

Friends of MSOE:

Senior projects at MSOE are a long-standing tradition. The showcase is in large part a celebration: an opportunity for friends and family, faculty and staff, and community partners and corporate sponsors, to bear witness to the bodies of work that define the graduating class.

Every fall, MSOE seniors across program areas put the knowledge they've gained and skills they've honed over their academic career to the test. Working with faculty advisors and industry partners, they form teams—or work individually—to solve a problem, improve a product or process, or create something entirely new. After months of learning and discovery, building and deconstructing, successes and failures, the culmination of these efforts are put on display during the Senior Project Showcase.

The showcase is filled with great optimism and inspiration. Navigating the mazes of student excellence on display, we can only imagine where they will go next and what they will accomplish, knowing only—and with great certainty—that it will be extraordinary.

### **Have a project idea?**

Send your suggestion to Angela Rome, executive administrative assistant, by Aug. 5 to be considered for the 2019–2020 academic year. Include a brief description of any senior design project, class project or internship position along with the name, address, email address and telephone number of the project contact person. Project ideas submitted for engineering courses must have a significant design component. Submit ideas to:

VP of Academics Office  
1025 N. Broadway  
Milwaukee, WI 53202-3109  
(414) 277-7190  
[rome@msoe.edu](mailto:rome@msoe.edu)  
[msoe.edu/senior-projects](http://msoe.edu/senior-projects)

# Senior Design

The following list of senior design projects, class projects and internships, compiled with the help of the academic department chairpersons and program directors, represents an important segment of student academic activities conducted during the 2018–2019 year. A variety of projects were completed, some for outside organizations and some for the benefit of the university.

MSOE has a very strong relationship with industry, and many senior design projects often originate in companies where students work as interns. Senior engineering students work in teams on senior design projects, which most students begin planning in the spring of their junior year.

Most engineering senior design projects run through the Fall, Winter and Spring Quarters. In the fall, design teams define a design problem, identify several alternative solutions and develop a project plan for evaluating the possible solutions and solving the problem.

Students develop a thorough project proposal, often working with the MSOE Institutional Review Board. The Winter and/or Spring Quarters emphasize design, where students draw from their specialty courses. At the end of the design project, students are expected to have produced complete project documentation and written reports and oral presentations are required.

Business and user experience and communication design students must complete an internship in the area of their intended career as part of their curriculum. Internships allow students to apply the skills that they have learned in the classroom in a work setting.

Nursing students complete senior research projects. Collaborating with staff nurses, nurse administrators and physicians, they work to implement a change in some aspect of the health care process.

# Student Projects Schedule and Building Locations

Guests are encouraged to park in Viets Field, 1305 N. Broadway, free of charge on May 24 starting at 6 a.m. Guests may also park in the State Street A Lot, 501 E. State Street; State Street C Lot, 429 E. State Street; and the Milwaukee Street A Lot, 1001 N. Milwaukee Street. Parking will not be available in the Broadway Lot or the Milwaukee Street B Lot due to move out day for residence hall students.

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## **Civil and Architectural Engineering and Construction Management Department**

Saturday, May 18, 2019 | 8 a.m.–noon  
Campus Center, lower level, 1025 N. Broadway

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## **Rader School of Business**

Projects not on exhibit

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## **Humanities, Social Science and Communication**

Projects not on exhibit

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## **Electrical Engineering and Computer Science Department**

Friday, May 24, 2019 | 11 a.m.–2:30 p.m.  
Walter Schroeder Library and Werwath Mall,  
500 E. Kilbourn Ave.

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## **Biomedical Engineering Projects**

Friday, May 24, 2019 | Presentations are from 8–10:30 a.m. in the Grohmann Museum auditorium, 1000 N. Broadway (posters and prototypes will also be on display in the library with other EECS projects from 11 a.m.–2:30 p.m.).

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## **Mechanical Engineering Department**

Friday, May 24, 2019 | Noon–3 p.m., Campus Center,  
Todd Wehr Auditorium, 1047 N. Broadway

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## **School of Nursing**

Friday, May 24, 2019 | 1:30–3 p.m.  
Campus Center, Ruehlow Nursing Complex, first floor, 1025 N. Broadway

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## **Physics and Chemistry Department**

Friday, May 24, 2019 | 11:30 a.m.–2 p.m.  
Campus Center, BioMolecular Engineering Atrium  
East (second floor), 1025 N. Broadway

# Civil and Architectural Engineering and Construction Management Department

The architectural engineering and construction management undergraduate senior projects are pseudo-design/build projects involving a client, faculty team and professional construction mentors. The project teams are composed of students from the architectural engineering (with design specialties in structural, mechanical and electrical) and construction management programs. The one-year project starts with programming and includes the design concept through development, working drawings and construction management. The design process includes architectural engineering systems selection and analysis. Construction management includes construction methods, project feasibility, estimating and cost analysis, and project scheduling. The civil engineering undergraduate senior projects also involve a client, faculty team and professional mentors. The project combines areas of civil engineering such as structural engineering, environmental engineering, water resources engineering and more. Presentation and communication skills are reinforced by the formal presentations to a jury consisting of the client and construction industry representatives.

## TEAM A

Jacob Adamczyk  
Trevor Ascherman  
Jennyfer Fernandez  
Whitney Marasco  
Kim Schonder  
Michaela Thiry

## TEAM B

Riley Buol  
Yunhui Jia  
Brian Jones  
Benjamin Rust  
Cameron Sauve  
Brooke Scott

## TEAM C

Husain Ali  
Jack Cerasoli  
Becky Guzman  
Erika Millard  
Michael Osep  
Brandon Strzelecki  
Brooke Scott

## Civil and Architectural Engineering and Construction Management Senior Design Student Projects

**Project: Site overlooking the Kinnickinnic River in Milwaukee's Harbor District**

**Clients: Gilbane Construction and Michels**

**Student Teams: A, B, C**

**Project Coordinator: Robert Lemke**

**Faculty Advisor: Robert Lemke (A), John Zachar (ST), Dave Grassl (HVAC), Doug Nelson (PL), Jayme Radomski (FP), Christine Brotz (ELEC), Jeong Woo (CM)**

A \$100 million mixed-use development, featuring offices, apartments and a possible hotel, is planned for a site overlooking the Kinnickinnic River in Milwaukee's Harbor District. Dubbed River One, the project would be anchored by an office building housing around 400 Michels Corp. employees. The 6-acre site is owned by affiliates of Brownsville-based Michels Corp., an underground utility contractor with 8,000 employees nationwide. River One would be on a bend of the Kinnickinnic River, west of South First Street and north of West Becher Street. Michels Corp. plans to begin construction of River One's first phase yet this year. This would feature an eight-story building with around

120,000 square feet. Those additional buildings could include two more office buildings, each with around 50,000 square feet; an apartment building with around 70 to 100 units and a restaurant on the ground floor; and a hotel with roughly 100 rooms. There also would be a public square, according to the plans. MSOE would be involved in one of the next phases of the development.

**TEAM D**

Erica Hasken  
Jonathan John  
Loveday Roman-Lemac  
Collin Rayome  
Trevor Symbal  
Xiao Wang

**TEAM E**

Matt Blain  
Shelby Borchardt  
Joseph Crooks  
Reggie Hot  
Sullivan Schrandt

**TEAM F**

Tyler Belofsky  
Zach Gaatz  
Brianne Harris  
Jaclyn McNulty  
Matt Struck

**Project: Medical College of Wisconsin Expansion**  
**Faculty Advisor: Mike McGeen (A), John Zachar (ST), Sarah Kannass (HVAC), Doug Nelson (PL), Jayme Radomski (FP), Tamara Omari (Elec), Shauna Boyer (CM)**  
**Student Teams: D, E, F**

The Medical College of Wisconsin is in the preliminary phase of looking at three campus expansions. MSOE would take on one of the following proposed developments: Option 1 includes a building addition to the wet and research labs that includes approximately five stories and 100,000 square feet. Option 2 is a stand-alone cancer center that would include wet and dry labs. Option 3 would be a mixed-use academic building that would include educational spaces, offices, classrooms, pharmacy, physical therapy, and profusion. This option would be a 4-6 story development with 30,000 square feet per floor and 150,000-200,000 square feet.

**Key:**

(A) Architecture  
(CM) Construction Management  
(CM/PM) Team Project Manager  
(E) Electrical  
(EE) Building Electrical Systems  
(Env) Environmental  
(F) Fire Protection  
(H) HVAC  
(ME) Building Mechanical Systems  
(P) Plumbing  
(S) Structural  
(ST) Building Structural Systems  
(WR) Water Resource

# Civil Engineering

## Senior Projects

### **FACULTY ADVISORS**

Dr. Philip Ciha (CM)  
Dr. Todd Davis (ST)  
Dr. William Gonwa (WR/Env)  
Doug Nelson  
(Course Coordinator)

### **TEAM ONE**

Timothy Rink (CM)  
Michael Silverling (Env)  
Cali Bonie (Env)  
Benjamin Gamerding (Str)  
Hunter Butera (Str)

### **TEAM TWO**

Frank Leuschen (CM)  
Jacob Goebel (Env)  
Guissel Davila (Env)  
Michael Cappelletti (Str)  
Hanpeng Liu (Str)

### **TEAM THREE**

Austin Heyman (CM)  
Dennis Weiland (Env)  
Joshua Scott (Str)  
Joshua Shefner (Str)

### **TEAM FOUR**

Austin Heyman (CM)  
Dennis Weiland (Env)  
Megan Hanelt (Str)  
Matt Mohapp (Str)

### **Project 1: Municipal Water System**

#### **Student Teams: One, Two**

A large manufacturing facility is moving to town and will need significant quantities of potable (ultra-pure) water for their process. The water demand will approximately double the current supply capability. Negotiations with nearby municipalities appear to be fruitless. Needs will include a new water well and treatment facilities for approximately 1 million gallons per day and a 500,000-gallon elevated tank.

### **Project 2: Onsite Wastewater Treatment System**

#### **Student Teams: Austin Heyman (CM), Nick Kalamy (Env), Alexander Weislak (Env)**

The Riveredge Nature Center is planning on doubling its size within the next two years by adding an additional education building that will include a charter school. The existing onsite sewage treatment system needs to be upgraded and expanded to handle the future flows. Any options for treatment will be considered, especially if they can be used in the school's educational mission. The existing system is a 20-year-old constructed wetland. The former system (prior to the wetlands) is still in place but has not been used in the 20 years since the constructed wetlands was installed.

### **Project 3: Pedestrian Bridge Over The Milwaukee River**

#### **Student Teams: Three, Four**

The Riveredge Nature Center has a remote area that needs a pedestrian bridge to be able to access. One end of the bridge will terminate on the elevated plain well above flood level. The other end must terminate into the floodway of the Milwaukee River. The RENC is open to any suggestions for the design of the bridge and methods to access each end of the bridge.

**Project 4: Kohler Andre Campground Entrance**  
**Student Teams: Elliot Sweet (CM), Reid Jahns (Trans),**  
**Casandra Reimbold (Trans), Michael Laes (Trans),**  
**Elizabeth Lodzinski (Trans), Alexia Ramirez (Trans)**

There are currently two driveways serving the campground. One is barely used because of its condition. The driveway goes through a wetland. It is settling, potholed and not standard roadway width. Soon, the non-used driveway will need to become the primary driveway due to new construction in the area.

**Project 5: Non-Potable Water System**  
**Student Teams: Brittany Davis (CM), Kimberly Baffin**  
**(Env), Drew Steger (Env), Michael Edge (Str)**

The City of Franklin is connected to a neighboring potable water system at high costs to the consumers. To reduce costs to residential, commercial, and industrial users, the City is planning to set up a non-potable water system near a water pipeline carrying treated wastewater effluent from another nearby community. The new system would serve developments planned. The developments will include at least one high water using industrial customer, other commercial lots, and a residential area. Water is expected to be used directly for irrigation or other non-potable needs, or to be treated to levels as needed by industry.

# Rader School of Business

## Undergraduate Management Internship Experience

**Student:** **Rebecca Spence**

**Advisor:** **Beth Slayman**

**Project:** **Privileged Access Management at TransUnion**

TransUnion is one of three major credit bureaus in the United States. They aggregate information on consumers to develop a credit report as well as offer other credit and fraud protection products to individuals and businesses. A recent audit has required enhancements to the existing Privileged Access Management (PAM) solution to enhance their security posture and reduce vulnerability.

**Student:** **Saksha Shetty**

**Advisor:** **Beth Slayman**

**Project:** **Hard Drive Swap Utility**

In my project, I have devised a software script that will aid Milwaukee School of Engineering's Information Technology Helpdesk employees to successfully rename hard drives when they are swapped to a different laptop unit. Implementing this procedure has recently yielded faster turnaround rates and hard drive swapping which has led to increases in efficiency in our dealing with customers.

**Student:** **Robert Klassen**

**Advisor:** **Dr. Katrina Moskalik**

**Project:** **German Thesis: Improving the warehouse utilization with the help of a customized LEAN management concept**

Warehouse analyzation and optimization project for a quickly growing local company using LEAN tools and processes. The goal is to improve efficiency and potentially increase revenue from the bachelor thesis recommendations.

**Student: Jonas Kolbe**

**Advisors: Dr. Kenneth Dobbs; Dr. Katrina Moskalik**

**Project: German Thesis: Costing and Training Project**

A training and costing research initiative with a local manufacturing company. The research will create time and variance reports on current situations to create training documents, database updates to an ERP system, and then optimize that system through their bachelor thesis process.

**Student: Laura Zirkel**

**Advisors: Dr. Michael Payne; Dr. Katrina Moskalik**

**Project: German Thesis: New Product Development Process**

This marketing-based research is targeted at analyzing the current industry products, upcoming trends, and future product prospects for a local manufacturing company.

**Student: Marvin Gerdes**

**Advisors: Cynthia Mand; Dr. Katrina Moskalik**

**Project: German Thesis: Intra-Company Logistics–Parts Preservation**

Develop standards and automation of packaging and load carriers for proper part storage, shipping methods, and material handling for HellermannTyton, a local manufacturing company. The goal is to improve preservation and flow of product when moving between departments.

**Student: Safar Khan**

**Advisors: Thomas Eberle; Dr. Katrina Moskalik**

**Project: German Thesis: Capacity Planning**

Developing a real view of work center utilization using MRP, master data, and forecasting in the lathe group for a local manufacturing company.

**Student:** Fabian Rose

**Advisors:** Cynthia Mand; Dr. Katrina Moskalik

**Project:** **German Thesis: Manufacturing Process Improvement**

This work will focus on the final assembly department for a local manufacturing company. The research will evaluate current processes and then attempt to reduce process time associated with completing operation steps, receiving, and issuing shop orders.

**Student:** Merle Scheunemann

**Advisor:** Dr. Katrina Moskalik

**Project:** **German Thesis: Warehouse Workflow Optimization**

The goal of this project is to improve cycle times for receiving/put away and picking/shipping of parts, including warehouse/workstation layout and workforce development/training for a local manufacturing company.

**Student:** Reena Mahlandt

**Advisors:** Gene Wright; Dr. Katrina Moskalik

**Project:** **German Thesis: Customer De-concentration–Customer Journey**

The focus of this project was to evaluate the current customer touch points for a local manufacturing company. From the evaluation, a series of vital measurements will be identified and recommendations for enhancing the customer journey will be provided.

