model for smart agricultural systems aligned with increasing global demand for sustainable food production.

Automated Greenhouse Dashboard

Live Sensors

Temperature 25.1 °C
Humidity 56.9 %
Soil Moisture 42.0 %
Light 326 lx
CO₂ 408 ppm

Download Log (CSV) Clear Log

Automation & Controls

Ventilate
Auto: humidity > 70% OFF

Cooler
Auto: temp > 28°C OFF

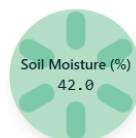
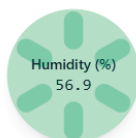
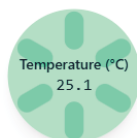
Water Pump
Auto: soil moisture < 35% OFF

Automation Thresholds

Max Temperature (°C) 28
Max Humidity (%) 70
Min Soil Moisture (%) 35

Recent Trends

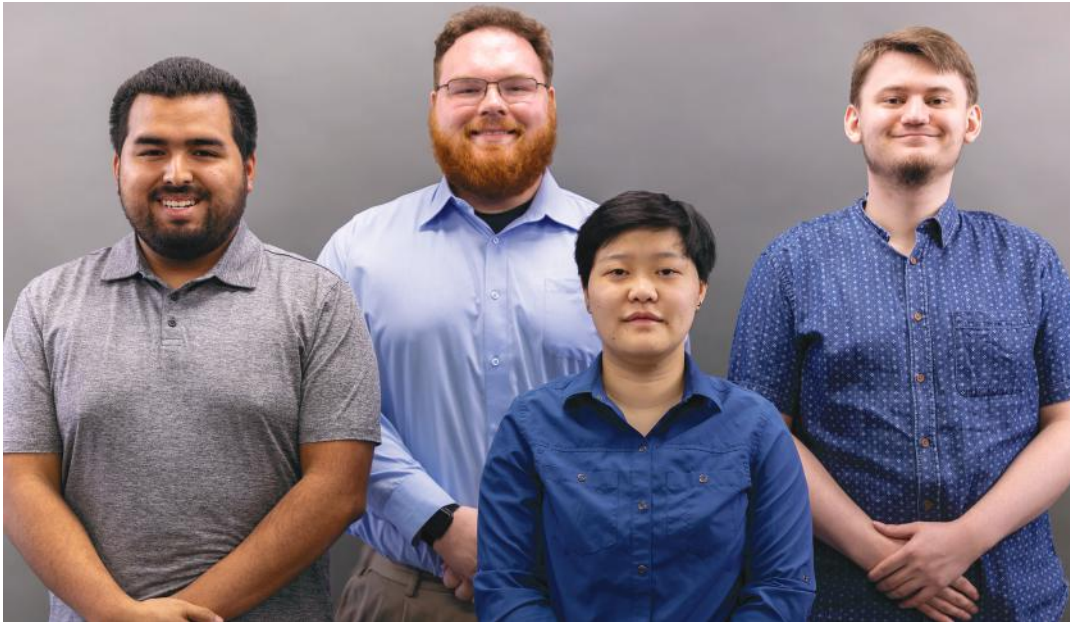
Click a flower to view the most recent sensor value



Raw Log (latest 20)

Time	T (°C)	H (%)	Soil (%)	Light	CO ₂
2/6/2026, 11:09:50 AM	25.1	56.9	42.0	326	408
2/6/2026, 11:09:46 AM	25.1	57.4	42.2	321	410
2/6/2026, 11:09:42 AM	24.9	57.2	42.4	329	407
2/6/2026, 11:09:38 AM	24.6	57.6	42.1	325	409
2/6/2026, 11:09:34 AM	24.3	58.1	42.0	320	410

Automated Memphis Zoo Catapult



Team Members

Angel Vieyra
Matthew Louks
Meilin Melson
Jonas Thomas

Faculty Mentor

Dr. Matthew Hale

Project Type

Industry-Sponsored

Client

Memphis Zoo

Team: Catapultures

This senior project addresses a need identified by the Memphis Zoo to improve efficiency while also improving the behaviors and mental welfare for their animals. Zookeepers are responsible for managing numerous enclosures across large areas and distributing treats at varied intervals to promote natural foraging, which can be time intensive.

Additionally, insufficient stimulation may contribute to undesirable behaviors. The project objective is to design a semi-automated, self-reloading catapult that can deliver food and treats at random distances and times within specified enclosures. The system is required to launch treats up to specific distances, depending on which enclosure it is assigned to, with a maximum launch of approximately 140 feet for the Grizzlies, and to launch up to eight rounds per loading cycle, with the integrated automatic feeder supplying treats in random intervals, such as one at 30 minutes, another an hour later, another in 20 minutes, and so on, for up to 8 hours to support a full shift.

Key design constraints include operator, guest, and animal safety; environmental durability and water resistance; mechanical reliability; and natural visual integration into the environment. The design will incorporate a launch mechanism via strong elastic bands, control over distances and intervals using a side panel, and an automatic loading device.

A randomized algorithm regulates launch timing and distance to help with natural food dispersion patterns for the animals. Deliverables for this project are to have a functioning scale prototype incorporating core mechanical and control elements, a fully operational automatic feeder, documented testing results, schematics and manufacturing prints, embedded control code, and comprehensive operating documentation.

The expected outcome is a durable and enriching catapult that reduces labor demands on staff while encouraging animals to explore and forage. This will help to improve operational efficiency, animal welfare through stimulation of natural behaviors, and demonstration of applied engineering technology in a real-world zoological setting.



Ryan Gore, coordinator



The heart of our Project, the autoloader. The final design will hold 8 payloads of treats and food.

Design and Development of an Automated Zoo Catapult Feeding System



Team Members

Franklin Hobbs
Javier Favors
Kerwin Dortch
Cedric Bonds

Faculty Mentor

Matthew Hale

Project Type

Industry-Sponsored

Client

Memphis Zoo

Team: Zoo Crew

Zoological facilities require safe, efficient, and enriching feeding methods for the animals that reduce manual labor while maintaining controlled food distribution. Current feeding approaches are often labor-intensive, limited in range variability, and dependent on direct human operation.

This project addresses the need for an automated system capable of delivering feed to programmable and randomized distances in a controlled, repeatable, and safe manner. The objective is to design and develop a fully automated electromechanical catapult system that launches feed portions to calculated distances without manual control.

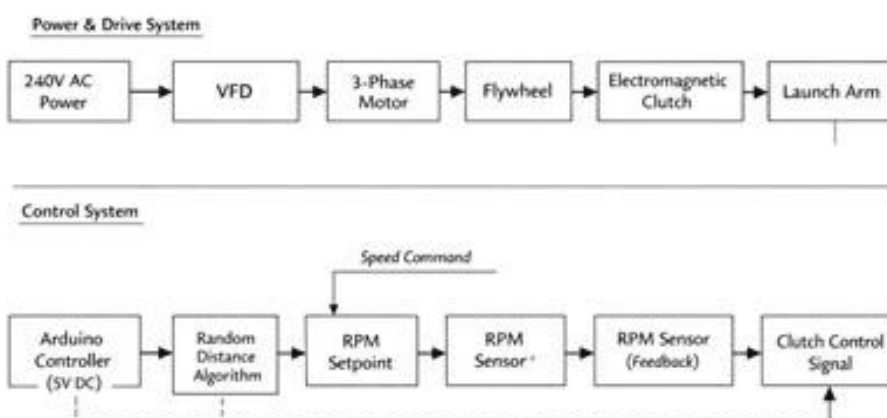
Key constraints include mechanical safety, launch consistency, controlled projectile range, structural durability under cyclic loading, electrical reliability, and cost effectiveness. The design integrates

mechanical energy storage with closed-loop electronic control.

A flywheel-driven launch mechanism powered by a three-phase induction motor is regulated by a Variable Frequency Drive (VFD) for precise speed control. An Arduino-based controller calculates a randomized target distance, determines the required rotational speed in revolutions per minute (RPM), monitors real-time feedback, and activates an electromagnetic clutch at the programmed release condition.

Deliverables include a functional automated prototype, validated launch testing data, safety documentation, complete schematics, and a Bill of Materials. The broader impact demonstrates scalable automation principles applicable to animal enrichment systems and controlled material-launching applications.

Figure 1. Automated Zoo Catapult Feeder System Block Diagram



Automated Zoo Catapult Feeder block diagram showing power and control architecture.

Prototype-based Catapult



Team Members

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Corterreus Bedford
Stephanie Beloria
Joshua Springer

Faculty Mentor

Matthew Hale

Project Type

Industry-Sponsored

Client

Memphis Zoo

Team: Safari Slings

The Memphis Zoo Elephant Care Team currently relies on manual feeding methods that require physical effort and limit varied food placement within the enclosure. Predictable feeding patterns can reduce enrichment, and manual placement increase staff workload. This project aims to design and build an automated catapult system that safely and accurately launches food over controlled distances to improve feeding efficiency, enhance enrichment, and reduce physical strain on zookeepers.