**Student:** Inga Von Mensenkampff

**Advisors:** Gene Wright; Dr. Katrina Moskalik

**Project:** **German Thesis: Customer De-concentration–Customer Intelligence**

The goal of this project was to develop a solution to collect customer feedback, gather information from the customer database, evaluate the data, and create solutions based on the gathered data to enhance the sales and service process for a local manufacturer.

<b>Student:</b>	<b>Nicolas Schroeder</b>
<b>Advisors:</b>	<b>Dr. Michael Payne; Dr. Katrina Moskalik</b>
<b>Project:</b>	<p><b>German Thesis: Logistics Operations Optimization</b></p> <p>This project focused on optimizing inventory location by efficient warehouse slotting in order to improve the warehouse operations, increase the facility's productivity and maximize the use of available space for a local manufacturer.</p>
<b>Student:</b>	<b>Owen Liebelt</b>
<b>Advisors:</b>	<b>Dr. Katrina Moskalik</b>
<b>Project:</b>	<p><b>Senior Capstone Project: Documentation Digitalization</b></p> <p>Working with a local financial advising company the project will create a change management process for customer record keeping and compliance. The project will also digitalize all current employee records to optimize workflow and compliance processes.</p>
<b>Student:</b>	<b>Joseph Al-Hasan</b>
<b>Advisors:</b>	<b>Dr. Michael Payne; Dr. Katrina Moskalik</b>
<b>Project:</b>	<p><b>Senior Capstone Project: Human Resources Management</b></p> <p>Working with a small start-up company, the student completed a job analysis for positions being created, then will create a full human resources documentation and guide for the owner of the company to use while hiring and managing new employees.</p>
<b>Student:</b>	<b>Robert Murray</b>
<b>Advisors:</b>	<b>Dr. Michael Payne</b>
<b>Team:</b>	<p><b>Briggs &amp; Stratton Management Team: Dan Roche, Director of Marketing and Jennifer Walth, Marketing Manager</b></p> <p><b>Briggs &amp; Stratton Engineering Team: Matt Donohue, Director of Production Management and Peter Lucier, Director of Engineering</b></p>
<b>Project:</b>	<p><b>Senior Capstone Project: Suspension Testing for Ferris Lawnmowers</b></p> <p>The purpose of this project is to determine whether or not the front arm suspension on Ferris riding lawnmowers makes an impact on the quality of the cut, and to support the outcome of several conducted tests with factual, numeric data. We plan to conduct several field tests that will measure how fast</p>

we can cut a standardized space, the quality of the cut at different speeds, and the vibrations emitted on the operator at different speeds using different models of mowers with and without this suspension technology. Ultimately, we want to prove that the suspension allows the operator to cut the same amount of grass faster, with the same or better quality of cut, while reducing the fatigue on the operator. The results of this project will then be used to write a marketing plan which will be distributed to Ferris dealers nationwide.

**Student:**           **Neha Gholap**  
**Advisors:**       **Dr. Michael Payne**  
**Project:**         **Similarities and Differences in Consumer Behavior for Non-Alcoholic Beverages across North American Regions.**

Consumer behavior depends on a lot of factors, such as experiences, loyalty, socioeconomic conditions, political conditions, environmental conditions, etc. This project aims at understanding how consumer behavior changes with respect to non-alcoholic beverages across North America. The project analyzes how the geographical location impacts various external factors that in turn change consumer behavior. The final aim of this project is to have a guide put together, which will help the reader understand the reason behind certain trends and patterns in consumer behavior with respect to the geographical location, as well as what to expect when diving into the non-alcoholic beverage industry in a certain market in North America.

**Student:**           **Jack Fisher**  
**Advisors:**       **Dr. Michael Payne**  
**Project:**         **King Fisher**

I am pursuing my own endeavor into the world of fishing lures, specifically in the swimbait market. My goal is to enter the market using a 3D printed mold design that would be downloadable for a fee. This would allow anglers an affordable option for creating their own trophy-catching lures.

**Student: Melanie Ehlers**

**Advisors: Dr. Michael Payne**

**Project: The Dog-Eared Page Business and Marketing Plan**

For my capstone project, I am creating a business and marketing plan for a dog-friendly bookstore called The Dog-Eared Page. The business plan is going to be a comprehensive business plan that will lay out all the back-end aspects of the business. It will include the organization of the business, an overall description, and a market analysis. For the marketing plan, it will include logos and slogans, buyer personas, marketing collateral, and other marketing-related materials. I chose this project because I can take the business and marketing plans and use them later in life. In addition, creating these plans utilizes a lot of what I have learned here in MSOE in one comprehensive project.

# Humanities, Social Science and Communication Department

## User Experience Senior Projects

Student:	<b>Britta Grayvold, B.S. User Experience and Communication Design</b>
Company:	<b>UX 498 Practicum with MSOE: Digital Marketing Assistant</b>
Faculty Advisor:	<b>Dr. Katherine Wikoff</b>

As the Digital Marketing Assistant, Britta aided Katie Klein-Murphy in various projects and assignments, including writing content for MSOE's social media accounts, writing meta descriptions for MSOE's website, helping in the creation of an interactive campus map, and using Google Analytics to examine website data. For MSOE's social media, Britta is in control of writing the content for Facebook, Twitter, Instagram, and LinkedIn. Her focus is making sure MSOE's voice, brand, and tone is being consistently shown. To improve search engine optimization (SEO), Britta writes meta descriptions for MSOE's website. These little captions summarize the page she is writing about, which will improve the visibility of the page and page ranking within search engines. Britta used Google Analytics to examine MSOE's website. She can see page views, the medium the user is seeing the website on, the location of most users, the length of a user's session, and more.

**Student:** Ben Kuchler, B.S. User Experience and Communication Design

**Company:** UX 499 Internship with Open Sky: GLOO and Character Formation Website

**Faculty Advisor:** Ashley Dzick

The main project of the internship was to analyze two components to the Character Formation Project: The CFP informational website and the GLOO platform. For the Informational website, Ben reviewed all the webpages within the domain and was tasked with identifying any major issues and to provide suggestions for improvement. Open Sky wanted recommendations to get potential customers from “initial interest” to purchasing the product and what would be the best layout in order to do so. For the GLOO platform, Ben was to provide a similar analysis. He reviewed the platform and identified issues for both users: teachers who read the lessons and the creators who publish them. Users have been reporting a handful of issues, and there were a few he noticed on a regular basis as one of the creators.

# Electrical Engineering and Computer Science Department

## TEAM MEMBERS

Joe Jarrell (EE)  
Bernice Kubicek (ME/EE)  
Arham Sattar (EE)  
Christian Schober (EE)  
Tim Sobie (EE)

## FACULTY ADVISOR

Dr. Cory Prust

## SPONSOR

Argonne National Laboratory



## 2-Axis Acoustic Levitator

Argonne National Laboratories, a national research laboratory operated by the University of Chicago for the Department of Energy, desires a student-built acoustic levitator that can be used in spectroscopy testing for pharmaceutical applications. Due to a significant amount of background information being available to us from previous design teams, our team decided to review their work on the project and improve upon it. Mainly, the system needed to levitate at a significant pressure level for the levitation of water droplets without overheating the amplifier. Along with this, a redesign of the power system, particularly the power factor correction network, was implemented. As a system can change over time, a feedback system was included responsible for fine-tuning the power factor correction network. Finally, a host of system parameters (e.g., power output, voltage levels, current readings, etc.) are then monitored by current, voltage and pressure sensors that are then displayed on a graphical user interface for a user.

## TEAM MEMBERS

Katherine Donahoe (EE)  
Matthew Gaffney (EE)  
Amber Hackiewicz (EE)  
Gladys Ramirez (EE)  
Nathan Russell (EE)

## FACULTY ADVISOR

Dr. Steven Fredette

## SPONSOR

Rader School of Business  
Plexus



## 3-DAD

There is a severe lack of inexpensive multifaceted image recording drones, especially for recreational users who do not see the value in buying a very expensive drone. A user may want to capture an experience, landscape, or market in a different way, which is why the product 3-Dimensional Anaglyph Drone (3DAD) has been developed. It is a drone camera attachment that can take a pair of 2-D images, controlled by the user from ground, and using custom image processing software can manipulate the data to generate a true 3-Dimensional anaglyph image. There is not an easy way to modify a drone for the basic user in order to acquire these desires, and existing solutions are orders of magnitudes more expensive than the product developed. To make this product even more desirable, the cameras can rotate independently from the drone by a separate remote control made specifically for the cameras so they move in unison and can also tilt downwards for a true bird's eye view of the ground.

#### TEAM MEMBERS

Caroline Groth (BME)  
Will Haeuser (BME)  
Cassidy Murphy (BME)  
Rachel Ruona (BME)

#### FACULTY ADVISOR

Dr. Larry Fennigkoh



### Advanced Instrumentation of a Rowing Ergometer

The goal of this project is to enhance the performance assessment features of a commercially available rowing ergometer through the design of a PC-based instrumentation package. This package will be able to measure foot force, chain displacement, and handle pull force of an athlete in real-time. A load cell will be used to measure the force the rower exerts on the ergometer handle, a force sensing resistor array will assess the forces applied to the foot stretchers, and a rotary potentiometer will assess the displacement of the chain attached to the handle. Additionally, this assessment equipment will have the capabilities of tracking the ergometer handle displacement path during the full stroke. To do this, an Xbox Kinect 2.0's motion tracking capabilities will be used. The data acquired with this enhanced instrumentation package can be used to more completely analyze the performance of the athlete.

#### TEAM MEMBERS

Stephen Brandt (EE)  
Sean Riordan (EE)  
Ihor Sahan (EE)  
Ryan Snyder (EE)

#### FACULTY ADVISOR

Dr. Cory Prust



### Automated Camera Tracking System (ACTS)

A hands-free, battery powered, automatic camera mount system does not currently exist for a recreational application that allows a user to use their own camera to record an object, including themselves, in motion. People who participate in action sports such as surfing, snowboarding, or racing must rely on another person if they want to film themselves, which might not always be an option. To solve this problem, a new product idea was developed to satisfy consumers' needs and rival competitor products. The product is called the Automated Camera Tracking System (ACTS). It uses a tripod mounted base almost any type of camera can be mounted on. The base contains two motors for horizontal and vertical movement of the camera based on tracking data from a GPS armband worn by the user. The system is completely battery powered to last at least 2 hours on a charge. It can track up to half a mile away from the GPS armband and can accurately track objects up to 150 mph at 5 meters away. After a simple calibration process, the ACTS is easy to use and provides user feedback for battery life and signal condition from the GPS. The system will work anywhere in the world and is expected to be a game changer and fierce competitor in the market.

**TEAM MEMBERS**

Patrick Carey (EE)  
Jose Garcia (EE)  
Brandon Morrow (EE)  
Christian S. Sartler (EE)

**FACULTY ADVISORS**

Prof. Laura Stevens

**Automated Kitchen Cabinet**

Practical home modifications are required to help people with disabilities become more independent. The project addresses a key issue of how to make kitchen cabinets more accessible. This innovative approach will provide the functionality of the existing solutions with reduced cost and increased performance. One area where performance was increased was achieved by adding Bluetooth control of the cabinet movement. This may be especially useful for individuals with more than one cabinet because one controller would be able to control multiple cabinets. An additional feature is the ability for hand gesture control. This enables the user to control the cabinets with a swipe of their hand rather than a physical button.

**TEAM MEMBERS**

Yaxu Liu (EE)  
Robert R Manocchia (EE)  
Haotian Niu (EE)  
Jacob C Seymore (EE)

**FACULTY ADVISOR**

Dr. Edward Chandler

**The Biobuoy Algae Bloom Detector**

Blue-Green algae is a dangerous water-based bacterium that harms humans and animals alike. It forms in large blooms that effect bodies of water. Currently, there exists no cost-efficient algae bloom detector device that can analyze and transmit water condition data to an on-shore device. Our solution consists of an offshore buoy system and an onshore database system. It can operate for at least four months with a 7-volt DC battery power supply within the offshore element. The water condition data (temperature, pH, and turbidity) is collected by four sensors in the offshore element. The collected data is encoded and transmitted by an RF transmitter from the offshore element to the onshore element. The received data is decoded and analyzed to determine whether the water condition meets the criteria for an algae bloom event. The system users have access to the data for further usage. The part of the data analysis that determines algae bloom detection is included in our system solution.

**TEAM MEMBERS**

Monika Gurdak (BME)  
Padee Lor (BME)  
Vedasai Sumanth Peram (BME)  
Bianca Trombley (BME)

**Biofeedback System to Prevent Diabetic Foot Ulceration**

Foot ulceration is a major problem in diabetic patients who experience peripheral neuropathy. Foot ulcers form when the diabetic patient continuously exerts pressure on the same area of the foot. Since these patients are unable to feel the bottom of their feet, they can't tell when an ulcer is forming. The task for this project is to design a biofeedback system to prevent foot ulceration. Our system should be able to measure pressure over a determined range from three sensors that are incorporated into a shoe and that pressure

**FACULTY ADVISOR**

Dr. Larry Fennigkoh

**TEAM MEMBERS**

Connor Christie (SE)  
Danielle Dorst (SE)  
Christopher Eidson (SE)  
Alex Hartford (SE)  
Kay Thao (SE)

**FACULTY ADVISOR**

Prof. Angela Wiedenhoef

**SPONSOR**

Direct Supply



data will be displayed with a graphical user interface. The approach for this project is to create a bracelet that will collect data via Bluetooth from an insole that contains three force sensor resistors (FSRs) placed at specific areas on the plantar side of the foot. The bracelet will alert the patient if they are applying an excess amount of force by turning on the vibrational motor and then the OLED screen on the bracelet will display the area of the foot that has been breached.

**Chatbot for Direct Supply (CH4DS)**

This project aims to provide a usable interaction-based client which integrates with Direct Supply's sales and marketing analytics systems to help with the decision-making process. Currently, Direct Supply employs a team of data scientists who are creating a dashboard-like interface for displaying sales and marketing tactics for internal team use. This application would be an overlay for that system, acting as an intermediary to provide quick answers and insights without having to scour the graphs and tables, especially during a rushed scenario such as a phone call with a customer. Thus, we would like to supply them with an efficient mechanism for providing linguistically comprehensible summaries to internal customer queries without necessarily making decisions for them.

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**Coin Cell Alternative**

Milwaukee Tool (MT) needed a device that will interface with existing MT battery platforms, power Bluetooth-enabled (BLE) MT products, and eliminate the need for users to replace the coin cell batteries in their Milwaukee Tool BLE devices. Our device will consist of a coin cell battery charging circuit that can be interfaced directly with Bluetooth-enabled MT platforms, will be powered by battery packs already compatible with Bluetooth-enabled MT platforms, and will allow for uninterrupted use of Bluetooth technology while the coin cell battery is charging.

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#### **Dandy Electronic Live Assistant**

The Dandy Electronic Live Textual Assistant (D.E.L.T.A) is a gesture recognition device which assists the user in performing regular daily tasks. This performs like other popular home devices with the key difference being its use of gestures as opposed to voice for inputting commands. A DE0-Nano-SoC field programmable gate array (FPGA) collects pictures from a D5M camera. These pictures are then processed in the FPGA to produce an edge-detected image. The edge-detected image is transmitted to a Raspberry Pi. Image recognition software TensorFlow will determine if the image contains a valid command gesture. If so, then a task is performed on the Raspberry Pi, with the output of the task being displayed on a command prompt. Some example commands include retrieving recent sports information, displaying personal google calendar information, setting a timer, and much more. DELTA was designed for those without the ability to speak to still have access to the growing home device market.

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#### **Eaton Internet Connected Device**

Eaton is an industrial power management company with global scale. Their products power and create technologies we use every day. Our project automatically gathers data from Eaton components and forwards it into the cloud. This can hook into components of any type, regardless of data schematics, and handle transmitting and storing their readings and logs. From there, users can view metrics on machine usage, performance, and errors using a web dashboard. A variety of graphical displays allow users to explore historical and real-time data from any level of manufacturing machines: individual machines, fleets, or companies. These analytics will provide companies using Eaton components, as well as Eaton themselves, insight into how their machines are being used and how to improve their machines in future iterations.

Using a Raspberry Pi board, our project connects to an EATON Variable Frequency Drive and pushes data read from the machine to a cloud server which stores the data. From there, data is requested from a web browser through a website and is displayed through different graphs allowing the user to see various measurements from the machine.

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#### ESCAPE

ESCAPE is an expanded senses cane for the visually impaired. The ESCAPE provides greater information of obstacles and warning of hazards to the visually impaired via sensing technology embedded into a standard cane. With vibration feedback, the user can navigate busy sidewalks or stores with far greater confidence and reliability. The ESCAPE will offer greater mobility and independence for the visually impaired in the constantly changing world.

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#### Fetal Heart Ultrasound Phantom

Motion Mode (M-mode) is one of the oldest forms of ultrasound. This mode is incredibly sensitive to small changes in velocity, making it useful to measure abnormalities in heart rate and structure. A common problem in populous nations, such as China, is that the number of patients that receive an ultrasound at any given time is so large that ultrasound machines are expected to remain powered on for hours, if not days at a time, before being powered off. This causes the algorithm to become less accurate with time in determining fetal heartbeat. Manufacturers don't understand why this phenomenon is occurring. Our product is a phantom modeled with the properties of a beating fetal heart, realistic in its frequency and displacement. It is designed specifically for M-mode, featuring an option to alter the frequency between 80-200 beats per minute, simulating conditions of fetal tachycardia and bradycardia. This phantom is designed with simplicity and robustness in mind and can run continuously for 72+ hours while still providing accurate results.

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#### Field Data Logger

Milwaukee Tool requires a device to record critical tool metrics during real life applications. This device will be capable of recording the metrics of interest over time and allow an engineer to review the data after application. Typical data to be recorded will be battery voltage, battery current, and other tool specific I/O's such as pressure or RPM. Specification requirements on device size, power consumption, cost, sensitivity, accuracy, sample frequencies, and input gain has yielded a highly efficient, low profile, custom PCB layout design.

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## Gamecube TAS Robot

The purpose of the Gamecube TAS Robot is to allow people who create a Tool Assisted Speedrun (TAS) on older video game consoles to create a TAS on the Nintendo Gamecube as well. Currently, creating a TAS on a Gamecube is impossible because the Gamecube has inconsistent read and write times due to its optical disk drive, which will desync a TAS. For our project, we are modifying the Gamecube by replacing its optical disk drive with an SD card to make its read and write times precise and consistent. We are also adding TAS replay and editing capability, which will make it convenient for people to create TAS's directly on the Gamecube.

## HAWK

For nearly 20 years, Cognex's stand-alone Machine Vision systems have been used to inspect a multitude of products as they are manufactured. Cognex products have evolved to gain speed, memory, and faster acquisition capability. An emerging opportunity is to use the same vision hardware used for inspection of parts to instead do inspection of the machine itself. Inspecting the machine will help manufacturers determine not just when they are producing defective parts, but why the machine is failing to operate optimally.

This senior design project is a new software/firmware product for the In-Sight single-camera family, giving the cameras an alternate purpose as a low-cost event capture solution. The solution uses a given vision system's image acquisition system to continuously record a stream of images. Upon a trigger, the system continues recording for a configurable amount of time and then saves the stream. The archived streams give users an opportunity to more thoroughly understand possible causes to product defects.

## Hydroforaya

Introducing Hydroforaya, a modular control system which allows for plug-and-play automation of hydroponic systems. A hydroponic system is a nonconventional farming technique which does not use soil to grow produce and other consumer vegetation. The project was inspired by a lack of customization and flexibility within the hydroponic automation market.

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To allow for varying structure, special-purpose modules will connect to a centralized control system, which also provides a standard automation technique. Modules communicate with the control system through USB. The control system will then automatically recognize the module based on the module's declaration of its identity. Modules are automatically linked for control by the centralized control system. If a sensor input module and control output module are linked, Hydroforya will automatically direct the control output module based off the sensor values from the sensor input module.

Adding to these features listed above is the Hydroforya Android Application. The central control system allows for a connection to the user's personal phone through an app, which allows for control and monitoring from any Internet connection. Check on and change automation levels for your Hydroponics system anywhere in the world!

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**ICARIS**

ICARIS (Image Circuit Analysis Recognition Integration System). ICARIS is the beginning of a progress of analyzing drawn electrical circuits from paper. The scope of the project is to take the image of a battery and resistor circuit sketched on a piece of paper and directly export that to a Circuit Simulation Platform on a computer. ICARIS uses machine learning image recognition techniques which utilizes TensorFlow to train and run large neural networks and Keras which has high-level Deep Learning API that makes it very simple to train and run those neural networks. ICARIS is solely a machine learning based project and thus the heart of the classification of ICARIS lies in the VGG image classification models. VGG contains convolutional neural network layers that allow a high accuracy classification of up to 1,000 different classes. VGG only serves as a skeletal backbone of ICARIS and is modified to be accustomed to our project and dataset of hand drawn battery and resistor circuits.

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**ICU Noise Pollution Generator For Use In Nursing Simulation Lab**

Alarm fatigue in an ICU setting occurs when a caregiver is exposed to a large amount of noise heard frequently and becomes desensitized to alarms and overhead calls. This can result in impaired recognition of worsening patient conditions and has been related to fatal patient events. The goal of this project was to develop a library of common hospital/

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ICU sounds in conjunction with a user-friendly interface for delivering and controlling these sounds to a four-channel surround system to be placed in one of MSOE's nursing simulation rooms. The purpose of this is to simulate real noises and sounds to expose the nursing students to the overwhelming nature of the alarms in that environment. Our project allows the user to select different medical device and overhead sounds to play within the nursing simulation lab. This also consists of a software package and graphical user interface, both on the MATLAB platform, which then connects to a four speaker surround system.

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**Improved Pelvic Retractor**

The current retractor used for colorectal surgeries does not effectively reach the deep pelvic region due to the static length and angle of the retractor. Our team will design a retractor that will dynamically reach the intended region and have an ergonomic handle for the medical personnel's comfort. There will be an incremented length of 7-12 inches, which is the standard lengths of the current retractors. There will be an angle adjustment that will use a locking mechanism to hold the desired length and angle. These incremented length and angle adjustments are currently not on the market, so any time the medical staff would need a different size they would need an entirely different retractor. One of the main goals of this project will be to add additional lighting using autoclavable LEDs to allow wireless use. The batteries will be mounted on the blade or length of the retractor and have a rechargeable station to reduce operating room costs. The handle will have a loop to reduce the need for constant force being applied to the retractor by the medical student. All the components will have to be sterilizable using an autoclave system, meaning all materials will have to be able to withstand a pressure of 15 psi above atmospheric pressure and around 250 degrees Fahrenheit for 8-30 minutes.

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**Improved Ultrasound Usability**

Team 19-01 has been tasked by GE Healthcare with the design and implementation of improvements to their current LOGIQ E9 Ultrasound system. GE Healthcare's current lovingly termed "frog-leg" mechanism allows extension of the ultrasound's keyboard and monitor to a maximum of 30 cm with rotation of  $\pm 45$  degrees. As outlined within their

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preferred requirements, rotation of the keyboard and monitor should be increased to  $\pm 90$  degrees while also increasing extension beyond 30 cm. In designing these improvements, it was decided that the “frog-leg” mechanism be retired in favor of a three-motion system utilizing a sliding lap joint beam with a pin and hole mechanic to allow movement in the xy-plane at either end. While increasing extension beyond 30 cm and degree of rotation to  $\pm 90$ , this design also allows implementation of additional “braking” mechanics to limit movement of the keyboard and monitor once desired measure of extension and rotation has been achieved.

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**KEY ++**

Key++ reimagines typing. It is a modern take on human-computer interfacing that can act both as an alternative or as a compliment to standard keyboards. Instead of being limited to a single letter or action per key, users are now capable of creating fully customized layouts both functionally and graphically. Additionally, Key++ is designed to be used with only one hand, allowing power users to elevate their productivity and users with disabilities to enjoy a more accessible and streamlined digital experience.

Key++ utilizes a compact, 4x6 key layout. All the keys are mechanical, giving the tactile feedback typists crave. Each key houses an individually-controlled oLED screen that can be programmed as desired. Keys can be arranged into pages, allowing users to isolate frequently used letters and software-specific combinations. For example, an A-G page could correspond to 1 on a number pad, H-N to page 2, and so on. In another application, such as video editing, pages could be arranged with specific hot keys and macro-instructions such as play/pause, volume adjustments, or music notes rather than typical English characters. Key++ implements a built-from-scratch desktop application to create, edit, share, and save custom layouts. Using this tool, the keyboard can be quickly and easily programmed for each different use case.

Whether the Key++ keyboard is being used to completely replace a keyboard or add to the experience, the Key++ keyboard will enable users to amplify their everyday typing experience.

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**LogiSteps**

LogiSteps is a full stack application that is designed to collect, process, and display user fitness data in a seamless, self-powered construct. LogiSteps enables a user to pair their Bluetooth enabled smart sole with their mobile device and stream data to the cloud in a manner that is unobtrusive and relies very little on the user. By using this system, users can enhance, monitor, and improve their personal fitness without the need of energy demanding equipment that is often bulky and uncomfortable.

To achieve this, Logisteps has designed a custom 3D printed insole which harvests the energy of a user's steps and uses it to power a microcontroller embedded into the custom insole. By harvesting the energy of the user's movement, it removes the need to frequently charge the device—setting Logisteps apart from its competitors. This microcontroller monitors and collects step data and then sends it over a Bluetooth connection to a user's paired mobile device, which acts as a bridge between the embedded microcontroller and a web server that collects and processes the data. Users wishing to gain further insight into their fitness can navigate to the online web portal, where they will be presented with rich interactive graphics.

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**Medication Dispensing Tracking Device  
for Assisted Living Centers**

Medication dispensing errors are a common occurrence in healthcare facilities, many of which are not reported or go unnoticed. Patients are then subject to receiving incomplete care and possible decline in health. The two most common forms of medication dispensing errors are over medication and omission of medication, with the former being the most common. Project 19-02 seeks a solution to the most common medication dispensing errors. The device utilizes in-drawer cameras, RFID, and drawer close sensors to detect whether medication has been removed at the proper times and helps track potential overdoses and medication omissions as indicated by medical records of the patients.

The drawer close sensor detects any time the drawer is accessed and activates the RFID antenna. Each medication pack has an RFID tag that the antenna reads to determine which packs have been removed. If a pack is removed too often, an overdose warning is generated. If a pack is not removed during a medication round, an omission warning

is generated. At the end of a given medication round, the in-drawer cameras determine if the medications have been removed. If they have not, an alarm sounds so that the medication can be properly distributed. This device also complies with current medication carts and medication packaging that is commonly used in senior living facilities.

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#### **MegaMeter**

The MegaMeter is a wireless digital multimeter system that uses a physical device to record measurements and a web interface to monitor measurements remotely. Cellular data and Wi-Fi are used to send measurement data wirelessly over the internet in real time to devices at any distance. Real time measurement data is served to connected web clients using an Amazon Elastic Compute Cloud Server. Historical measurement data is also available for view and analysis via a hosted cloud-based Mongo database. The web client uses Angular to present measurements via a modular and customizable, tile-based user interface to best fit the desired use case.

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#### **MSOE Lake Level Monitoring System**

A water level recording system was designed for year around use at the Eagle Springs Lake. The system was recently placed at Wambold Dam. Data is transmitted roughly 100 feet away periodically. The data is used to notify dam operators via text when action must be taken to prevent water damage if water level changes too rapidly. The data can be viewed from close by on a web interface with various graphs and trend data.

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**Network Controlled IR Remote**

Wide adoption of smartphones and Wi-Fi enabled devices has enabled new creative ways to control in-home devices. Many internet-capable devices have been developed to control older devices that do not have smart-connection features. The primary goal of this project is to create an embedded, Wi-Fi enabled device that is capable of controlling IR devices with a configurable Android mobile application. This will allow users to add smart features to their older devices without the large cost of replacing the device entirely. Through a short and simple setup procedure, users of the NCIR will be able to control infrared devices through the smartphone app, allowing for more flexible control over devices such as TVs, Blu-ray and other media players, and more. The NCIR device will support connection to the custom-developed Android remote application, programmability for use across multitudes of devices and IR standards, and the ability to repeat IR signals in order to effectively utilize a device's original remote control. Simply put, the main features give the NCIR control over older devices using the same commands sent from the original remotes.

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**Pocket Password Safe**

Every individual needs to use passwords. Passwords are hard to remember and maintain. Utilizing existing solutions such as Post-it® notes, password books, and third-party cloud-based services can compromise security. Complex random and non-dictionary passwords are also hard for the average user to enter. The project aims to create a small hardware device for password storage and entry. The device, built around a microcontroller, implements a display and scroll-wheel for user interaction, a USB port for direct password entry, and a fingerprint scanner to verify user identity. The device is fast, easy to use, and small enough to be mistaken for an automotive key-fob. The planned user experience consists of tapping the fingerprint scanner to unlock the device. Once unlocked, the user can navigate to the desired credential. Data can be taken directly from the display or you can plug the device into almost any USB port to inject the password as text directly. Upon completion, the user simply unplugs the device and walks away. No software or drivers are required under most circumstances. Compatible devices include PCs, tablets, phones, and servers.

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**Predictive Algal Neural-Networked Tracking System**

Algae blooms can cause environmental hazards to people, animals, and sea life by producing dangerous toxins or depleting water oxygen levels. The environmental conditions in which blooms can occur are known, however there are no automated systems in place for predicting an algal bloom. This project aims to build a blue-green algae bloom predicting and monitoring application for inland lakes as an early warning system for public safety.

**Project Orion: Ruggedized Data Acquisition System**

The existing ruggedized data acquisition (DAQ) systems offered by Hi-Techniques can be excessive and expensive for the needs of a potential customer. Hi-Techniques offers a variety of data acquisition products for industries across the globe, however, they lack a lower-cost DAQ system. The costs associated with their current DAQ products are between \$18,000 and \$150,000 per unit. For many applications, a less expensive alternative is desired. Our solution is a compact, low-cost, ruggedized, multi-channel DAQ system still offering a high level of DAQ precision. The multi-channel inputs each have adjustable-gain amplifiers accommodating a wide range of input signal levels, and the acquired data is transferred out of the newly developed DAQ system via a 1GB Ethernet interface.