The device consists of a wooden-frame catapult powered by four or six 12-volt direct current motors. An Arduino Mega microcontroller is used to coordinate motor operation through motor controllers, enabling controlled arm rotation, tensioning, and release. The structure and mechanical components are designed using CAD to ensure proper alignment, strength, and repeatable motion before fabrication. Wokwi and Tinkercad were used in designing and testing the circuit with software code. The design constraints include safety, structural stability, controlled launch angles, repeated mechanical loading, and suitability for outdoor use.

The methodology includes computer-aided modeling, mechanical construction, electrical integration of motors and control hardware, and embedded programming to automate the launch sequence. Repeated testing is conducted to refine angle control, tension consistency, and launch accuracy.

The deliverables include the capability of launching up to 150 ft along with various angles, a safety and user manual, and randomized automated feeding. This project demonstrates the integration of mechanical systems, motor control, and embedded electronics to address the Elephant Care Team's issue.



Ryan Gore, coordinator



3D CAD design of the automated elephant feeding catapult mechanism

Baptist Hospital Improvement Project



Team Members

Shwki Altwalah
Kaleb Peterson
Mario Arrendondo
Nathan Cotton

Faculty Mentor

Rajesh Balasubramanian

Project Type

Industry-Sponsored

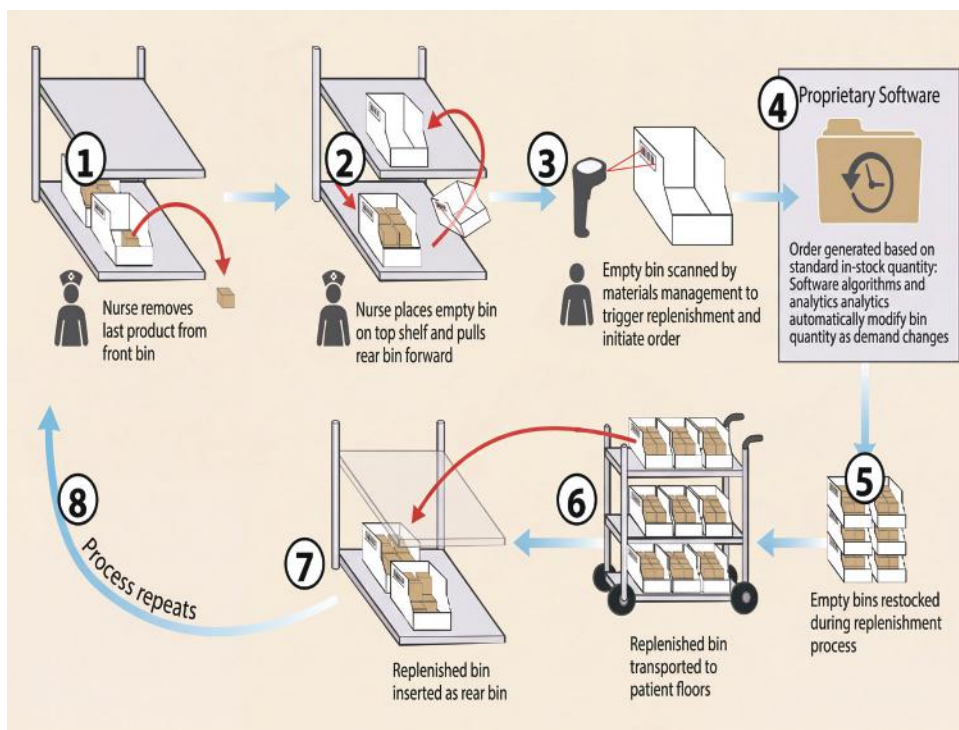
Client

Jared Moses,
Baptist Memorial Hospital-
Memphis

Reducing expired medical supplies on the 2 West unit at Baptist Hospital was the primary goal of this project. Inefficient inventory management practices, limited supply visibility, and inconsistent restocking procedures contributed to supplies expiring before use. The unit also lacked a clearly defined process for managing empty supply bins, which created uncertainty around replenishment responsibilities. As a result, nurses frequently traveled to the Central Supply Room (CSR) to retrieve supplies that were unavailable on the unit. These reactive supply requests generated a high number of CSR checkout transactions

and indicated poor inventory control within the 2 West supply room.

CSR checkout transactions were used as the measurable performance indicator because frequent supply retrieval from the CSR reflected inefficiencies in unit-level inventory management and contributed to supply waste. A current-state assessment was conducted to evaluate workflow gaps, storage layout, space utilization, and replenishment behavior within the 2 West supply room. Lean workplace organization principles were applied to redesign the supply layout and improve visibility and accessibility of inventory. A two-bin replenishment system



was introduced to establish a structured method for maintaining supply levels and improving product rotation.

The redesigned process includes an empty-bin scanning procedure that automatically triggers a replenishment request when the first bin becomes empty. Central Supply Room staff then restock the supply and deliver it directly to the unit, creating a continuous pull-based inventory cycle. Key deliverables include a future-state layout, a standardized replenishment workflow, measurable performance metrics, and a sustainability framework to maintain the system. By improving supply management on the highest-impact unit, the project reduces expired inventory, decreases unnecessary CSR visits, and establishes a scalable improvement model that can be applied across additional hospital units.

Two-bin replenishment process showing nurse-triggered empty bin scan, automated order generation, CSR restocking, floor delivery, and continuous pull-based inventory control cycle.

Mobile Robot



Team Members

Tyler Willingham
Jack Cole
Corbyn Carlyon
Emmanuel Barrera

Faculty Mentor

Dr. Kevin Berisso

Project Type

Internal

Client

Herff College of
Engineering

Team: Pathfinders

This senior design project addresses the need for safer and more efficient material handling within machine shop environments, where operators frequently transport heavy components across confined and obstacle dense workspaces.

The team developed a mobile robotic platform capable of transporting a 100-pound payload using a wireless Bluetooth control system. The objective was to create a reproducible, robust, and maneuverable solution that reduces operator fatigue, improves workflow efficiency, and enhances overall shop safety.

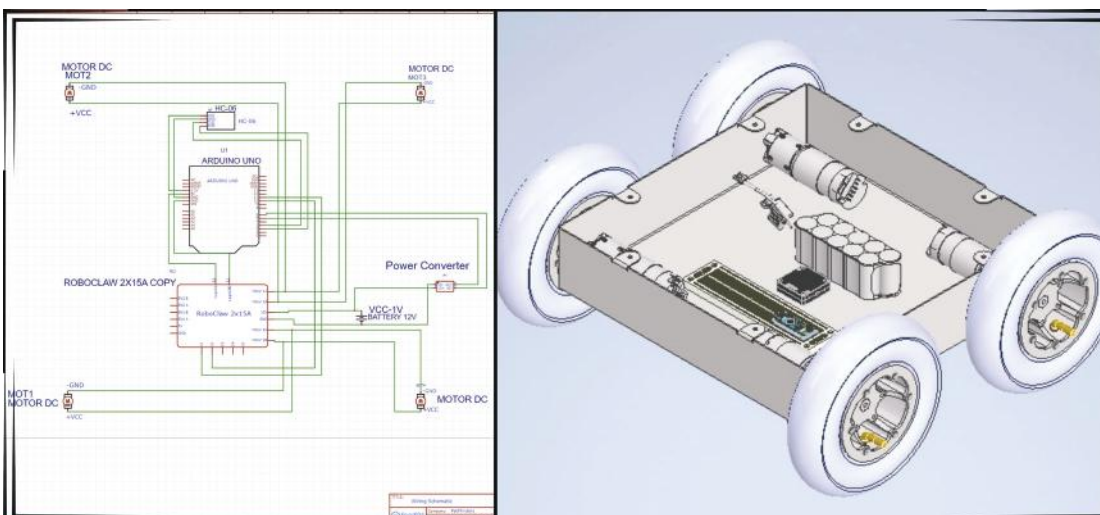
The design approach integrated mechanical, electrical, and control subsystems into a cohesive platform. The sheet metal chassis with a shoe box style frame was selected to provide structural rigidity, effective load distribution, and stable bearing alignment under both static and dynamic loading.

The robot utilized four heavy duty pneumatic wheels to improve traction and vibration damping on typical shop flooring. The drivetrain

incorporated flanged ball bearings to minimize frictional losses and support the rotating shaft under load. The electrical system included a rechargeable battery, power conversion hardware, a motor controller, and an Arduino based control architecture paired with a Bluetooth module. Custom control logic enabled zero turn capability and variable speed operation to achieve precise maneuverability in tight spaces.

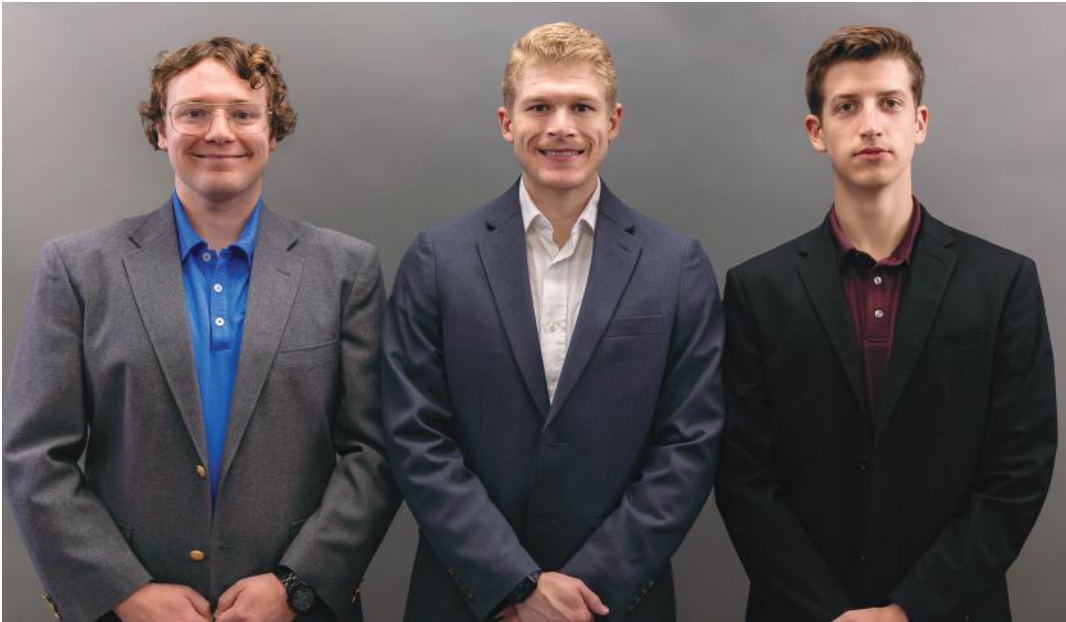
Key deliverables included the fully functional robotic platform, detailed mechanical models, engineering drawings, electrical schematics, and embedded control software. Performance testing validated the robot's ability to safely transport the specified payload while maintaining stability, responsiveness, and operational reliability.

The resulting system demonstrates a practical and scalable approach to improving material transport in machine shops and similar industrial settings, offering potential benefits in ergonomics, productivity, and workplace safety.



Assembled robot design alongside its detailed electrical schematic, highlighting the seamless integration of mechanical structure, wiring architecture, and control systems powering reliable, intelligent operation.

Project Aqua Bot



Team Members

Cooper Werth
Dylan Haas
Owen Cook

Faculty Mentor

Matthew Hale

Project Type

Industry-Sponsored

Client

Memphis Zoo

Team: Aqua Bot

Underwater welding is a critical operation for maintaining global marine infrastructure, yet it remains one of the most hazardous civilian engineering professions. Human divers face life-threatening risks, including extreme hydrostatic pressure, nitrogen narcosis, and electric shock, alongside the high logistical costs of specialized life-support systems.

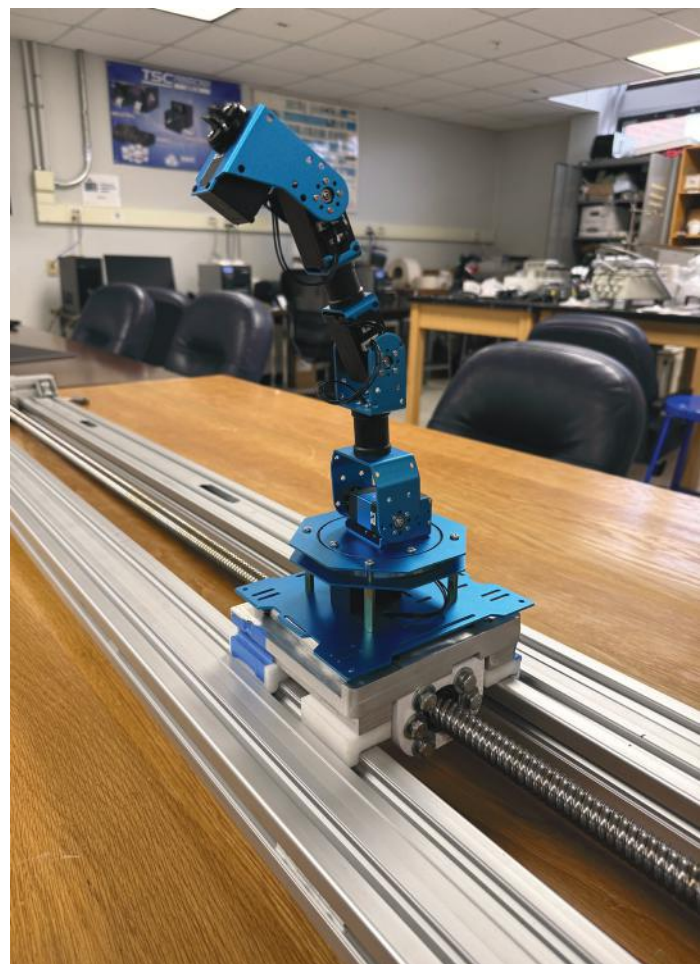
To address these safety and financial challenges, Project Aqua Bot involved the development of a Remotely Operated Vehicle designed to perform simulated underwater welding tasks, effectively removing human operators from the immediate subaquatic hazard zone. The primary objective was to create a functional prototype that demonstrates the maneuverability, stability, and control required for robotic intervention in marine environments.

The design methodology focused on the integration of several engineering subsystems. This included a custom-built waterproof chassis and a multi-axis robotic arm specifically engineered for path precision. An Arduino-based control system was utilized to manage system mobility, while an onboard camera provided a real-time visual interface for the operator to carry out tasks from a safe distance.

Key deliverables for the project include the functional robotic prototype, a debris-resistant controller housing, the underlying Arduino software code, and comprehensive technical documentation consisting of Computer-Aided Design prints, sketches, and electronic schematics.

Several project constraints were identified during the development process. Due to the scope of a senior design proof-of-concept, the prototype was designed strictly for path simulation and did not possess the high-voltage power systems required for live arc welding.

Furthermore, the operational range was restricted by a physical communication tether, and the design was optimized for controlled aquatic conditions rather than high-current open-water environments. Ultimately, Project Aqua Bot successfully demonstrates the broader impact of utilizing robotic systems to mitigate the extreme risks and costs associated with traditional underwater maintenance.



Project Aqua Bot Assembly

Stripes and Pipes



Team Members

Albert Stanley
Brandon Rodriguez
Donovan Moore
Angelica Martinez

Faculty Mentor

Dr. Kevin Berisso

Project Type

Industry-Sponsored

Client

ABB

*in conjunction with
Precision Painters*

The Pipes and Stripes/ABB Pipe Sprayer Project aims to address the current inefficiencies and inconsistencies present in the manual internal coating of industrial piping for ABB. The current process requires manual operation of the paint sprayer and pipe bed, resulting in uneven coating thickness and prolonged production times. To solve these issues, this project focuses on the development of an autonomous CNC gantry system designed to automate the spraying process for various pipe sizes and layouts.

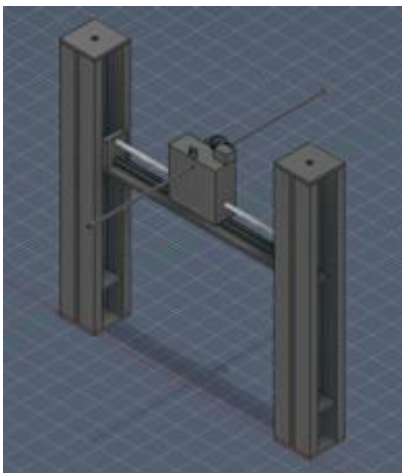
The primary objective is to implement a synchronized motion system akin to a CNC system that utilizes an industrial arm equipped with a specialized paint nozzle and an advanced industrial machine vision solution for pipe detection. This system is engineered to maintain a constant distance from the internal pipe surface while a pressurized delivery system ensures a consistent flow rate of coating material.

Key deliverables include functional CNC gantry, custom-coded PLC routines for path execution, and specialized End-of-Arm Tooling (EOAT)

capable of accommodating varying pipe diameters. Additionally, a Human Machine Interface (HMI) allows operators to input specific pipe parameters using an industrial machine vision solution and initiate the spray cycle autonomously.