**Prosthetic Foot Impact Tester**

In the US military, there are many amputee service members who would like to return to active service, however we don't know if prosthetic feet can withstand the impacts necessary for field work and there is no standard test to determine if they can. The Department of Defense has tasked a team of engineers at the Minneapolis Veterans Hospital to build and establish these tests and standards. The current testing device is functional, but it has no means of giving accurate data. Our team has been asked to develop improvements for the device. First, we have added a velocity sensor to the system which continuously measures the distance to the foot as it falls and divides the change in distance by the time it took. This velocity data will be used to determine the amount of force on the foot and how much it can withstand before breaking. We added a shock absorbing system to

the device in the form of a platform that the foot falls onto. It accurately models the shock absorption provided by a person's knees and hips. This biofidelic response will ensure the testing is taking place in the most real-life conditions possible. We added a few quality-of-life improvements to the device such as a display for the velocity sensor and a remote control to reset the system. We hope that this impact testing device can be used to improve the lives of amputee veterans.

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#### **RESS –Renewable Energy Storage System**

As the push towards using sustainable energy increases, it is important that there are enough products on the market to help drive the movement. The renewable energy storage system, or RESS, is a design which allows customers to scale their energy storage capacity while also making the energy portable. The RESS has the capability of being charged with any 24 VDC renewable energy source. Using circuitry and a custom control system, the RESS was designed to have multiple battery modules with stored energy. Each module can be taken out of the fixed unit and placed in the portable unit for on-the-go usage. The stored energy can also be used in the home via a custom 2.5 kW inverter. The concepts in the RESS were designed with the intent of expandability to have the product meet the needs of any customer.

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#### **Sensor for In-Shoe Measurement for Diabetic Foot Ulceration Prediction**

Foot ulceration is a serious complication of diabetes which most of the time leads to the need for foot amputation. Due to diabetes, patients have abnormal gait and anatomical foot features which cause compressive and shearing forces that develop into foot ulceration. All clinical devices that are available nowadays don't measure all necessary components that cause foot ulcer development, mainly because they are too large to fit into a shoe. Our approach is to create an ST shaped sensor with a total dimension of 0.99 cm x 2.69 cm machined from Aluminum 2024 which has a high elastic modulus deformation under load, and higher thermal conductivity which shield the strain gauges from temperature environment change. Through modeling, the strain gauges placement was chosen. Strain gauge technology is used to measure compressive and shear forces simultaneously and convert these forces into voltages which are then processed using a microcontroller and displayed to patients and technician by an LCD screen to notify them of ulcer development, helping them make decisions about treatment.

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**Smartphone App for Dermatological Lesion Tracking**

This smartphone app will allow users to track various concerning skin regions. It will primarily be used for tracking potential cancerous moles and for tracking pigmentation for users with vitiligo. For users with concerning moles, this app will monitor and detect changes in moles, which is very important when trying to detect Melanoma (cancer in moles) at an early stage. This app will not diagnose users' moles or evaluate the risk of melanoma or skin cancer in any way, as that would result in FDA regulation. For users with vitiligo, this app will automatically detect vitiligo-affected skin from the normal skin and calculate the ratio between vitiligo-affected skin area and the whole skin area for specific parts of the body. This app is meant to assist users in tracking areas of skin over time by maintaining a time/date stamped photo database with changes in size, shape, and color calculated and documented for the user and the user's physician.

**Solar Panel Cleaning System**

Our system consists of solar panel control, which includes radiation sensor, current/voltage sensors, and water level sensor. Those sensors are connected to a programmable board. What we will do is compare the energy that is taken from the solar panel by using the current/voltage sensors with the reading from the radiation sensor. When the comparison decreases a significant amount, it will check the level of the water remaining in the tank. When there is enough water, the system will start to run the water pump. It will run for 10 minutes, which is enough time to clean a panel. The system pumps water in nozzles that have enough pressure to clean the panel.

**Spindle Test Bench Design**

The manual process of verifying spindle parameters at Fischer USA is inefficient, causing a more labor intensive and time-consuming work environment. Industrial spindles have many applications and must run at various speeds with various intervals of pause under different conditions. These spindles require testing prior to use in industrial applications. Test equipment set-ups, also referred to as test benches, which test the spindles at relatively high rotational velocities, can be either relatively simple with many of the test phases needing manual reconfigurations and adjustments of test parameters, or can be automated to sequence through the various cycles that sometimes include parameter changes

from cycle to cycle. This sponsored project includes the selection of several of the critical sensors (such as temperature, vibration, rotational speed, and run-out), and includes the selection and programming of a programmable logic controller (PLC) that will control the tests and monitor the sensor outputs. The PLC will allow automated testing, control the motor drive for the spindle, and interface with a human-machine interface (HMI) device for controlling the tests. The project will include the capability of being expanded to accommodate a greater number of sensor-device inputs in the future. Safety is a major consideration during spindle testing, and the PLC is programmed to take appropriate action when unsafe conditions are indicated by the sensor outputs.

#### **TEAM MEMBERS**

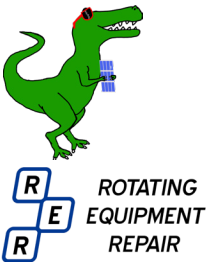
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#### **FACULTY ADVISOR**

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#### **SPONSOR**

Rotating Equipment Repair



#### **TEAM MEMBERS**

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### **Sun Tracking Autonomous Recharger (S.T.A.R.)**

The Sun Tracking Automatic Recharging System, or S.T.A.R. System for short, is a dual-axis solar panel mount that can track the sun's movement throughout the day to ensure peak charge from the solar panel. The system is being designed for our sponsor company, Rotating Equipment Repair, to charge a backup power supply for their server room in the case of a power outage. Our system can track the sun's position through the use of multiple "position" photocells that act as a voltage comparator, following the sun's movement both horizontally and vertically. Two separate motors will move the solar panel to the desired angle and the solar panels will provide power to a backup battery that will store the energy for an emergency power outage. The company will be able to access the power quality readings of the solar system at all times through the use of probes that will transmit the current and voltage readings of the system to a website.

### **Switched Reluctance Motor Controller**

Our project is to design a flexible SRM controller as a compromise between cost, transparency of operation, complexity, and motor availability, providing a platform for further SRM research and development. This will allow more universities and companies access to feasible SRM control without spending exorbitant amounts of time and money in initial startup costs.

Our controller can power an SRM up to 500 W in speed or torque mode up to 7000 RPM. It switches at a high frequency of 25 kHz to stay out of the audible range. All the

functionality is confined in a single, condensed, and affordable circuit board. Control is handled by either analog inputs (provided by the end user), or a graphical user interface run on a PC connected via USB. Our solution, using relatively cheap components and an open source design, provides an opportunity for more companies and students to launch into the relatively new technology of switched reluctance motors and the benefits that come along with them.

### **Terrarium Climate Controller**

The Terrarium Climate Controller (TCC) is a system that aims to provide users with full control and monitoring of the climate inside a terrarium. The user provides their own temperature, humidity, and lighting sources, which are plugged into an outlet array while sensors gather climate data from inside the terrarium. The user then uses this data to program the power cycles of eight individually programable outlets. The user can also log onto a web app where they will be able to see real time and past data from each sensor, as well as program each individual outlet. In the web app, the user will have total control over the outlet outputs and can change them dynamically with respect to temperature and humidity sensor inputs or time of day.

This project was implemented with a Raspberry Pi 3b+ as the main controller. It reads in sensor data from custom designed sensor PCBs and communicates with a custom designed relay board to individually control power to eight 120V AC outlets. The Pi is also responsible for communicating with the Web App to update device settings and send sensor data.

#### **TEAM MEMBERS**

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#### **SPONSOR**

MSI Data



### **Uber for Supply Techs**

The goal of this project is to bridge the gap between a service technician and their customer. This is to be achieved by using a web app similar to what Uber has. This app will allow customers to view the service technician's contact information, picture, appointment information, and current location in real time. Our project consists of two parts, a front-end and back-end that host the information that the customer is to see.

#### TEAM MEMBERS

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### WEPSOM-Wi-Fi Enabled Power Strip Monitoring

Oftentimes, it can be difficult to estimate how many high-power electronic devices can be plugged into a powerstrip or outlet without the risk of overloading it, which can lead to dangerous situations. We offer a solution to this problem in the form of a power strip with a uniquely simple and intuitive LED indicator that can tell the load status at a glance, along with added Wi-Fi remote control and detailed power monitoring functionalities that can be adapted to a smart home environment. Our solution also comes with all the safety features found on high-end power strips such as surge suppression, EMI filtering, and over-current protection. The widely popular and low-cost ESP32 microcontroller is used for its built-in wireless functionality; the system is configured to be compatible with all devices without the need to download a specific application and is made to be easily integrated with IoT platforms such as Amazon AWS.

#### TEAM MEMBERS

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Luke Kipfer (EE)

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#### SPONSOR

Plexus



### Wrist Rescue

Elderly people who experience a fall or have a history of heart problems regularly face life-threatening circumstances that do not allow them to call for help for themselves. To mitigate this issue, Team RARL has designed Wrist Rescue. Wrist Rescue is a wearable watch-like device that monitors heart rate and detects falls while being connected to the user's cellphone via Bluetooth. If a medical crisis is detected, the device will alert the user, and the user will have 30 seconds to respond. If the user does not respond within that time frame, a call to emergency services will automatically be placed. The device has audio capabilities, meaning the user can communicate with emergency responders via a speaker and microphone embedded in the device in the case that the user's cellphone is not nearby. The user is also able to initiate an emergency call by pressing and holding a button on the device if an undetectable medical crisis occurs. By connecting the device directly to the user's cellphone, Wrist Rescue does not require a monthly subscription like other medical alert devices. The cost for Wrist Rescue is singular, thus making it the more economical choice. In addition, thorough compliance testing ensures that the device will function as a successful health monitoring device for elderly users.

# Mechanical Engineering Department

## Industrial Engineering Senior Projects

### TEAM MEMBERS

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### Tax-Air A

Tax-Air plans to improve their dock efficiency at the company headquarters in Milwaukee. Forklift drivers must scan every pallet of freight that enters the building and the rate at which they scan each piece is low in comparison to other Tax-Air terminals. This creates a domino effect of excess time to unload trailers and causes driver delays. The goal of this project was to increase the scans per hour by 10 percent and improve worker efficiency. Facility design techniques were used to improve the overall layout of the terminal. A standard operating plan for the current process as well as a future state including recommendations was developed using process mapping, time studies, and fishbone diagrams. To ensure the sustained success to the standard operating plan lean techniques, such as 5S, were used to eliminate waste in the system and unnecessary downtime.

### TEAM MEMBERS

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Elsey Kohlmann

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### Johnsonville

Johnsonville, one of America's leading sausage companies, requested assistance from an MSOE Senior Design Team to address defective packaging in their Meadowside facility. A funneling approach was used to consolidate Johnsonville's 23 defect factors into 6 all-encompassing defect codes. Next, Pareto analysis was used to determine the main cause of defective packaging: creasing. With a narrowed focus, alternatives were developed and data was collected to support their development. Quantitative analysis and qualitative considerations led to three final supported recommendations: localized training initiatives to target the reactive mindset, a line speed reduction to allow more effective identification of causes of creasing, and an improved floor storage system to better protect the rolls of films used for packaging. These changes will shift Johnsonville towards a proactive mentality, reduce the defective package rate from 3.19% to 2.59% and save on raw material costs with a payback period between 0.95-3.3 months, respectively.

#### TEAM MEMBERS

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#### Empire

Demand for safety and utility tape is forecasted to increase 18% this year. Throughput in the Slitting Department only increased 7% last year. To accommodate for future demand, the goal was to increase throughput capacity, the rate of production per time unit, in the Slitting Department by 4.5%. To accomplish this objective, the team focused on reducing setup time. The new setup procedure reduces machine downtime during the internal changeover process by completing several operations before the machine becomes idle, as well as streamlining several steps. Incorporation of these changes allowed for a decreased internal setup time of 45.5%, and an increased throughput capacity of 15.7%.

Additionally, an ergonomic analysis was conducted on a process, obtaining a REBA score of 4. The redesigned process reduced the REBA score to 3, classifying it as low risk.

#### TEAM MEMBERS

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#### Aurora Health Care

With over 4,600 blood tests conducted every month, Aurora Clinical Labs (ACL) plays an essential part in helping Advocate Aurora Health to provide quality medical treatments. The purpose of this project was to locate delays in the blood retrieval process and provide recommendations with the goal of reducing lead time. After observing and conducting time studies, it was concluded that the cycle time of the blood retrieval process at ACL was 6.6 minutes; out of that time, 5.7 minutes consisted of non-value-added wait time. The three areas of delay have been labeled as the (1) "tube station," (2) "blue bin," and (3) "tube tray." Using a fishbone diagram and the "Five Why's" technique, the team was able to generate four alternatives. After creating a decision matrix, changing two lab assistant roles to a call center representative and a constant runner was found to be the most beneficial recommendation.

#### TEAM MEMBERS

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Matthew Powers

#### Putzmeister

Putzmeister is a German company that manufactures various concrete pumping solutions, which includes concrete pump semi-trucks. At their Sturtevant, Wisconsin facility, Putzmeister's Final Finish department functions as the final step in production for this product line. The primary and secondary goals, respectively, for this project are to decrease the cycle time for trucks and travel distance for operators

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within Final Finish. To achieve these goals, the different tasks that need to be executed on every truck must be equally balanced across multiple operators and a new floor layout must be designed that minimizes the number of non-value-added footsteps taken by each operator. The main tools used by the team during this project included time studies, spaghetti diagrams, and Excel-based simulation. After fully implementing the team's recommendations, Putzmeister should expect an 11 percent improvement in cycle time and a 24 percent reduction in operator travel distance.

**TEAM MEMBERS**

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**Xylem MRO**

The project focuses on the labor utilization of employees in charge of material handling. Material handling is a necessary activity, but it does not add value to the work being done. The project analyzes how material handlers carry out their work and discovers more effective methods in which tasks can be completed. This is done to reduce the amount of travel and wait time in the facility. By constructing a decision matrix, the team was able to discern which ideas were objectively the best. We narrowed our ideas down to five ideas, plus two additional ideas that might prove to add value to our client. Once we figured out our best ideas, we calculated their cost of implementation and projected time and money savings. At the end, implementing the top five ideas would save our client a projected average of 750 hours per year, which amounts to \$9,562 per year. The team concluded that it would be most beneficial for the client to implement these five ideas from our decision matrix as they were inexpensive and would provide them with the time and money benefits they were looking for.

**TEAM MEMBERS**

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*We grow your malts*

**Malteurop**

This project was conducted for Malteurop, one of the largest malt producers in the world. The focus of this project was on reducing Malteurop's supply chain costs. The main objective of the project was to achieve a reduction of 1.5% for the total production cost that Malteurop spent across all four manufacturing plants within North America. The team created an in-depth cost model to evaluate the different cost factors each plant incurred, such as labor, maintenance, and electricity. Then, a solver tool was used in Excel to optimize the total cost Malteurop spent each year to a minimum value. The team achieved a reduction in cost of 0.61%. Although this fell short of our goal, it results in nearly a \$200,000 savings within

a single year. Malteurop will be able to use this tool year after year to allocate malt production across its North American plants, benefiting their organization for years to come.