By integrating precision motion control with specialized hardware, the system aims to significantly increase production output and accuracy. The process focuses on replacing manual pipe painting with a reliable, automated routine that ensures a uniform, high-quality finish in line with ABB, and industry standards for corrosion resistance.

The broader impact of this project is the achievement of a repeatable and efficient methodology for industrial applications, reducing manual labor while enhancing the production and reliability of coated piping systems. Ultimately, this solution provides a good framework for automating complex industrial painting tasks that currently rely on human operation.



Shows the CAD file of our main frame; systems will have motors on each axis, and the camera is mounted on top of the box.

Order Location and Warehouse Efficiency Improvement Project



Team Members

Toni Thomas
Anjelica Evans
Kaylin Hunter
Jayden Moody (not pictured)

Faculty Mentor

Dr. Kevin Berisso

Project Type

Internal

Client

Herff College of Engineering

Team: TJX RFID

Warehouse order retrieval processes often relied on manual verification methods that were time-consuming, inconsistent, and prone to human error. These inefficiencies created delays and limited visibility into order completion status. This project addressed these challenges through the development of an RFID-based order retrieval and tracking system designed to improve operational efficiency while reducing non-value-added search time.

The objective of the project was to design and implement an integrated hardware and software solution that enabled accurate box identification, real-time status updates, and centralized order tracking. The system incorporated RFID-tagged boxes, a Bluebird handheld scanner, a mobile application developed using .NET Multi-platform App UI (MAUI), a desktop management interface built in WinForms, and

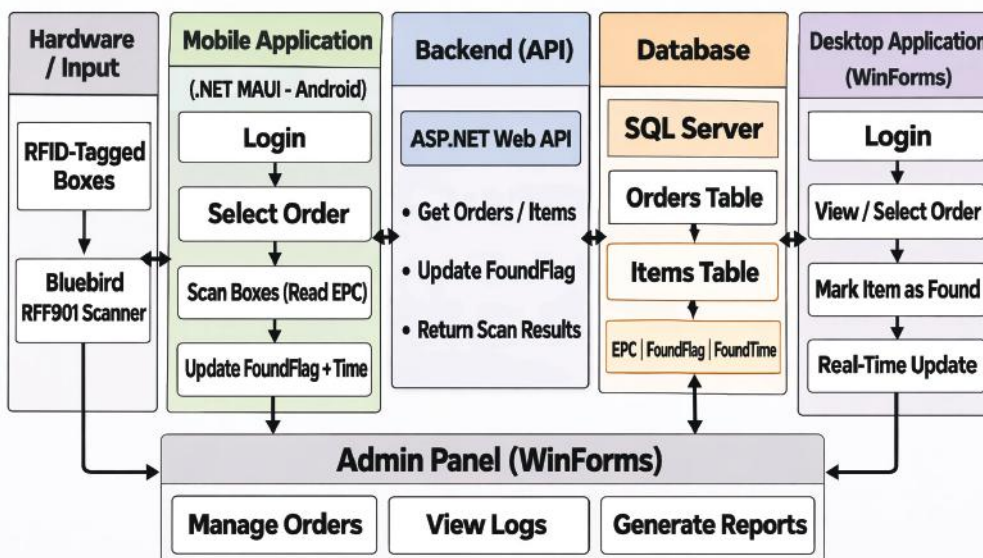
a backend ASP.NET Web API connected to a Microsoft SQL Server database. Each box was linked to a unique order identifier, and scanned Electronic Product Code (EPC) values were transmitted through the API to update item status fields and timestamps in real time. The software components were developed using a modular architecture so that mobile application, backend API, database and desktop interface functioned as connected but independent parts of the system. The ASP.NET Web API followed REST-based design principles, while the SQL Server database stored box identifiers, EPC values, and order tracking information use by both applications.

The design approach followed lean engineering principles by focusing on waste reduction, process visibility, and measurable performance improvement. A baseline time study of the manual retrieval process

was conducted and compared to RFID-assisted retrieval performance to quantify system impact. Key deliverables included a structured relational database, a functional web API, mobile and desktop applications, and a validated performance comparison between manual and automated workflows. This project demonstrated how integrated RFID technology and lean-oriented system design enhanced accuracy, reduced retrieval time, and improved data driven decision making in warehouse environments.

This diagram lays out the design and connectivity of the developed software system

(SQL Server + ASP.NET API + WinForms + .NET MAUI Android)



Mechanical ENGINEERING

Faculty Advisor



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Ultrasonically Enhanced Vacuum with Transducer Assisted Cleaning



Team Members

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Jaden Palmer

Faculty Mentor

Dr. Ranganathan
Gopalakrishnan & Dr.
Piyush

Project Type

Internal

Client

Herff College of
Engineering

Team: Dust Busters

Current cleaning methods for microscopic dust and particles in industrial sectors are limited by current vacuum technology, creating a need for a more efficient cleaning solution. Using just a vacuum alone, finer dust particles are left behind or stuck that can later cause issues, defects, or contaminants in finished products, like computer chips.

This project introduces an innovative design system aimed to increase cleaning efficiency and reduce cleaning time in industrial vacuum technology by utilizing ultrasonic transducers on hard surfaces, such as industrial flooring and worktables.

Complying with safety and electrical standards as well as avoiding excess noise, heat, and vibrations that would otherwise cause the transducer device to not function properly, the team aims to incorporate these features into the prototype.

The team also took a research and experimental based design approach to the problem that led to the following conclusions: the

transducer(s) must be within a limited range of the hard surface to function properly and create a standing wave that travels and reflects off the surface to create a levitating effect on the stuck particles and the materials used in the prototype must allow the standing wave to travel through undampened, or uninterrupted.

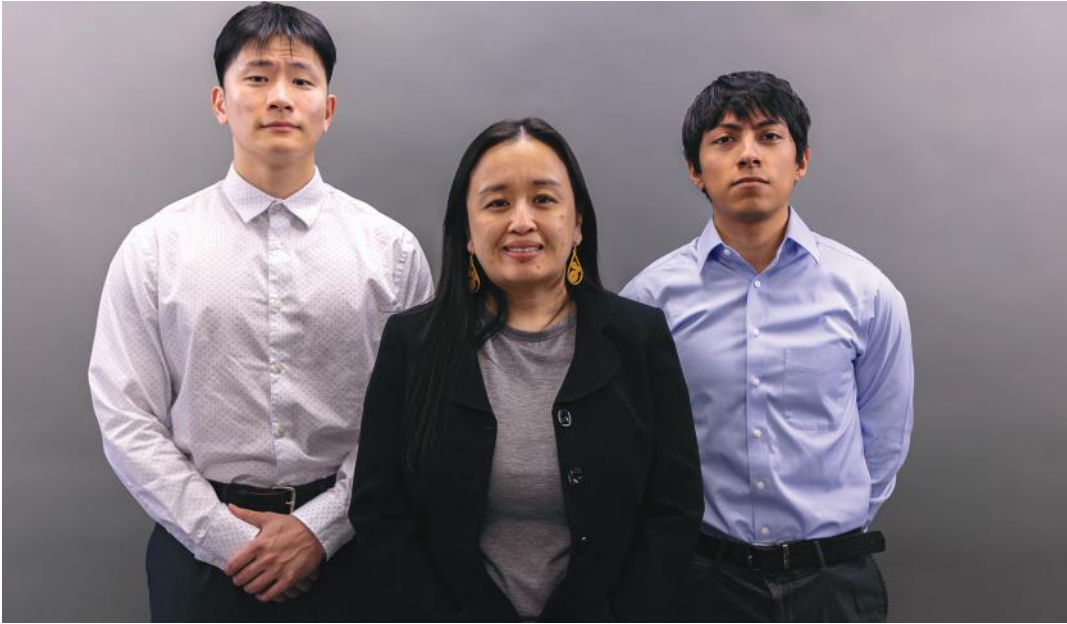
Through experimentation in the P3ARL Lab, the team aims to quantify the data to validate the improvement of the transducer-vacuum prototype over a vacuum alone. This cleaning system can be integrated in many industrial applications such as in manufacturing, semiconductor, and computer chip machining rooms, or other cleanrooms.

Along with reducing cleaning time, defects, and harmful contaminants, the project also increases overall safety in the listed work environments by reducing the number of contaminants in the air, on the floor, and other work surfaces.



Figure 1: Experimental Setup with Variable Voltage Regulator, Step Up & Down Transformer, and Circuit Board with Transducer Connected (pictured left to right)

2025-2026 AIAA Design, Build, Fly



Team Members

Xiaofeng Tan
MyHanh Lee
Bryan Mendoza
Callie Brigance (not pictured)

Faculty Mentor

Dr. Jeffrey Marchetta
Dr. Daniel Foti

Project Type

Internal

Client

American Institute of Aeronautics and Astronautics (AIAA)

Team: Flaps and Furious

The 2025-2026 Design, Build, Fly (DBF) competition objective is to design, build, and test an electric-powered, remote-controlled bush plane capable of performing charter missions and towing a deployable banner. The aircraft must complete three missions, each mission requiring the plane to fly three laps within five minutes: Mission I without payload, Mission II transporting at least three passengers and one cargo, and Mission III remotely deploying a banner.

The passengers are standard size 2.3-inch rubber ducks, and each piece of cargo is a standard hockey puck. The constraints for the aircraft consist of a maximum wingspan of five feet and a fuselage containing at least one passenger compartment and one cargo compartment.

The final design selected optimizes mission performance and features a high wing, single tractor propulsion system, conventional tail, and a tail dragger landing gear. These choices were driven by the objectives of the DBF missions as well as practical considerations including cost, availability of components, efficiency, stability, and manufacturability.

This design configuration formed a baseline for the team's aircraft design for further iterations.

During the transition from the preliminary design to the detailed design, the team determined key challenges that drove design modifications. The first iteration involved a material selection change for the airfoil ribs.

Material sourcing constraints and limited access to a CNC machine represented the first challenge the team encountered. The team transitioned from balsa wood to polylactic acid (PLA) based on structural, manufacturing, and consistency of tradeoffs. Following the change, the team focused on optimizing the ribs for the airfoil.

In the final iteration, additional lightening holes and cuts were added to accommodate the spars including the leading spar edge. The design evolved from its preliminary configuration into a more structurally sound, manufacturable, and enhanced solution through team-selected iterations.



Figure 1: Airfoil Rib and Fuselage Attachment

Tiger BAJA Frame and Cockpit Integration



Team Members

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Christopher Cicalla
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Jayce Fiene

Faculty Mentor

Dr. Kazi Mahmud Mirza

Project Type

Industry Sponsored

Client

Tiger BAJA, SAE BAJA
competition

Team: Frame Job

The Tiger Baja 2026 Primary Frame and Cockpit Integration project focuses on rebuilding a competitive and technically compliant Baja SAE vehicle platform for the University of Memphis. After a period of limited team continuity, the primary goal is to design and fabricate a race-ready frame that meets all Baja SAE safety and technical inspection requirements while allowing successful integration of suspension, steering, powertrain, and safety systems. The project must be completed within a \$2,500 budget by a four-member team, making cost control, manufacturability, and practical decision-making central to the design process.

The frame is constructed from ASTM A513 Type 5 1020 DOM steel tubing (1.5-inch outer diameter with 0.095-inch wall thickness). While the original intent was to optimize stiffness-to-weight ratio, material selection was ultimately guided by sponsor availability and timeline constraints. As a result, the team prioritized developing a structurally sound and

manufacturable design that could reliably compete rather than pursuing full structural optimization. The entire frame was modeled in Autodesk Inventor based directly on Baja SAE rule requirements for tube sizing, safety zones, and required clearances. Although outsourcing fabrication was possible, the team chose to manufacture the frame completely in-house using metal inert gas welding to gain hands-on experience, maintain control over quality, and increase competition scoring potential. Validation efforts focus on dimensional compliance, yield-strength-based calculations, and complete inspection documentation.

The final deliverable is a fully integrated, competition-ready primary frame that restores operational momentum to the Tiger Baja program. In addition to competition performance, the project provides valuable student exposure to automotive design, fabrication practices, sponsor collaboration, and national engineering competition, helping strengthen both technical skills and professional development.

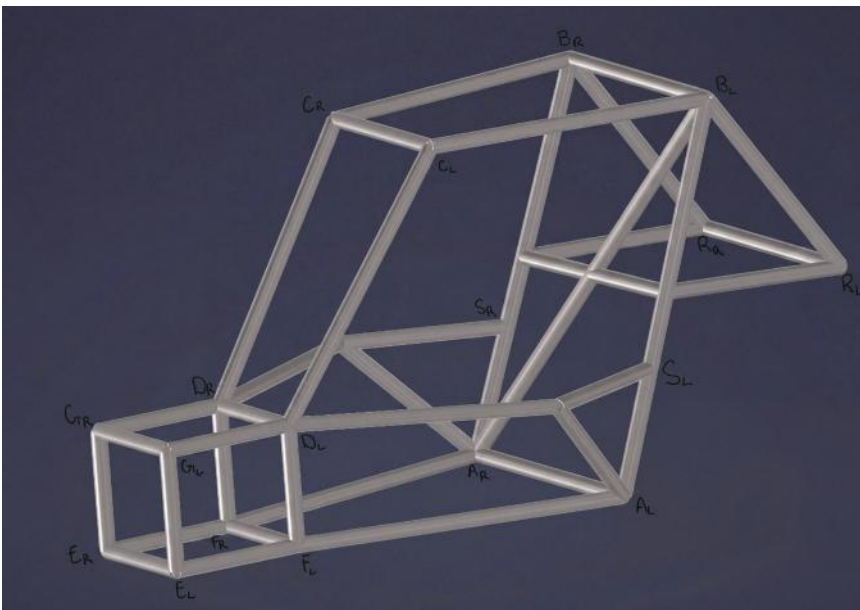
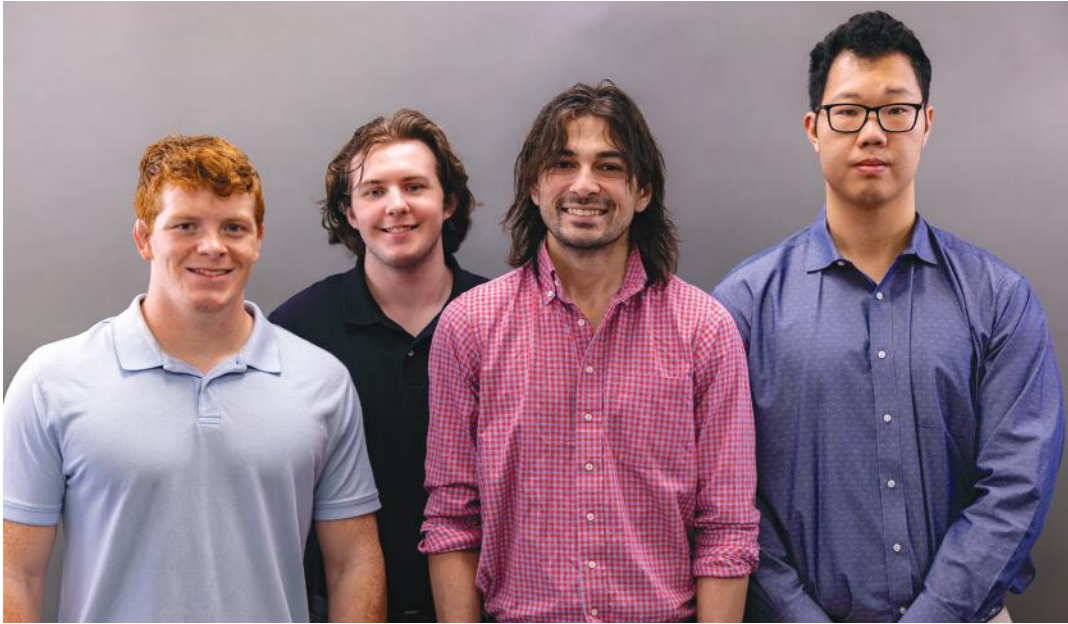


Figure: 2026 Tiger Baja Primary Frame and Cockpit Structure.

Strand Tank Cooling System



Team Members

Luke Krepela
Tyler Owens
Stephen Johnston
Denny Jun

Faculty Mentor

Dr. Yuan Gao
Dr. Alexander Headley

Project Type

Industry Sponsored

Client

Stephen Doorley, RAPAC

Team Frostbite Fabricators

RAPAC, the largest polystyrene recycling company in the United States, operates an industrial production line composed of shredders, compactors, densifiers, extruders, and pelletizers that generate substantial thermal energy during continuous operation.

Effective cooling is required to maintain safe operating temperatures, protect equipment, and sustain production efficiency. RAPAC currently relies on empirically selected chiller setpoints, which may result in excessive energy consumption and higher operational costs.

This project aims to replace empirical operation with an analytical, data-driven approach to optimize coolant temperatures and overall chiller performance. The engineering objective is to model heat transfer across the production line and determine the true thermal load of each major component.