**TEAM MEMBERS**

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**Children's Hospital of Wisconsin**

The Children's Hospital of Wisconsin (CHW), is currently involved with a \$265 million expansion. This expansion motivated the staff to seek improvements to the current Emergency Department (ED), as well as to the newly designed ED. The purpose of this project was split among three areas: (1) to redesign the supply workflow in the ED for better placement of supplies; (2) to conduct ergonomic evaluations on selected computer workstations in an effort to identify potential musculoskeletal problems; and (3) to use the 5S methodology to sort, clean and standardize storage of equipment in the soiled utility room in the ED to reduce the safety hazards there. The team also created a visual management board to help to communicate and to sustain the level of inventory in the ED soiled utility room. The team used the information gathered from the evaluations to provide recommendations for improvement in these three areas.

**TEAM MEMBERS**

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**Sjoberg**

Sjoberg Tool and Manufacturing Corporation is a sheet metal manufacturer located in Hartland, WI. Many of their products are produced make-to-stock and stored in finished goods inventory. They do not currently have a good measure of the holding costs of this inventory or a defined method for setting lot sizes, and therefore are unable to determine whether their current lot sizes are economical. The purpose of this project was to develop a lot sizing model to determine appropriate lot sizes for provided part numbers, reducing the total sum of setup and holding costs for those parts by 10%. The final recommendations were created using the Economic Order Quantity (EOQ) model, which seeks to balance the cost of having or not having inventory. The lot sizes created by the model showed a 20.1% cost improvement over the current quantities and are thus recommended for consideration in future lot sizing.

**TEAM MEMBERS**

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Abhisht Bhartia

**FORCE America**

Our senior design project was with the Electrical Division of FORCE America, Inc., which specializes in snow and ice control systems. The company has outgrown its current

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facility and is looking at two alternatives to increase production capacity. It could either remove the hydraulic department and expand in the existing facility or buy a new facility. We used industrial engineering tools like systematic layout planning, tagging sheets and value stream mapping to study the process and design the alternatives. We used the growth projection provided by our clients to determine the minimum space required for a new building that will accommodate growth until 2038, and we designed a new building along with the cost justification. Our recommendation is to invest in a new building, which will be more profitable in the long term with an internal rate of return of 4% as compared to 2% for the redesigned layout of the existing building.

**TEAM MEMBERS**

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Dakota Miller

Tara Rahmani

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**Xylem Model Cell**

This project was performed for Xylem, Inc., a world leader in water transportation solutions. The goal of this project was to eliminate overstock caused by production exceeding demand. The core objectives were to reduce stock quantity by 30%, so excess stock accumulating in aisles would be eliminated, overall stock cost would be reduced by 20%, and customer demand would still be met. To meet these objectives, the team produced stock model alternatives using statistical analysis, Monte Carlo simulation, and regression modeling. The team also produced a standard operating procedure for a job triggering system so that production quantities would be held to the recommended level. Ultimately, the team determined that the best solution available to Xylem would be to produce stock to the seasonal fit regression model as this solution is expected to reduce inventory by 43% and decrease stock cost by 27% annually while minimizing overall stock outages.

**TEAM MEMBERS**

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Aaron Lowery

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**Harley-Davidson: Food Services**

The Juneau Avenue Rally Point Café, run by SodexoMAGIC, serves breakfast and lunch to the employees and visitors to the Harley-Davidson headquarters. The Café has six main stations (Deli, Entrée, Grill, Flatbread, Salad Bar, and Cashier), not including drinks and packed snacks, available for customers. The team focused on reducing the amount of time a customer spends in the Café. It was determined a customer spends, on average, 4.93 minutes per visit. The team recognized different problem areas affecting the Café, including the layout of the stations around the Café, how customers ordered the food they desired, food preparation methods, and visual management for the Café.

Implementation of the recommendations caused the average time a customer spent in the Café to be reduced, on average, to 3.44 minutes per visit.

#### **TEAM MEMBERS**

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#### **DreamBikes**

DreamBikes is a non-profit organization which repairs donated bikes, selling them at a discounted rate or donating them back into the community. Currently, bikes are not inventoried until after being repaired. The basement inventory at the Milwaukee location, consisting of 890 bikes broken down into 14 bike categories, was manually audited. Upon the completion of the audit, the detailed information was entered into a sequel compatible excel database which utilized a simplified entry form. Following the implementation of the inventory management system, a three-step plan consisting of an initial inventory presort, shipping inventory surplus to other DreamBikes locations, and donating inventory excess back into the community was recommended. This plan was designed to maximize without exceeding special capacity, lower overall investment, and increase inventory turnover rate to save DreamBike time and money, allowing them to better serve their goal of shifting communities forward through bikes.

#### **TEAM MEMBERS**

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#### **Harley-Davidson: Office Services**

The focus of the project was to improve the efficiency of the package delivery service performed by the Office Services Department at Harley-Davidson in Milwaukee, Wisconsin. The team used several industrial engineering tools, i.e., process maps, fish-bone diagrams, time studies, and spaghetti diagrams, to identify the primary problem, which was determined to be package delivery trips being performed too often. Based on the data analysis of package inbound time and the number of packages in each delivery trip, the team determined that some of the trips could be eliminated or combined. The team designed a new package delivery mechanism which reduced the total number of daily deliveries from nine to five, and pure package deliveries from six to two while maintaining the on-time delivery objectives. As a result, the average time spent to deliver each package was reduced from 1.77 minutes to 1.54 minutes, which represents a 13% reduction.

**TEAM MEMBERS**

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**Tax-Air B**

Tax-Air is a less than truckload shipping company that is currently operating with six terminals that are located across the upper Midwest. Pickups and deliveries are made to and from terminals and line-haul deliveries between terminals are all made using two types of trucks: tractor trailers and straight trucks. Tax-Air's total cost depends on mileage cost (fuel and maintenance), non-mileage costs (rent), time-based costs (driver wages) and fixed costs (utilities, equipment, insurance, etc.). Tax-Air would like to rearrange their terminal network to operate more cost effectively so they can be more competitive. A meta-heuristic genetic optimization method was used to find the best rearrangement of their terminal network and minimize their total costs.

## Mechanical Engineering Senior Projects

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**Acoustic Levitator**

Currently, Argonne National Laboratory (ANL) has a commercially available one-axis acoustic levitator used for x-ray spectroscopy testing of pharmaceutical solutions. Levitation is desired so testing can be more accurate, efficient, and free of contamination. By vibrating a transducer, a standing pressure wave is created through interference between the sound wave from the horn and sound wave reflected off a surface. Levitation occurs at the nodes of this standing wave. ANL has partnered with MSOE senior design teams for the past three years to develop a more stable and efficient levitator compared to their one-axis system. Previous teams have increased stability with a two and three-axis system but have not been able to run long enough or are unable to levitate water. This year's system features a two-axis design with integrated anechoic material to reduce noise and increase particle stability. The group has optimized the transducer design to include six piezo electric discs with a 27.5 kHz horn creating a strong pressure field able to levitate water. An EE team has been working alongside the ME team on this project and has significant contributions, such as a power factor correction network (PFCN), which will improve the system's run time.

**TEAM MEMBERS**

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**Human Powered Mobile Home Project**

The human-powered mobile home will provide users with a reliable, comfortable, and aerodynamic way to travel as well as a minimal space for sustained living. This mobile living space is equipped with a combination of design features to encompass a broad spectrum of users, such as a bed, a sink, stove, toilet, kitchen, shower, and much more. Cross-country travelers, avid outdoors men, migrant workers, homeless refugees, and even destitute vagrants could benefit from the unique combination of features as society shifts ideals to smaller, more efficient living situations. Engineered with a strong but lightweight structure and a safety minded but aerodynamic design, this comfortable and sustainable living space adheres to both federal road and state park camping regulations. This wide combination of features in an efficient human-powered form gives the user the ultimate freedom to set up camp anytime and anywhere along their journey. The human powered mobile home is an affordable and versatile solution to a wide variety of user needs.

**TEAM MEMBERS**

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Milwaukee Tool

**Milwaukee Tool Jigsaw Counter-Balance Design**

The purpose of this senior design project was to modify the counterbalance mechanism of the M18 FUEL D-Handle Jigsaw in order to reduce the vibrations experienced by the user. Based on the conditions set by the design team, Milwaukee Tool, and the tool's availability in the market, there cannot be any significant changes in the weight or performance of the tool and the casing that contains the mechanism. The counterbalance-gear system was modified by removing mass from the gear and increasing the mass of the counterbalance plates. These changes were made to reduce the force generated by the unbalance in the gear and to tune the net moment and net force in the tool to counteract each other. This reduced the net vibration produced by the tool.

*Appreciation is extended to Milwaukee Tool for sponsoring this project.*

**TEAM MEMBERS**

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Jason Palesse

**I.S.Sa. (International Space Salad)**

Team International Space Salad (I.S.Sa.) is teaming with NASA's project VEGGIE to create a watering system for growing plants aboard the ISS for a fresh source of food for the crew. As the crew currently takes time out of their

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**NASA ADVISOR**

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full schedules to water these plants manually, Team I.S.Sa. is tasked in creating an autonomous water delivery system for Outredgeous lettuce with a restriction of not utilizing electricity. Past MSOE senior design teams have investigated the concept of watering plants in microgravity. To make an autonomous watering system, the past teams discovered there were “expansion-based” and “timed” watering concepts. This school year, Team I.S.Sa. has been focused on creating a fully functional “timed” prototype that utilizes constant torque springs to draw water in and out of a plunger and a kitchen timer-like system to initiate that mechanism. Team I.S.Sa. has been growing crops for experimental watering data as well as researching the concept of surface tension versus gravity in order to prove the device will function correctly in microgravity.

**TEAM MEMBERS**

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**Additive Subtractive Hybrid Manufacturing Machine**

The Additive Subtractive Hybrid Manufacturing Machine (ASHMM) was created to quickly place MDF blocks, adhere them together with a water-activated adhesive, and then use cutting tools to reduce them to a desired shape. There is not a machine on the market that performs additive and subtractive manufacturing processes with materials commonly used by the pattern and mold making industries. The process begins by importing a CAD model of the desired shape that is imported into software that generates the near-net-shape part made of cubes and the machining path for the CNC process. The ASHMM places a layer of blocks, spraying water before each block is placed to activate the adhesive coating on the blocks. After each layer is placed, the layer is machined to the desired profile. The machine continues alternating between placing layers of blocks and machining until the build is complete. The ASHMM design team has achieved a proof of concept that demonstrates the desired functions of the machine by minimizing gaps between blocks during placement, improving the block feeding capacity from previous designs, and implementing an adhesive application system and a CNC machining process.

**TEAM MEMBERS**

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Sean Spring

**Additive Manufacturing an Ankle Foot Orthotic**

Ankle Foot Orthotics, AFOs, are used to stabilize deformities caused by cerebral palsy. Currently, the production of an AFO is an inaccurate and timely process. Because of this, we were tasked with creating a methodology to use additive

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manufacturing to produce an Ankle Foot Orthotic, with a printed prototype as the result. The 3-D printed AFO had size, weight, and factor of safety constraints. We also wanted to use as little material as possible, increase airflow, and not cause any adverse effects. The final design we came up with met all our objectives and constraints. Our AFO uses Nylon 680 and was analyzed using Finite Element Analysis to predict the resulting factor of safety and deformation.

#### **TEAM MEMBERS**

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Daniel Cook  
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#### **Apartment Aquaponics**

The goal of this project is to write a guide which covers the core concepts of aquaponic gardening and provide instruction on building of an apartment-scale aquaponics system. Commercially available systems are often more decorative than practical, and techniques used in large-scale systems do not scale down well for residential applications. Team members are responsible for designing, building, and testing an aquaponics system that can operate in a normal apartment. The design and guide must be accessible to someone with a limited technical background.

#### **TEAM MEMBERS**

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Justin Pawlowski  
Cheyenne Phakousonh

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#### **Argus Offworld Mining Robot Sensor System Development**

The NASA Robotic Mining Competition (RMC) is a collegiate-level competition held in the Kennedy Space Center in Florida. Inspired by the goal of one day mining ice from the surface of Mars, the aim for the 2019 competition will be to dig gravel (ice simulant) from underneath regolith, a fine sand-like material. NASA will take the ideas prototyped by these bright minds with the possibility of utilizing these ideas for future space missions. The Space Raiders is the NASA RMC competition team at MSOE and is separate from the senior design team to encourage underclassmen to join the team and promote retention. However, the competition team has limited time for research and development. Therefore, the senior design team, Team Argus, will be focused on creating a spatial and physical awareness sensor package. This will enable future RMC teams to create an autonomous mining robot, which scores additional points during competition. This sensor project consists of several subsystems: localization, excavation, drivetrain, proximity, and video. The localization system uses an IR beacon and receiver with an accelerometer to calculate the position of the vehicle. The current draw of the drivetrain motors is monitored for wheel slippage.

The status of the collection bin is monitored to provide data on excavation effectiveness. Proximity sensors and a video camera provide additional location information. This information is aggregated in the mainboard and sent to a monitoring station.

#### TEAM MEMBERS

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Charlie Paddock

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#### NASA Swamp Works Senior Design Research Project: Converting Resources into Operable Combustibles

Team CROC was tasked with establishing an autonomous proof-of-concept design for the collection, transportation, and storage of raw materials on the surface of Mars. It is not feasible to bring enough fuel to Mars for a return trip to Earth, so fuel must be created using Martian resources.  $H_2O$  and  $CO_2$  collected on Mars can undergo a chemical reaction to produce methane rocket propellant. Different approaches studied include the collection of resources from the atmosphere, regolith, and subsurface glaciers. The mass and energy consumption of each potential method was heavily weighted to determine the most feasible process. The best method for  $CO_2$  acquisition was determined to be collection from the atmosphere using a cold trap. The recommended method for  $H_2O$  depends on the parameters of the operation site, with the most prevalent method entailing the mining of subsurface glaciers with an auger and heating probe. Experimentation was performed to refine the models and sculpt CROC's recommendation for a resource collection, transportation, and storage system.

*Acknowledgement: Special thanks to Greg Galloway and Paul Hintze of NASA Swampworks.*

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#### FACULTY ADVISOR

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**PRESTWICK**  
GOLF GROUP

#### Team Must-O-Pen

The Prestwick Group manufactures a variety of golf course furnishings made from the highest-grade recycled plastic. The storage boxes are a staple product line; they are used in a variety of applications ranging from divot mix and sand storage at golf courses to general storage at hotels and resorts. The current closing mechanism used on the storage boxes was identified as a potential area for design improvement from both a reliability and a performance standpoint. In light of this, our client asked us to provide a solution that will provide both a lift-assist and a controlled-close feature to improve the user experience as well as prevent possible pinch-point injuries. Our solution utilizes a unique mounting of gas springs to achieve a lift-assist and

a controlled-close for all users and box sizes. The unique mounting ensures the lid has an applied force throughout its entire range of motion, allowing for the gas springs to provide enough force to open the box unassisted after a designated user input, without compromising the closing ability of the lid.