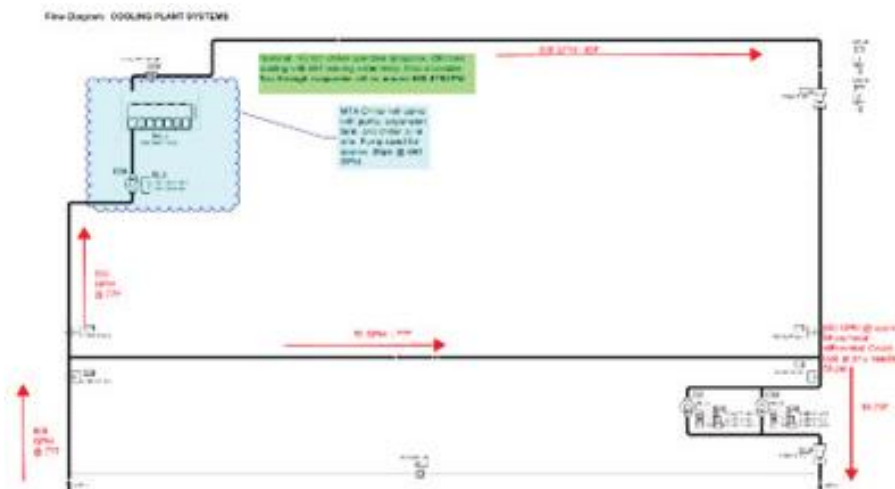
The team will develop a comprehensive map of the chilled and cooling water distribution network and document the heat transfer mechanisms associated with each machine. Required water temperatures, volumetric flow rates, and resulting cooling tonnage

will be calculated using measured system data and fundamental thermodynamic principles.

Central to the analysis is the heat transfer relationship ($Q=m \cdot c\Delta T$), which connects mass flow rate, specific heat capacity, and temperature change to quantify heat rejection. A custom software tool will be developed to automate this analysis and translate field measurements into actionable engineering outputs.

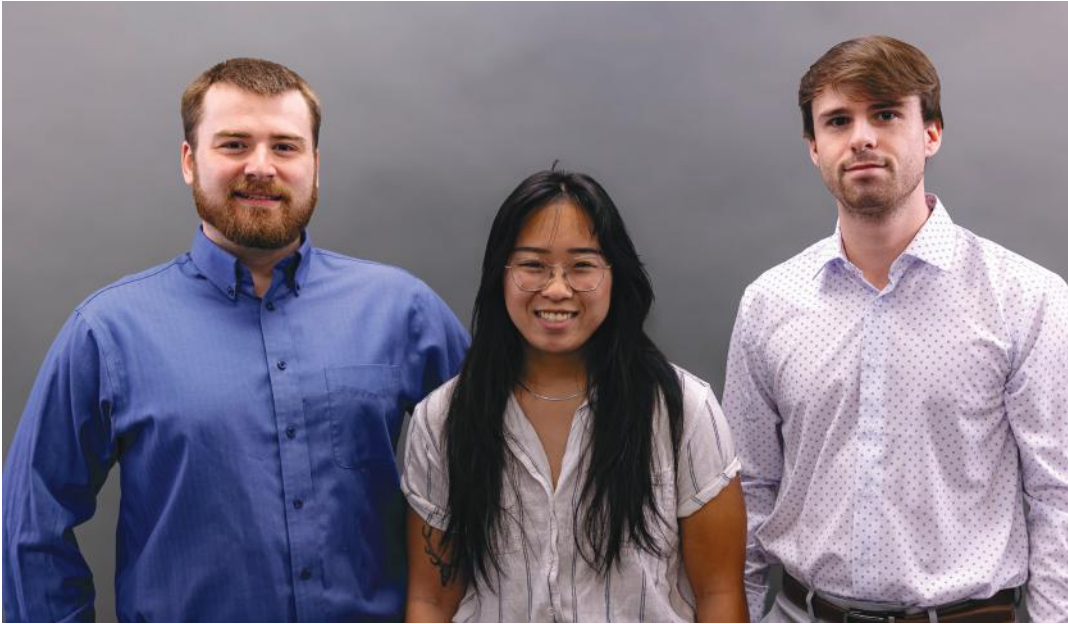
The application will estimate equipment heat loads, predict total chiller demand, and recommend optimized coolant operating conditions. This tool provides RAPAC with a repeatable framework for evaluating system performance under varying production scenarios.

By enabling analytical control of cooling parameters, the project supports energy conservation, reduces operating expenses, and enhances long-term system reliability. The resulting methodology establishes a scalable foundation for future process optimization and demonstrates how thermal modeling and software integration can improve industrial energy management in recycling operations.



Cooling plant layout supporting RAPAC process optimization, detailing chiller capacity, flow rates, and thermal balance for improved chilled water efficiency and production reliability.

Johnny A. Seed



Team Members

Cameron Tingly
Betsy Nations
Ayden Ashwill

Faculty Mentor

Dr. Vipin Agarwal
Dr. Mohammadreza Davoodi

Project Type

Internal

Client

Herff College of Engineering

G.O.A.T.

The agricultural industry is faced with increased pressure to improve production efficiency as the global demand for food increases year by year. Plug seedling transplanting, a vital form of vegetable production, remains dependent on manual labor, requiring hundreds of labor hours per hectare and high production costs. To combat this growing challenge, this project develops Johnny A. Seed, an integrated electromechanical system that aims in automating seedling transplanting to reduce labor intensity while improving consistency, efficiency, and accessibility for small to mid-range farming operations.

The primary mission of this project is to design an autonomous planting system capable of reliably transplanting seedlings from tray into the soil while also performing the processes of tamping and backfilling the seedling to ensure maximum production efficiency. The project's key constraints are the budget of ~\$750, ensuring compatibility with common tray sizes, and generating enough mechanical force and accuracy to penetrate and tamp tilled soil. The engineering approach

combines the use of a gantry-based system, a stem gripper mechanism, and a custom two-stage planting system designed to form the cavity, insert the seedling, and perform soil back-filling and tamping. Structural analyses, soil-resistance calculations, and iterative prototyping guide component selection and mechanical design decisions.

The expected deliverables for this project include a fully integrated prototype comprised of a gantry transport system, a gripper assembly, planting system, UGV mounting platform, and preliminary control architecture. Planned testing will quantify insertion forces, validate gripper reliability, and assess the planting consistency of the planting system. When completed, the system aims at reducing labor requirements and costs, increasing the planting output, and providing a foundation for the future of autonomous field robotic applications. This project is just a small contribution to the ongoing efforts to automate high-labor agricultural tasks, supporting more sustainable and efficient crop production.



3D model of planting system attached to unmanned ground vehicle (UGV)

A Novel Design of a Bone Screwdriver for Use in Internal Fixation of Long Bone Fractures



Team Members

Jackson Harris
Benjamin Cerniglia
Michael Rose
Christian Davis

Faculty Mentor

Dr. Gladius Lewis

Project Type

Internal

Client

Herff College of Engineering

Team: Heal Team 6

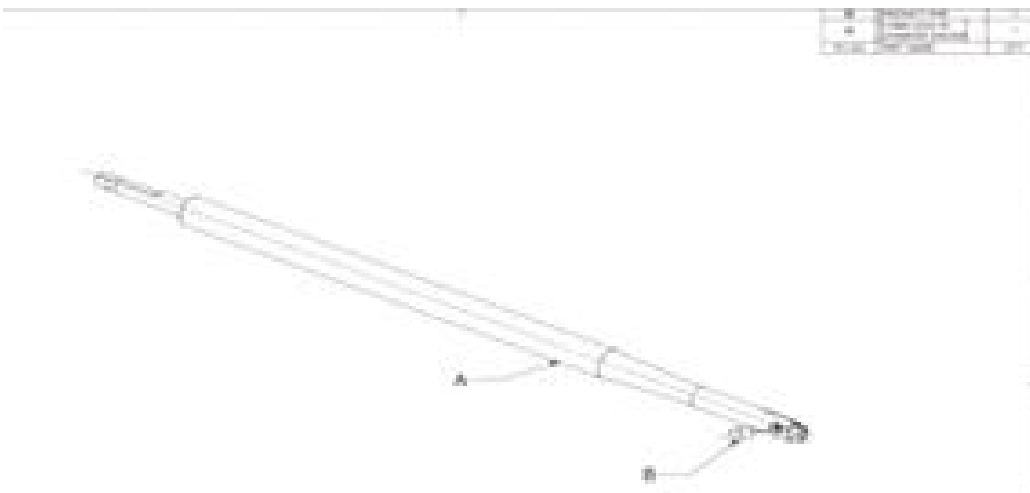
Fractures of long bones such as the femur and tibia are commonly treated using open reduction and internal fixation with fracture plating. In this procedure, a metal plate is positioned across the fracture site and secured with screws to stabilize the bone and promote proper healing. Although effective, currently available surgical screwdrivers do not consistently retain screws during pickup and insertion, which can increase operative time and reduce procedural efficiency.

HEAL Team 6 seeks to design and fabricate an improved surgical screwdriver that enhances screw engagement and placement while maintaining compatibility with existing orthopedic systems. The primary objective is to develop a device that securely captures standard fracture screws and allows controlled release during implantation. Key constraints include sterilization compatibility, durability under repeated autoclave cycles, ergonomic handling, manufacturability, and mechanical reliability. Our driver should also be compatible with the

existing medical handles along with a power drill. That way, it is easily transferable and will save time in the operation room.

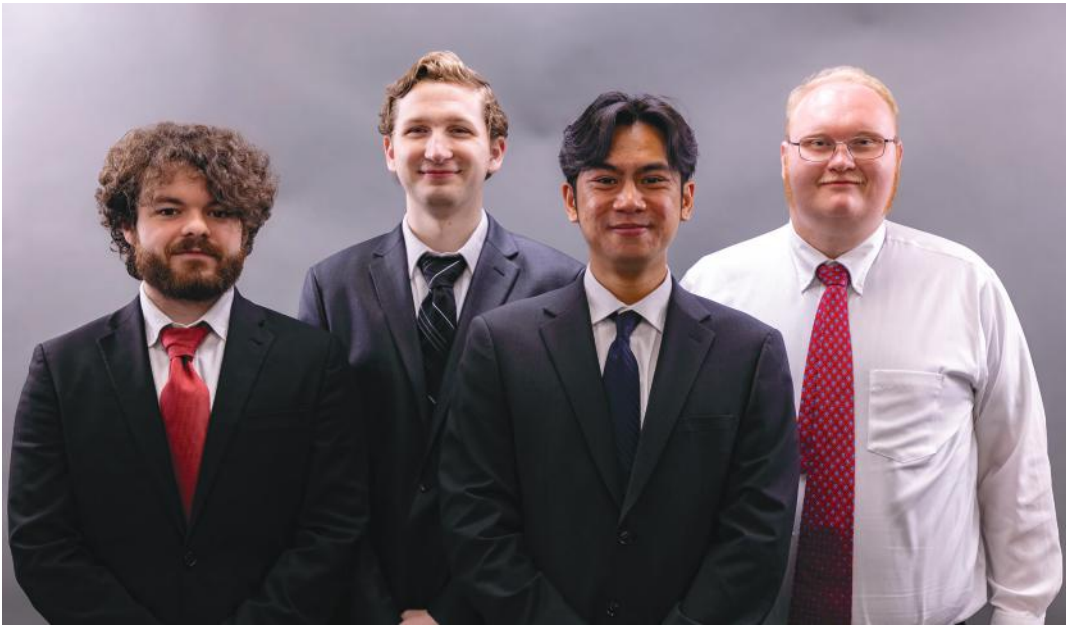
The final design incorporates a lead-in chamfer at the distal tip to guide the screw head into alignment, a longitudinal slit to provide controlled radial compliance during engagement, and a press-fit retention pin to improve mechanical capture. Computer-aided modeling was used to optimize geometry and tolerances, and prototype testing evaluated screw retention strength, alignment accuracy, and ease of use under simulated surgical conditions.

The project deliverables include a functional prototype, engineering drawings, and validation data. By improving screw handling reliability, the device has the potential to reduce operative time, enhance surgical precision, and improve workflow efficiency in orthopedic fracture fixation procedures.



CAD design of Lead in Chamfer drive with a press fit pin for stability

Design & Build Multi-Door Sliding Testing Apparatus



Team Members

Caleb Edwards
Cody Chamberlain
Dylan Dinh
Joseph Perry

Faculty Mentor

Dr. Seyed Hojjatzadeh

Project Type

Industry-Sponsored

Client

Jackie Carter,
PEMKO/ASSA ABLOY

Team: High Clearance Doormen

PEMKO/ASSA ABLOY is a sliding and folding door hardware company based in Memphis, TN. Their products are extensively tested to ensure quality and safety before they reach consumers. PEMKO inspects their sliding doors with various tests that simulate real-world applications. These tests must adhere to the standards set by the American National Standards Institute (ANSI) and the Builders Hardware Manufacturers Association (BHMA). Currently, the client's testing process is limited to one sliding door at a time, which is a significant hinderance, considering that these tests can take several days to complete.

To address this challenge, PEMKO has tasked the senior design team with developing a sliding hardware testing apparatus capable of testing two doors simultaneously. The new proposed system must uphold the same rigorous testing standards while enabling smooth transitions

between various sliding hardware styles in PEMKO's product line. The system is required to be enclosed in a robust safety cage equipped with sensors, electronic stops, and other safety features. The design will be optimized to occupy minimal facility space, reducing its footprint without compromising functionality and performance. The testing process will require little employee involvement once the sliding doors are mounted and the safety cage is closed. The senior design team proposes that the system is propelled by a power screw mechanism, which offers improved performance, reduced maintenance, and finer position accuracy compared to the previously used chain-driven system. The assembly will significantly improve testing efficiency and minimize maintenance needs, providing PEMKO with a durable, long-term solution that streamlines their operations.



CAD model of apparatus as of February 2026

Universal Pump Test Stand



Team Members

Seth Bowers
Carson Brimhall
Kole Crenshaw
James Crunk

Faculty Mentor

Dr. Gladius Lewis

Project Type

Internal

Client

Herff College of Engineering

Team: Mechanical Engineering Tigers (METs)

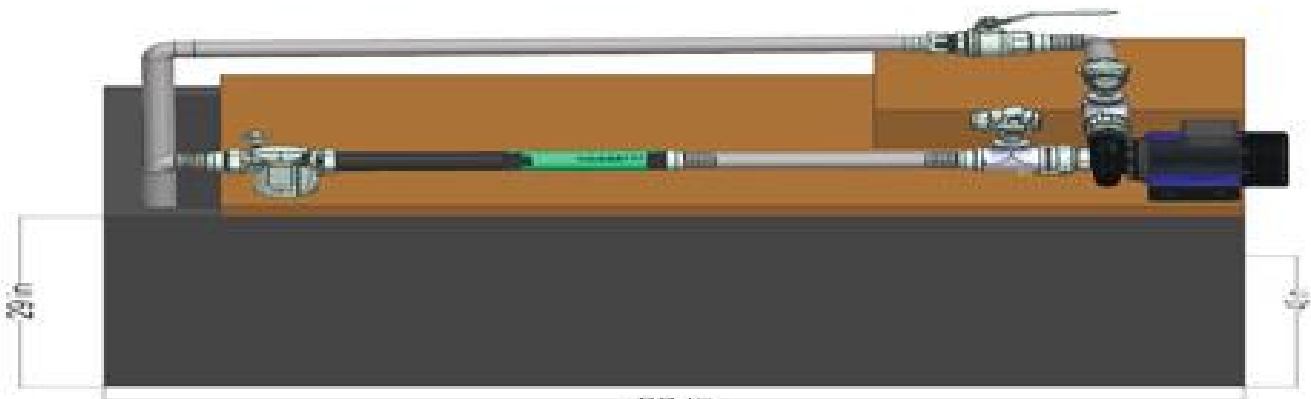
Memphis Pump seeks to develop a universal pump testing station capable of collecting performance data for its pump products. Memphis Pump has been supplying Memphis and the surrounding areas with centrifugal pumps for industrial, commercial, and agricultural use for over 75 years. Currently, every pump leaving the facility is water-tested using an existing tank, but no pump characteristic data is recorded by this test. Memphis Pump does not have equipment to measure pump performance curves and currently relies on pump curves produced in the 1970s.

This project involves designing and manufacturing a universal pump testing stand that is compatible with a wide range of pump configurations. The testing station can work with multiple pump models that Memphis Pump sells and can also be used to produce performance curves for future pump designs. This design uses Memphis Pump's

existing water tank as its reservoir for the system. Custom supports and mounting hardware, such as cam and groove fittings and pipe ring clamps, are selected which securely position and connect suction and discharge lines during testing.

In addition to mechanical design, the project focuses on the selection of measurement equipment. Flow and pressure sensors are selected and installed to collect performance data, and appropriate hardware and software, such as LabVIEW, are identified to support data acquisition and storage. The data collected is then used to validate the original pump performance curves.

The team collaborated closely with Memphis Pump throughout the project to make a testing solution that enhances product validation, documentation, and long-term performance.



Universal Pump Test Stand Projected System Model

Pipe Inner Diameter Spraying Challenge



Team Members

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Michael Bowen
Evan Klement

Faculty Mentor

Dr. Yong Hoon Lee
Dr. Kevin Berisso

Project Type

Industry-Sponsored

Client

Matt Davis,
ABB

Team: Precision Painters

Manual industrial painting processes have common issues such as inconsistent coatings, overspray, operator health and fatigue. This situation is challenging for large-scale manufacturing settings, which often lack affordable automation solutions or space that can provide the precision and repeatability necessary without the high cost and complexity associated with large robotic systems. As a result, there is a demand for a compact, reliable, and low-cost automated painting system that ensures consistent results, minimum wasted paint, and diminished manual operation.