#### **TEAM MEMBERS**

Michael Aceto II  
Hayden Heun  
David Koper  
Jacob Rusch

#### **FACULTY ADVISOR**

Dr. Robert Rizza

### **Design of an Additive Manufactured Ankle-Foot Orthotic for Children with Spina Bifida**

Myelomeningocele (my-uh-lo-muh-NING-go-seel), a form of spina bifida, leads to patient mobility impairments. In the case we are working on, the patient does not have the strength to keep their knees pushed back to prevent a crouched position and to keep their knees from buckling inward. The objective of this project is to create a fully-functioning prototype of an Ankle-Foot Orthotic (AFO) for the spina bifida medical condition using a material that meets all Food and Drug Administration (FDA) requirements as well as patient needs. The project uses Additive Manufacturing (AM) in order to create a cost-effective AFO that has the necessary FDA approval, sagittal stiffness, torsional stiffness, comfort, and structural integrity that is required.

#### **TEAM MEMBERS**

Ziyad Alatas  
Jacob Anderson  
Joshua Heraly  
Bradley Johnson

#### **FACULTY ADVISOR**

Dr. Nebojsa Sebastijanovic



### **Baja SAE: Weight Reduction**

The Baja SAE club team competes in an annual competition that challenges students to design and build an off-road recreational vehicle and be able to give a sales presentation of the vehicle. The Weight Reduction team this year is tasked with redesigning areas around the car to reduce the overall weight of the vehicle and have it ready for a mock competition in April. The four areas of improvement that the team redesigned were the driver's seat, wheels, firewall/skid plate, and body panels.

The driver's seat was remade in house out of aluminum sheet metal to provide a rigid seat. The wheels are planned to be downsized to reduce weight, and the front knuckles plan to be modified to allow smaller size rims to fit. The firewall was reduced in thickness to cut weight out, and the skid plate was remade out of steel to be able to weld in and more easily repairable. The body panels had a change in material and thickness. The driver's seat, firewall/skid plate, and body panels are all made in house to decrease manufacturing cost.

*A special thank you to Milwaukee Tool and the MSOE SAE Chapter.*

### TEAM MEMBERS

Tyler Brown  
Hendrik Meier-Gerssler  
Mirko Neumann  
Eric Tien

### FACULTY ADVISOR

Dr. Nebojsa Sebastijanovic



### Green Machine: Baja Vehicle Drivetrain Redesign

The MSOE Baja SAE Club Team approached Team Green Machine to complete a total drivetrain redesign for their vehicle. The team was tasked with reducing the overall weight of the drivetrain from 170 pounds to 100 pounds and required the new gearbox enables the car to reach a minimum top speed of 25 miles per hour. Team Green Machine produced a single gear ratio gearbox that utilizes a Continuously Variable Transmission to act as a clutch mechanism. The gearbox has an overall gear ratio of 9.6, has a theoretical top speed of 31.5 miles per hour, and the total weight of the drivetrain weighed under 100 lbs.

*Appreciation is extended to Milwaukee Tool.*

### TEAM MEMBERS

Philip Helwig  
Kenneth Holbrook  
Travis Theisen  
Kenneth Holbrook

### FACULTY ADVISOR

Dr. Mohammad Mahinfalah



### ASME Design Team Competition

Every year, the American Society of Mechanical Engineers (ASME) hosts a student design competition where students from universities across the country design robots for a certain challenge. The goal of this year's ASME design competition project was to build a robot that can collect and deposit balls of various sizes from a uniform array of stands as quickly as possible. The competition consisted of two rounds, one where each individual robot operated the field alone and another where two competed against each other on the same field. In addition, the robot was required to meet the regulations set by ASME. The speed and reliability of the robot were the most important factors of the design. After designing and practicing with the robot, the team took the MSOE robot to E-Fest North at Michigan State University. The robot designed and constructed by this team competed head-to-head with other robots from across the Midwest.

### TEAM MEMBERS

Nick Gross  
Seth Irwin  
Julia Marsh  
Caleb Patrie  
Jamal Rahaman  
Noah Schmidt

### Hughes Window Husker

Hughes Equipment Co. is an international manufacturer of engineered food processing equipment that serves both the Fresh Market and Ready-to-Eat Meals sectors. Their products provide innovative, efficient, and productive solutions for customers' unique needs. Hughes identified a market gap in automated window husking machines and have worked for years to develop a prototype machine to address this need. The window husker is an automated machine that partially husks ears of corn to keep the corn fresh for longer periods of time while allowing the consumer to view the kernels under the husk.

**FACULTY ADVISOR**

Dr. Mohammad Mahinfalah



The main objective of this senior design project was to increase the existing machine success rate of about 30 percent to above 90 percent, meaning that over 90 percent of the ears of corn sent through are properly husked by the machine. The project was narrowed to focus on the device that presents a partial husk to the stripper unit. The design is an adjustable guide that creates a husk flag by removing a pre-cut section of the cob from the husk and guiding that flag to the stripper unit. The stripper unit utilizes a pair of rubberized, rotating rollers to both remove the section of husk and eject the cob. Proper presentation is imperative to a successful window. Full size testing was done to validate the design.

**TEAM MEMBERS**

Ryan Boatright

Jake Boebel

Josh Boyce

Michael Butzen

Travis Mueller

Joshua Walling

**FACULTY ADVISOR**

Dr. Prabhakar Venkateswaran

**Turbolab: Gas Turbine Engine Project**

The purpose of the Turbolab Senior Design Project is to create a thrust generating gas turbine engine that can be used as an educational tool by future MSOE students in thermodynamics courses. The engine will utilize a GT1544 turbocharger, which provides cost effective compressor and turbine components. Components designed and fabricated separately include a combustion chamber, nozzle, fuel and ignition system, lubrication system, and data acquisition system. The final project deliverables include a safe and reliable gas turbine engine, necessary instrumentation to conduct a thermodynamic analysis of the system, a lab procedure with background and methodology, and documentation for proper maintenance and safe use of the system. Despite other educational gas turbine engines costing over \$60,000, the initial projected cost of this apparatus is \$1,974 (not accounting for the work of the Turbolab team members). This low projected cost forces the Turbolab design team to make economical decisions, and leaves room for students to further refine the system in the future.

**TEAM MEMBERS**

Chandler Armstrong

David Konstorum

Justin Schultz

Alex Van Dyck

**FACULTY ADVISOR**

Dr. Michael Cook

**Sirius Automation**

Sirius Automation in Buffalo Grove, Illinois is a company that specializes in laboratory automation solutions. Their current fluid dispensing system on their robots uses one pipette which requires priming to switch between different liquids to decontaminate the tubing. To increase productivity, four separate dispensing orifices can be used to create compound liquids more efficiently. This module will allow Sirius Automation to expand its applications in liquid handling

for laboratory automation. Therefore, Sirius Automation in conjunction with the Milwaukee School of Engineering Senior Design created a new modular attachment capable of multi-channel liquid dispensing called VARISPAN.

#### **TEAM MEMBERS**

Rudolph Arlt IV  
Alexander Banse  
Jacob Schilling  
Joshua Unser

#### **FACULTY ADVISOR**

Prof. Richard Dykowski



#### **Formula Hybrid All-Wheel Drive Team**

Every year the Society of Automotive Engineers hosts an international competition of formula style hybrid vehicles the first week of May at the New Hampshire Motor Speedway. For the 2019 Formula Hybrid competition year, the team commissioned a research and preliminary design effort about how best to implement an All-Wheel Drive (AWD) system on the current competition vehicle. The main purpose of this project was to increase power output of the vehicle while eliminating the potential for loss of traction. Other goals were to improve engineering design scores and reduce event and lap times at competition.

To accomplish these tasks, the design team has selected to install a pair of QS 273 hub motors to the front wheels of the vehicle. Implementing these motors on the front wheels distributes the tractive load to all four of the vehicle's wheels and prevents the vehicle from losing traction under acceleration. A parametric design study was also performed to characterize power, torque, and tractive force of the vehicle when more advanced motors become commercially available. The team also quantified handling considerations of the new system. Vehicle handling characteristics such as weight bias, steering force required, and approximate lap times were investigated.

#### **TEAM MEMBERS**

Sam Crawford  
Eric Ehrhardt  
Sam Hosch  
Helen King

#### **FACULTY ADVISOR**

Dr. Nebojsa Sebastijanovic



#### **In-Store Bottle Cleaner and Sanitizer**

Olive oil boutiques and suppliers pride themselves on providing their customers with high quality olive oil. Oxygen, high temperatures, and UV light all decrease the shelf life of olive oil. Due to concerns about oil spoiling, these bottles are currently a single use item that are discarded due to the difficulty of the cleaning process. Currently there isn't a device geared specifically to clean these bottles for reuse. Because this product is used in the food industry, the design will also need to adhere to several FDA regulations and requirements.

The bulk of the task is designing a custom nozzle that allows for maximum spray coverage of the bottle interior while also creating strong enough water jets to effectively cut through

the oil. The system also utilizes hot air and sanitizer solution to add to the cleaning effectiveness. This results in a system having to deal with three different fluids. One is the water supply which is drawn from a faucet and ran through a booster pump to increase the nozzle pressure and assisting the velocity fluid exiting the nozzle. The second fluid is the sanitizer solution which is siphoned out of a separate tank using the pressure already built up from water supply. Finally, the heated air will be used before and after the cleaning process in order to loosen the oils and then dry the bottle after.

#### **TEAM MEMBERS**

Samantha Felhofer  
Reilly Flynn  
Kaleigh Kraft  
Amanda Mudlaff  
Brett Samuelso

#### **FACULTY ADVISOR**

Dr. Subha Kumpaty



#### **Team Cry me a River**

The Harbor District of Milwaukee requested a design that would meet their requirements of utilizing solar power to provide a trash collecting solution for the Kinnickinnic River. A current solution is in the Baltimore area, also known as the Trash Wheel. However, the Harbor District decided to receive more designs to account for their specific needs. The Kinnickinnic River experiences large amounts of flooding throughout the year and is one of the few rivers with a reverse flow. The team has created a design that will fit the river's needs, taking into consideration the solar energy available and various flow simulations. A full proposal will be submitted to the Harbor District of Milwaukee for their review.

#### **TEAM MEMBERS**

Leonard Kruse  
Malte Loeschenkohl  
Philipp Ziel

#### **FACULTY ADVISOR**

Dr. Mathew Schaefer



#### **HYDAC: Development of a device to measure flow forces acting on a cartridge valve**

Flow control cartridge valves have a very broad range of use in hydraulic applications. It is of great interest to be able to determine the behavior of the valve during operation as accurately as possible. The goal of the project, which is done in collaboration with the HYDAC Technology Corporation, focuses on the development of a test method to measure flow forces acting on a hydraulic cartridge valve. Through the assessment of different design ideas, a final solution was established. The measurement of the flow forces is executed in two fundamental steps. In the first test setup, the standard valve is operated as usual except having a rod leaving the valve at its end which allows the detection of the spool position. By knowing the displacement of the spool and corresponding values for volume flow rate and pressure difference across the valve, the state of operation

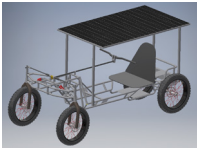
can be reproduced in the second test setup. Therefore, the spool is no longer displaced by solenoids but with the help of a linear actuator to drive the spool accurately. A sensitive force sensor is placed between spool and linear actuator to measure the flow forces as isolated from disturbance influences as possible. A test plan is set up which can be executed at HYDAC in Glendale Heights. Beforehand the test rigs will be assembled in the Milwaukee School of Engineering to ensure the mechanical functionality of the system. The final testing analyze can lead to better understanding of the cartridge valves function, enabling its improvement regarding the valve's geometry, performance, and efficiency.

#### **TEAM MEMBERS**

Anthony Casaletto  
Spencer Dittmann  
Brandon Gruber  
Anthony Pappalardo  
Ryan Runke

#### **FACULTY ADVISOR**

Dr. Mark Daugherty



#### **Off-Road Solar Powered Vehicle**

The purpose of this senior design project was to design and build an off-road vehicle. Batteries, a solar panel, and an electric motor were included in the design to assist the pedaling of the driver. The design also includes a shock and damper suspension system to provide smooth riding on bumpy surfaces such as gravel roads and grass fields. Steering, braking, drive train, and electronics were all designed to give a safe and fun user experience. The vehicle is intended for recreational use and was not designed for mass production.

*Appreciation is extended to: SunVest Solar Inc., Erik Lutz Ent., and DreamBikes.*

#### **TEAM MEMBERS**

Brad Boxrud  
Jake Jossart  
Jean-Paul Nguyen

#### **FACULTY ADVISOR**

Dr. Nathan Patterson



#### **UPWCS Team: Ultrasonic Plastic Welding Cooling Sleeve**

The overall objective of the project was to design a cooling sleeve for ultrasonic plastic welding sonotrodes that would cool the sonotrode to allow for more efficient welding and more frequent welding times. The need for an optimized cooling sleeve arose when the sonotrode overheated during long welding cycles, which caused each subsequent weld to decrease in quality below acceptable standards. MATLAB and ANSYS were used to simulate the heat transfer, internal heat generation, convection, and conduction of the system. The collected analytical data and the simulation models were used as a basis for a more optimized cooling sleeve. Once a physical prototype of the optimized cooling sleeve was constructed, dry air would then be run through the sleeve to adequately cool the sonotrode.

*Appreciation is extended to Herrmann Ultrasonics for providing this project.*

#### TEAM MEMBERS

Karolina Klimont  
Dan Lisowski  
Bingtian Piao  
Marcus Welsh

#### FACULTY ADVISOR

Dr. William Farrow



### Mechanically Minded Mining: NASA RMC Drivetrain Subsystem

As part of research and development for The NASA Robotic Mining competition team, this team has focused on designing a more robust drivetrain sub-system as an employable option for the coming years. The NASA RMC competition primarily comprises navigating a simulated lunar terrain containing craters and boulders to mine and deposit gravel. This simulates the mining of "icy regolith" with autonomy, the robot's ability to perform tasks unassisted, becoming an increasing focus over the years. This project focuses primarily on the wheels and grousers, or treads, as well as the motors and gearboxes. Effective wheel-grouser configurations would allow for better maneuvering around obstacles and across the arena while keeping wheel slip to a minimum. A more effective and responsive power train system would also aid in the autonomy of the robot where responsiveness and precision are essential.

#### TEAM MEMBERS

Max Dunst  
Björn Matthews  
Phillip Schöning

#### FACULTY ADVISOR

Dr. Mathew Schaefer



### Formula Hybrid Weight Reduction Team

Every spring, the MSOE Formula Hybrid Club competes in the Society of Automotive Engineers (SAE) Collegiate Design Series. The Formula Hybrid series challenges the students to design and fabricate a formula-style vehicle that is powered by a gasoline engine and an electric motor. This year's senior design will support the Formula Hybrid Club research design concepts that will reduce or optimize the weight of the race car. The weight optimization was split up in three different projects, including a redesign of the steering columns, firewall, and a refinement of the current frame structure by adding gussets. The steering columns were calculated against failure in critical situations with different materials. The lightest design with aluminum was chosen with connections to implement it into the vehicle. The firewall was analyzed with different materials in order to find a lighter design. Gussets of different shapes were added to the current frame structure and simulated in ANSYS. It was shown that this can decrease critical stress and deformation significantly, improving stiffness and safety. In order to reach a lighter or improved design, safety analysis calculations, CAD models in SolidWorks and simulations in ANSYS were done. The outcomes of these built the foundation to change material, dimensions or add gussets. The developed designs will help the Formula Hybrid team to build a lighter, more competitive vehicle for future competitions.