The proposed design centers on a mechanically driven painting arm that utilizes a lead screw-based linear actuation system to achieve precise and quick motion. This system is specifically engineered to

avoid unintended rotational movement while ensuring smooth travel along the mechanism. To address potential operational challenges, structural components were meticulously selected and analyzed for stiffness under load, which is crucial for minimizing deflection that could adversely impact coating uniformity. Significant attention has been given to the overall movement mechanism to be easy to replicate and could paint faster.

The prototype showcases a simple replicate system, controlled by positioning the arm, making it well-suited for automated coating applications. By focusing on mechanical simplicity, structural integrity, and ease of manufacture, this project showcases a scalable idea for low-cost industrial painting automation.

Privacy Screen Kit



Team Members

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Derian Williams
Tanya Prahalathan
Juan Guerrero

Faculty Mentor

Dr. Alexander Headley

Project Type

Industry-Sponsored

Client

National Guard Products

Team: School Guardians

National Guard Products (NGP) has a Security Sliding Door product, which covers door windows, and has explored bulletproof security sliding door concepts. However, market research has indicated demand for screens that prioritize privacy over bulletproof protection and have aesthetic appeal. The main objective is to develop a cost-competitive privacy screen that is easy to install and does not compromise the certified fire-resistance rating of the door to which the product is applied.

The design solution repurposes existing NGP components and products and supports mass production and widescale commercial implementation, particularly in school buildings. School lockdowns in America require line-of-sight blocking for classrooms. However, schools still rely on rudimentary alternatives, often slow and flimsy, to cover windows. The designed product is a fast, reliable solution to this problem.

The final design consists of an accordion panel system mounted in frames that deploys to cover the window. When folded, the aluminum panels stack at the top of the frame to allow a view through the window. The screen has quick deployment, allowing the panels to unfold and block the window's line of sight. The assembly consists of a back, middle, and front metal frame, as well as aluminum panels and a simple latching mechanism.

The panels are glued to a flexible fabric that acts as a hinge between panels. The front panel is welded to the middle frame, and the back frame is attached with screws to allow easy access to the screen for maintenance. The whole assembly is attached to the door's window frame with the use of magnets, which are secured to the frame using an adhesive. In case of a fire, the product is designed so the magnets will fail, and the assembly will fall from the door, preventing the product from interfering with the fire-resistance of the door.



Privacy Screen Kit Prototype CAD Model

Smart Adapter



Team Members

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Caleb Taylor
Sophie Nieder
Wyatt Walorinta

Faculty Mentor

Dr. Yue Guan

Project Type

Industry-Sponsored

Client

Jerald Redmond and
Shane Riding,
Medtronic

Team: Shear Genius

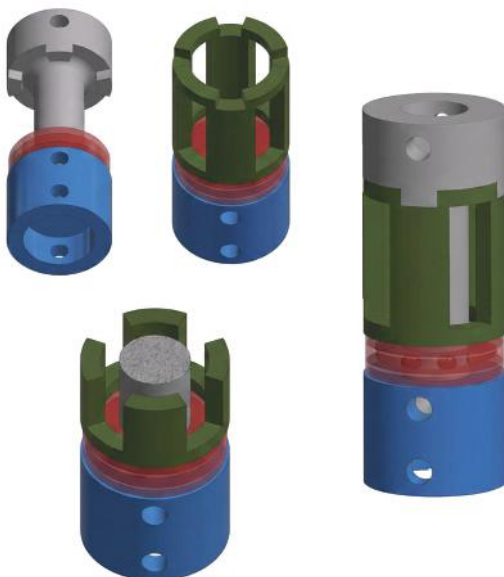
During surgeries on the cervical spine and pelvis region, rods are used to aid in realignment of the spine to help correct scoliosis, a condition involving curvature in the spine, or to perform interbody cage expansion to repair issues with disc height during herniation. Placing pedicle screws to secure these rods involves creating a pilot hole through the bone at the fixation point and inserting these screws to anchor the spinal rods.

Currently, tactile feedback is used to determine the appropriate amount of force which has implications for instability at the screw site from excessive force. This instability can affect bone alignment along the spinal column. Additional data is needed on how much force can be safely applied to a patient during screw driving, based upon their relative bone density.

A prototype involving a wireless device that pairs with Medtronic screw driving equipment and gives live feedback via a Bluetooth

connected app currently exists to address this need. Areas for improvement include the indication of bending moment to prevent screws from bowing out of the pilot hole, while also reducing signal noise during combined loading. The project team aims to address these concerns with an updated prototype that can both meet these metrics and expand upon pre-existing feedback architectures.

The proposed solution is an updated load cell model that mitigates signal crossing of detected force during combined loading. Strategic placement of strain gauges improves sensing of deflection through the load cell from axial force, torque, and bending moments. Bending is to be indicated with a user-interface displaying a crosshair to track screw trajectory that alerts if out of bounds. Advantages of this design are more accurate data collection, clearer communication to users, and improved safety for patients.



Initial 3D rendering of load cell assembly

The Medtronic Depth Stop



Team Members

Aubrey Durham
Michael Dumas
Michael Moore

Faculty Mentor

Dr. Amir Hadadzadeh

Project Type

Industry-Sponsored

Client

Brian Butler, Product Development Engineer, and Jacob Loschinsky, Senior R&D Engineer
Medtronic

Team: The Lords of Lumbar

Cervical radiculopathy and myelopathy are conditions that occur in the spine that are usually caused by a herniated disc. The condition can cause immense pain and weakness in the patient. The Anterior Cervical Discectomy and Fusion (ACDF) surgery was implemented to solve this problem. The surgery involves making an incision near the throat and removing the damaged intervertebral disc and replacing it with a cage. This cage acts as a bridge between the two vertebrae and promotes fusion. Success of the surgery depends heavily upon expert level surgical techniques due to the proximity of the spinal cord. This also means that the tools and devices the surgeons would be using need to be reliable.

During the surgery, the surgeons use devices called Trials and Inserters that measure cage size as well as implanting desired cage size. Maintaining precision of the inserter depth is critical as any slight misstep could result in serious neurological injury. While surgeons are known to rely on experience and feel during surgery due to reduced visibility from the depth stop, a mechanical depth stop could be added to enhance patient safety.

The depth stop being proposed is designed to limit insertion depth while preserving visibility and control of the surgeon. The increasing number of ACDF surgeries highlights the need for innovation in instruments in the surgical field. Even small ideas or tweaks towards existing devices can have a profound impact on someone having a successful surgery. This project puts an emphasis on visibility and simplicity, so the proposed concept seeks to enhance the existing ACDF equipment rather than replace them. Ultimately, the purpose of the project is to enhance patient safety and improve usability of the already used devices like the inserter and cervical trials.



Privacy Screen Kit Prototype CAD Model

Tiger BAJA Suspension and Steering System



Team Members

David Maybee
Olivia Ganavazos
Caleb May
Isabella Selvera

Faculty Mentor

Dr. Vipin Agarwal

Organization

Tiger Baja

Project Type

Industry-Sponsored

Client

Rud Hunsley,
Rough Country

Team: Suspension is Killing Me

The University of Memphis Tiger BAJA team is working to design and build a competitive off-road vehicle for participation in the SAE BAJA competition, marking the program's return to competition for the first time since 2019. A key component of this effort is the design of the vehicle's front suspension and steering systems, which play a critical role in vehicle control, durability, and driver safety during off-road events.

This senior design project focuses on creating a reliable, manufacturable front-end system that can withstand rough terrain while providing predictable and responsive handling.

The project involves the custom design of the upper and lower control arms and the steering knuckle. These components were designed to balance strength, weight, and ease of manufacturing while meeting SAE BAJA competition requirements. To complete the steering system, commercially available components were selected based on durability,

compatibility, and safety considerations.

The overall system was developed using computer-aided design tools to ensure proper integration with the rest of the vehicle. Design decisions were guided by the need for strength, serviceability, and straightforward assembly, allowing the vehicle to be maintained during competition. While advanced engineering analysis was used during

the design process, the final design emphasizes real-world functionality and reliability.

Beyond its technical objectives, this project represents a major step toward reestablishing Tiger BAJA as an active and competitive team at the University of Memphis. By delivering functional and competition-ready front suspension and steering systems, this project helps lay the foundation for future teams.

The completed system will be integrated into the vehicle with the goal of returning the team to SAE BAJA competition and generating renewed excitement around hands-on engineering at the university!





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