**TEAM MEMBERS**

Hailey Butler  
 Xikun (Marshall) Han  
 Muffi Kaiser  
 Francis Sena  
 David Thiel  
 Yiwei Wang

**FACULTY ADVISOR**

Dr. Farrow and Dr. Armstrong



## **Milwaukee Air: Commercialization of a Small Unmanned Aerial Vehicle**

The initial problem Milwaukee Air set out to solve was to find and develop a functional application for an unmanned aerial vehicle (UAV) that has the potential to become commercially viable in today's market. Milwaukee Air's task was to design, assemble, test, and improve an unmanned aerial vehicle with the purpose of extinguishing small fires in the home, office, classroom, and general indoor setting. The design utilizes existing extinguisher technology from off the shelf canisters and a quadcopter frame design as well as thermal and smoke sensors to autonomously and quickly seek out a fire and extinguish it. The UAV is designed to extinguish class A, B, and C fires originating in indoor settings. When arriving on market, the system will be fully autonomous and will include a charging/docking station for it to rest on while not in use. The system has the goal of supplementing, potentially one day even replacing, sprinkler systems by putting out the fire before fire sprinklers are needed in order to minimize both fire and water damage. For demonstration purposes the UAV will be remotely piloted with operational sensors instead of fully autonomous and the fire simulated.

**TEAM MEMBERS**

Jake Allen  
 Fabian Beets

**FACULTY ADVISOR**

Dr. Nathan Patterson

**Team Ben**

This project was started to give an individual with type 2 spinal muscular atrophy the ability to throw a baseball. Due to the limited motions of the individual, the product had to be as autonomous and compact as possible. The entire assembly will be attached to the individual's wheelchair and actuated with a single button press. This device will incorporate a laser range finder to determine the distance from the device to a catcher and launches the baseball via rotating wheels. The device will also contain a feeder assembly to allow storage of multiple baseballs. The baseballs will be released when the button is pressed by actuating a solenoid, allowing it to be launched by the wheels. This project was driven by the desire to help an individual enjoy their youth.

**TEAM MEMBERS**

Shubham Daler  
 Guy Kieckhefer  
 Jean-Luc Mayer  
 Anmol Sharma  
 Gage Wright

## **Cream Separator Restoration and Exhibit Creation**

The purpose of this project is twofold, restore an original DeLaval 1910's Cream Separator and develop a comprehensive exhibit. Old World Wisconsin and the Wisconsin Historical Society require the functional restoration of an original #17 DeLaval Company Cream Separator and the

**FACULTY ADVISOR**

Prof. Mark Ryan



development of an interactive and informative exhibit. The Cream Separator contains a cone assembly that has been damaged over the years. The cones have been reversed engineered to be remanufactured. The exhibit is a large table that houses a centrifugal mechanism in the form of a large spinning bowl that users can operate to separate different objects contained within the apparatus. This will provide a multi-faceted and comprehensive approach to providing visitors an understanding of the S.T.E.M. (science, technology, engineering, and mathematics) history, functionality behind the cream separator, as well as a memorable experience. Visitors will be able to watch the Cream Separator in action as well as use a hands-on exhibit to visualize how the Cream Separator works. Additionally, supplemental explanatory posters will integrate the exhibit and the machine together with history and science included to facilitate the visitor's understanding.

**TEAM MEMBERS**

Joseph Marlowe

John Smith

Dravin Thomas

**FACULTY ADVISOR**

Dr. Subha Kumpaty

**OWWO: Old World Wisconsin STEM Outreach**

The purpose of the Old World Wisconsin STEM Outreach project was to improve the existing program and to design and introduce new portions of the exhibits and curriculum of STEM related concepts at Old World Wisconsin. The former program at OWW consisted of simple levers, pulleys, a scale, and a rope making machine, each of which adequately demonstrated the related concepts such as moments, energy conservation, force multiplication, and basic statics. The improvements center around the formerly unutilized bicycle and wagon shops. At the bicycle shop, a sprocket and chain assembly with an encoder on each axle was assembled to demonstrate gearing concepts and the advantages and disadvantages of a reduction or increase of gear or sprocket ratios. At the wagon station, wheels of differing radii were constructed with a corresponding track in order to illustrate the relationship between radius and travel distance per wheel revolution without slip. In addition, supplementary educational material was created to aid in the process of conveying the concepts taught at each exhibit, including interactive worksheets for the students. The dialog used by the program facilitators also was altered to more accurately represent the concepts in a more engineering-based approach. The exhibits and their worksheets are designed to meet research done on the NAS and NAE guidelines for teaching STEM education to a K-12 audience.

**TEAM MEMBERS**

Wenzhe Liu  
Brett Knutson  
Alexander Pauls  
Samuel Rathburn  
Miro Stojanovic

**FACULTY ADVISOR**

Dr. Luis A. Rodriguez

**Educational Pneumatic Robot Team**

The overall goal of the Pneumatic Quadruped Walking Robot Senior Design Project was to further design and develop the control logic/user interface to implement a walking motion within the pneumatically actuated robot. Utilizing an animalistic gait walking pattern, the robot is to demonstrate a similar walking pattern seen within various four-legged animals. Upon successful implementation, the robot is to be used for educational purposes. The robot is to inspire today's youth into pursuing STEM related careers, specifically within motion control and fluid power systems. Also, the robot can be used as a teaching aid to higher level education courses. The specific objective for this Senior Design Project included using Simulink software to provide the control framework for the robot. Through the use of position feedback, the robot is to exhibit a smooth walking gait pattern. The robot is to be controlled via a simple user interface which can be operated by individuals with little to no experience within the engineering field. The team would like to extend much appreciation to SMC Corporation, as their generous support has allowed the project to progress and achieve the intended objectives.

## Bachelor of Science in Engineering Design Projects

**TEAM MEMBERS**

Nick Edwards  
Andrew Fritchen  
Gary Kniess  
Jon Tess

**SPONSOR**

Triton Trailers, LLC  
(Hartford, WI)

**Triton Trailer Redesign**

This team has been formed to assist Triton Trailer in evaluating concepts for a next-generation snowmobile trailer design. The team has chosen to divide up the redesign into three separate sub-projects: leak avoidance, frame optimization, and aerodynamics optimization. Each of these sub-projects are running in parallel with the work being divided up amongst sub-teams. The team is focused on designing a new trailer based on the platform of the TC-128 trailer. Changes made to this trailer should easily scale to the other sizes of hybrid trailers.

**TEAM MEMBERS**

Jonathan Austin  
Mitchell Kremel  
Thomas Porter

**SPONSOR**

Prestwick Golf Group  
(Sussex, WI)

**Prestwick Group Production Process Redesign**

The Prestwick Group (TPG) is an innovative company that produces creative, unique outdoor furniture from recycled plastic panels. They use CNC machines to remove material and create any design required in recycled high-density polyethylene (HDPE) panels with wood grain type finish. As with many companies, TPG is faced with a manufacturing issue that must be addressed; after material is removed, the HDPE panels bow upwards in the direction of the design. To combat this, TPG affixes a steel frame to the outer edges of each panel with screws. This project will examine new processing solutions for TPG to reduce the bowing of the HDPE panels, with a goal of eliminating the need for the steel frame.

## THL/MSOE Bachelor Theses

<b>Max Dunst</b>	Formula Hybrid Vehicle Frame Optimization and Weight Reduction
<b>Jonathan Enderle</b>	Utilizing State-of-the-Art Steel in an Offworld Mining Robot
<b>Miguel Joaquin</b>	Analysis and Improvement of Ice Hockey Helmet/Padding Material to Reduce Concussions and Other Symptoms
<b>Leonard Kruse</b>	Improving the Reliability of Threaded Connections of Cartridge Valves in Hydraulic Assemblies
<b>Malte Loeschenkohl</b>	Fluid Flow Simulation (CFD) of a Hydraulic Cartridge Valve to Determine the Effects of Geometrical Changes of the Spool on the Flow Forces Acting on Parts of the Valve and on the Behavior of the Valve
<b>Bjoern Matthewes</b>	Weight Reduction of the Bodywork for the Formula Hybrid Vehicle
<b>Hendrik Meier-Gerssler</b>	Design, Analysis and Weight Optimization of the Gearbox Housing of the MSOE Baja SAE Vehicle
<b>Mirko Neumann</b>	Design and Analysis of the Geartrain for the SAE Baja Vehicle
<b>Isaac Otterson</b>	Analysis and Redesign of a Piezoelectric/Acoustic Transducer
<b>Justin Pawlowski</b>	Automated Truck and Trailer Docking System
<b>Phillip Schoening</b>	Analysis and Optimization of the Formula Hybrid Steering Wheel with Rapid Prototyping
<b>Christian Tango-An</b>	Dense Fluid Injector
<b>David Thiel</b>	Quadcopter Frame Design, Analysis, and Optimization
<b>Pufu Tian</b>	Suspension System for the Off-Grid RV Bike
<b>Marcus Welsh</b>	Simulation Assessment of Position Reckoning Algorithms to Enable Autonomy
<b>Jan Philipp Ziel</b>	Computer Modeling for Fatigue Life Calculation of an Aluminum Hydraulic Manifold

# School of Nursing

## Summer 2018 Senior Projects

### STUDENTS

Kelly Blaha  
Kate Chodak  
Sarah Goldammer

### **Implementing a Pre-Insertion Checklist to Prevent Central Line Infections**

Central line infections are the most common and preventable infections in healthcare. The CDC estimates central line infections cost more than \$1 billion annually with a cost per patient of more than \$16,000. Implementing a central line insertion bundle is a simple and affordable way to improve patient safety, reduce cost, and use the most current evidence-based practice. We are focusing on the emergency room because there is less evidence about the incidence in this setting. We want to improve the central line infection bundle by adding a checklist, adding mandatory education about preventing central line infections, enabling nurses to speak up if staff are not complying with the checklist, using standardized insertion kits, and incorporating current best practices found in research.

### STUDENTS

Colin Opay  
Rachel Semenak  
Rob Karczewski

### **Implementation of Early Warning Systems in Adult Inpatient Settings**

In the adult clinical setting, there currently is no standard numeric system implemented to indicate the deterioration of a patient. The early warning system (EWS) has been implemented in a variety of settings across the world and has shown benefit to the patient population. The goal of this project is to implement early warning systems in the hospital setting in order to efficiently evaluate patient acuity and appropriate escalation of care. When these systems are implemented correctly, hospital staff, especially nurses, are empowered to practice more efficiently and improve patient outcomes.

### STUDENTS

Brittany Daniel  
Hannah Zobel  
Ruthie Ballweg

### **Implementing Bereavement Debriefing Sessions in Rural Hospitals to Reduce Anxiety Surrounding Pediatric Death**

Small rural hospitals tend to have limited resources for dealing with the pediatric bereavement process. The purpose of this project is to develop a process and structure for conducting bereavement debriefing sessions after the death

of a pediatric patient. Death anxiety is a negative emotion that is associated with healthcare workers who provide care for pediatric patients who die. The goal of debriefing sessions is to reduce death anxiety for healthcare providers.

#### **STUDENTS**

Ryan Vanderloop  
Amy Green

#### **Decreasing Medication Nonadherence Among Geriatric Patient Populations in an Ambulatory Setting Through the Implementation of a Medication Organization Tool**

Nearly 50% of Americans are non-adherent to their prescribed medication regimens. The geriatric patient population commonly experiences barriers to medication adherence, such as polypharmacy, forgetfulness, costs, and lack of adequate medication education. Our goal is to implement a medication organizational tool into ambulatory care settings that will promote medication adherence among the geriatric patient population.

#### **STUDENTS**

Sumayo Mahamood  
Coua Moua  
Julie O'Hara

#### **Utilizing Mobile Transitional Care to Prevent Hospital Readmissions for Mental Health Patients**

Mental health is a growing patient population. The developing data within this population indicates that their needs are not being adequately met, leading to an over or under utilization of medical services. If this issue is not addressed, it can negatively impact patient, facility, and community outcomes. The purpose of this paper will be to determine the relationship between post hospital discharge tele-mobile transitional care and readmission rates among mental health patients. Ideally, providing these patients with additional support and resources after discharge will not only decrease re-hospitalization, but also improve patient outcomes, allow for appropriate medical service utilization, and decrease unnecessary readmissions.

## Fall 2018 Senior Projects

### **STUDENTS**

Emorie Harty  
Jaenelle Ignacio

### **FACULTY ADVISOR**

Professor Ellen Toth

### **Debriefing and Supporting Hospice Nurses After A Patient's Death**

Nurses experience patient deaths often, but what happens when organizations do not support the nurses on the frontlines of death? Burnout. This project looks into the concept of providing debriefing services for hospice nurses after a patient's death and connecting nurses with other nurses to help them with their loss. The purpose of the project is to look at the many benefits of providing hospice nurses with a debriefing service to reduce the high rate of nurse burnout in hospice.

### **STUDENTS**

Tylar Pon  
Lauryn Przekurat

### **FACULTY ADVISOR**

Dr. Jennifer Klug

### **Elimination of Bath Basins to Decrease Nosocomial Infections**

As nosocomial infections are a leading cause of death in hospitals, increasing hygiene measures can stop preventable infections and promote skin health in clients. While evidence reveals that the supplies used for traditional bed baths are colonized by bacteria, the transition to bath wipes from bath basins can promote healthier client outcomes.

### **STUDENTS**

Jill Brebeck  
Therese Morel  
Marissa Schultz

### **FACULTY ADVISOR**

Professor Ellen Toth

### **Subcutaneous Insulin Pump Use in an Inpatient Setting**

The purpose of this project is to improve patient and family satisfaction in the pediatric inpatient setting. This would be done by allowing the use of subcutaneous insulin pumps throughout the patients stay if unrelated to diabetes. An admission document was designed to be completed upon arrival by the patient or qualified family member. Given they can fulfill all the requirements of the document, patient insulin pumps would remain applied while admitted. This would help reduce cost and waste for the hospital while keeping patients and families satisfied with their care.

## Winter 2018–2019 Senior Projects

### **STUDENTS**

Kaitlyn Goss  
Krystal Allman  
Amanda Dahlk

### **Improving Quality of Care in Skilled Nursing Facilities Through an Increased Registered Nurse Utilization**

Current state statutes regarding registered nurse (RN) staffing in skilled nursing facilities (SNF) require only one registered nurse on a unit for up to 100 residents. This high patient to nurse ratio leads to more adverse patient outcomes, which can end up costing the SNF hundreds of thousands of dollars a year. The purpose of this project is to show how adding extra nurses on shifts in skilled nursing facilities will show a decrease in costly adverse patient events, such as falls, pressure ulcers and UTI's. This will improve CMS quality measure indices, saving skilled nursing facilities hundreds of thousands of dollars a year.

### **STUDENTS**

Katie Russo  
Lyndsay Wilde  
Crystal Ruppert

### **Simulation Tool to Assist ER Nurses in Identifying Postpartum Pre-Eclampsia**

A simulation was created for use with ER nurses to assist them in identifying signs and symptoms of postpartum pre-eclampsia. Research has shown that postpartum pre-eclampsia is often missed and patients go undiagnosed or are treated for other conditions. Nurses are at the front lines and, when properly prepared, have the opportunity to catch these patients and improve outcomes.

### **STUDENTS**

Kendall King  
Caitlin Prunty  
Lauren Zemke

### **Text Messaging as a Case Management Strategy for Outpatient Diabetes Management**

The purpose of this project is to devise an educational tool using text-messaging communication for case management in outpatient diabetic patients. The educational tool will improve diabetic self-management through facilitated glucose control, health education, and continuity of care.

### **STUDENTS**

Katie Witten  
Tylor Hine  
Chad Kelsey

### **Recommended Laundering Practices for Uniforms to Prevent the Spread of Micro-Organisms in the Healthcare and Home Setting**

The purpose of this project is to incorporate facility provided scrub suits and laundering practices to prevent the transmission of potentially harmful micro-organisms to reduce Healthcare Associated Infections. To accomplish

this, a policy was instituted and instructional guidelines were provided to all staff members to obtain maximal reduction in micro-organisms on scrub suits and personal clothing.

#### **STUDENTS**

Paige Woeckner  
Patricia Espino  
Sara Weselowski

#### **Family Presence During Resuscitation in the Emergency Room**

This project explores the pros and cons of allowing family members to be present during cardiopulmonary resuscitation in the emergency room.

#### **STUDENTS**

Kate Sasse  
Claire Songkakul

#### **Establishing Modified Frailty Parameters and a Cardiac Rehabilitation Program for Frail Heart Failure Patients**

Establishing modified frailty parameters through a new assessment tool as well as creating a specialized cardiac rehabilitation program for frail heart failure patients. The goal of these new modifications in frailty parameters and interventions are attempts to improve outcomes and prognosis for frail heart failure patients.

#### **STUDENTS**

Loran Hazlett  
David Kupsy  
Tylor Rockwell

#### **Incorporation of Social Determinants into Patient Care Plan**

This project is to implement a tool that addresses the social determinants of health for patients in a simulated outpatient diabetic clinic. Research has shown the environment people live in can have a detrimental affect on health outcomes. This tool is to help bridge disconnect between the clinical setting and the patient environment to produce improved health outcomes.

#### **STUDENTS**

Amanda Bretzmann  
Raechel Helmen  
Sarah Arguello

#### **Increasing Cardiac Rehab Admissions for Vulnerable Populations**

This project purpose is to increase the admission rate of cardiac rehab for vulnerable populations with the use of a questionnaire. This tool was created to assess risk factors for individuals who have a more difficult time receiving care from cardiac rehab.

**STUDENTS**

Jennifer Hebl  
Melinda Rodriguez-Salus  
Alexis Stevens

**Early Auditory Stimulation for Enhancing Premie Brain Development**

When babies are born prematurely, the auditory part of the brain is often underdeveloped, which may affect their ability to hear, speak, learn, and connect socially later in life. We are proposing a program which records and plays back a paternal voice and heartbeat for babies in the NICU. It is known that these sounds improve vitals, sleeping and feeding patterns, and potentially later outcomes.

## Spring 2019 Senior Project

**STUDENTS**

Mathew Urick  
Shumo Gu  
Sharon Romero

**FACULTY ADVISOR**

Dr. Victoria Carlson-Oehlers

**The Use of High-Fidelity Simulation with New Nursing Graduates in Hospital Preceptorship**

Patient safety is a critical concern within a hospital setting. It is imperative for newly licensed registered nurses (RN) to have proven abilities to practice with safe knowledge, skills, and attitude when delivering human care. Through intense review of nursing research literature, a project has been designed to test new RN employees through simulated hospital events that would demonstrate their competencies in delivering high-quality safe care. This project explores how using a change process to implement these high-fidelity simulation centers could benefit institutions by improving nursing skill competency among current staff nurses and ultimately improve outcomes for patient safety.

**STUDENTS**

Levi Barnes  
Travis Martin  
Sam Bertram

**FACULTY ADVISOR**

Professor Ellen Toth

**Promoting Policies for Proper Prevention of Pressure-Ulcers for Patients Prone to this Prevalent Problem**

Each year, more than 2.5 million people in the US develop pressure ulcers with an associated cost of approximately \$9.1 billion to \$11.6 billion, averaging \$20,900 to \$151,700 per pressure ulcer (Agency for Healthcare Research and Quality, 2014). To reduce the complications and costs associated with these, our paper focuses on implementation of a pressure ulcer bundle which includes: initial skin assessments within four hours of admission, incontinence care, frequent patient turning, proper nutrition, and identification of at-risk patients using the Braden scale. We have concluded that having a standardized bundle regarding pressure ulcer prevention successfully reduces the incidence of pressure ulcers in many settings.

**STUDENTS**

Jamie Spanbauer  
Mari Schaefer

**FACULTY ADVISOR**

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**Effects of Early Skin-to-Skin Contact  
of Breast feeding Success**

Mother-infant separation following birth is accepted practice in labor and delivery units in the United States. This project examines the research question: In breast fed babies, how does early skin-to-skin contact (SSC) affect breast feeding success of the newborn. SSC is defined as placing the dried, naked baby prone on the mother's bare chest, covered by a blanket. Ideally, SSC should be initiated immediately post-birth and sustained for at least the first hour of life. Education regarding the benefits of SSC should be provided to all nursing staff in labor and delivery units to improve adherence to SSC protocols. Labor and delivery nurses should also be instructed to offer SSC to new mothers while performing routine procedures for the newborn.

**STUDENTS**

AylseBosman  
Heather Dukat  
Amalia Melissourgous

**FACULTY ADVISOR**

Dr. Victoria Carlson-Oehlers

**Changing Unit Based Nursing Practice: Transforming How  
Hospital Nurses Perceive the Need to Provide Accurate  
and Timely Patient Acuity Information**

Adequate nurse staffing ratios are essential to high quality care in patients. It has been documented that when there are not enough nurses to provide care, there is an increase in poor patient outcomes, such as medication errors, missed therapies, and sometimes even death. Adequate communication on the complexity of each patient is essential in receiving adequate nurse staffing for care. On many hospital units, this complexity level is measured through using a numerical system called patient acuity rating. When investigating this issue on a unit at a Midwestern pediatric hospital, it was found that patient acuity was not provided in a timely method prior to the following shift, thus affecting the nurse staff ratio for that shift. The purpose of this project is to design a process that affects change on this unit for more timely and accurate patient acuity documentation. This process will be driven to change perceptions and influence nurse behavior to provide more timely information that will more accurately reflect nurse staffing ratios for the care of these pediatric patients.

**STUDENTS**

Michelle Askrud  
Kelsy Hahn

**FACULTY ADVISOR**

Dr. Victoria Carlson-Oehlers

**Consequences of Poor Nurse Staffing**

Amongst the health care world and nursing industry, it is known that there is a shortage of nurses to provide care. However, the consequences of this is not always understood. This paper will demonstrate the negative impact of this

nursing deficit. Currently, there are too many patients and not enough nurses to take care of them. This leads to poor nurse to patient ratios, meaning there are too many patients for one nurse to care for. Poor ratios can lead to a variety of complications such as inadequate care, rise in infection rates, and even death (Avalere, 2015). This paper will be focusing on infection rates in a hospital environment. Specifically, the question this paper will address is: Due to inadequate staffing, is there a correlation of increased infection to inadequate nursing staff on medical surgical floors? Solutions may include a mandated nurse to patient ratio and incentives for nurse retention. In this paper, research information will be provided that illustrates the necessary rationale for why there needs to be adequate nurse staffing for patient care with potential solutions for this problem.

#### **STUDENTS**

Katelyn Petersen  
Madeline Schroeder  
Emily Snow

#### **FACULTY ADVISOR**

Professor Ellen Toth

#### **Oral Care in the ICU**

Hospital-acquired infections are a significant concern, especially in the Intensive Care Unit (ICU). One of the most common nosocomial infections reported in critically ill patient population is ventilator associated pneumonia (VAP). Though it has been well-established that good oral care can prevent VAP, effective oral care practices among ICU nurses remains inconsistent. The purpose of this paper is to systematically identify, analyze and discuss various strategies to be implemented to increase oral care compliance among nurses within the ICUs while integrating the best evidence-based protocols.

#### **STUDENTS**

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#### **The Use of High-Fidelity Simulation with New Nursing Graduates in Hospital Preceptorship**

Patient safety is a critical concern within a hospital setting. It is imperative for newly licensed registered nurses (RN) to have proven abilities to practice with safe knowledge, skills, and attitude when delivering human care. Through intense review of nursing research literature, a project has been designed to test new RN employees through simulated hospital events that would demonstrate their competencies in delivering high-quality safe care. This project explores how using a change process to implement these high-fidelity simulation centers could benefit institutions by improving nursing skill competency among current staff nurses and ultimately improve outcomes for patient safety.

**STUDENTS**

Gabrielle Weber  
Tonya Jobe

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Professor Ellen Toth

**Protection for First Responders when Dealing with Fentanyl Exposures**

Fentanyl overdoses have become a highlighted problem within the general society in the recent years; however, not much emphasis has been focused on the risks that the first responders are faced with. Recently, there has been some development concerning protecting the various responders, however the measures currently in place are not nation-wide standards. Although fentanyl overdoses have become a recent problem, much research and new safety implementations should be investigated in order to ensure safety for the people trying to provide services for the public.

**STUDENTS**

Haniah Ahmad  
Yazmine Wright

**FACULTY ADVISOR**

Professor Ellen Toth

**Effects of Discharge Teaching on Readmission Rates in Children with Asthma**

Clinical pathways are set policies and guidelines based on a patient's condition. It guides the treatment of the patient, such as what medications to give, and allows for discharge teaching to be completed throughout their stay. Our project assesses how clinical pathways can be used to improve patient outcomes, decrease readmission rates and overall decrease hospital costs.

**STUDENTS**

Sukainah Alwersh  
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Professor Ellen Toth

**Pain Management of Sickle Cell Disease**

The hallmark of Sickle Cell Disease (SCD) is intense pain throughout the body. The most common way to treat SCD is short-acting opioids. In this paper, we discuss the great advantages of using long-acting opioids, such as Methadone, in comparison to short-acting opioids. Long-acting opioids, supported by Evidence-Based Practice (EBP), have many great advantages, such as better management of pain, a significant reduction in hospital admission rates, and increasing the overall sense of well-being. In addition, with the use of long-acting opioids, the patient requires smaller and fewer dosages of opioids in comparison with a short-acting opioid, which requires higher and frequent dosages to subside the pain. We will compare and contrast a few research studies conducted about the use of long-acting versus short-acting opioids in patients with SCD.

**STUDENTS**

Sarah McConnell  
Victoria Fischer  
Hailey Blount

**FACULTY ADVISOR**

Dr. Victoria Carlson-Oehlers

**Improving Vaccination Rates through Education and Eliminating Barriers to Access in Care**

It is well known that there is an increase in outbreaks of childhood disease that are vaccine-preventable. Vaccinations protect and prevent communicable diseases and provide immunity to children who have not yet acquired resistance to many communicable diseases. Children from birth to three years old are the highest numbered population that are most susceptible to vaccine preventable diseases and require vaccination. This project is designed to develop a process to promote vaccinations through education and on-site clinic immunization programs, minimizing barriers to vaccination.

# Physics and Chemistry Department

## BioMolecular Engineering Senior Projects

### TEAM

BioE2

### TEAM MEMBERS

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### **Design of a pectin-based bioink containing estradiol-loaded microspheres for bioprinting towards fertility restoration applications**

About one-third of couples in which the woman is older than 35 years have fertility problems due to damaged endometrial tissue and/or aging. Estradiol (E2) is an estrogen hormone which has been shown to increase fertility and the chance of conception in women. The goal of this project was to integrate E2 into a novel, bioprinted tissue scaffold to promote fertility restoration and potential tissue regeneration. After considering its properties, E2 was encapsulated into a S/O/W emulsion system and electrosprayed to create microspheres for controlled release. The E2-loaded microspheres were incorporated into a pectin-based bioink and its bioprintability was tested. The chemical and imaging analysis results showed that the E2-loaded microspheres could be prepared under optimized conditions to achieve ideal size and morphology, and microsphere incorporation did not adversely affect the bioprinting process. Moving forward, this novel tissue scaffold shows great promise for endometrial tissue restoration and fertility improvement.



**TEAM**

Code Cartographers

**TEAM MEMBERS**

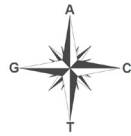
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**Google Maps Inspired Genome Browser**

Genome browsers are an essential tool for researchers and academics alike to navigate bioinformatics data in a comprehensive format. Our project introduces a Google Maps inspired browser to present genomic data in a navigable circular format that is intuitive to users. Users may scroll through a list of peptide-coding genes and snap to a specific location on a pre-loaded bacterial genome. The coding and noncoding regions are colored differently, with the origin of replication (oriC) marked and highlighted. The control buttons for rotation functionality further make it easier to navigate through the loaded circular bacterial genome. For each gene clicked, a box will pop up in the lower-right corner of the user's screen, displaying its gene identifier, codon information, and its respective translated peptide sequence.

**Developing a Visual Comparative Genomics Tool**

This project is to improve upon the previous teams' GeneFunc genome browser by adding comparative features. The resulting comparative genomics tool loads and displays two different bacterial genomes simultaneously as concentric circles, along with a menu of annotated peptide-coding genes, allowing users to comparatively navigate identified and annotated peptide-coding genes between two different bacterial organisms. The tool could be used by researchers and students, allowing them to visualize bacterial genomes and their shared/unique sequence features. Our goal this year is to improve its user interface by adding more user-friendly comparative features and make it possible to navigate and compare two bacterial genomes more interactively and more intuitively. Our team has so far added a dynamic color legend and enabled a rotation feature of the two loaded genomes.

## **TEAM**

Guts and Glory

### **TEAM MEMBERS**

Kyle Brown (Engineer)

Kajal Kajal

(Assistant Project Manager)

Hannah Pekarek

(Project Manager)

Rachael Romano (CFO)

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## **TEAM**

R.E.D.

### **TEAM MEMBERS**

Alexa Anderson

Amanda Cherwin

Grace Kusik

Shelby Namen

Justyna Rapacz

## **Probiotic Modulation of Immune Response**

Overuse of antibiotics is causing antibiotic-resistant bacteria, which traditional medicine can't cure. As a result, excessive antibiotic prescriptions are being cut down and new cures for bacterial infections are being explored. This issue has caused a push to use probiotics that facilitate growth of amiable bacteria instead of antibiotics that kill off bacteria. This amiable bacterium can help fight against the same pathogens that antibiotics are used to treat. However, to fight these pathogens with the same efficacy as antibiotics, new bacterial strains or strain cocktails will need to be investigated. To aid in this research, Team Guts and Glory will aim to study the effects of different probiotics on the porcine cell line IPEC-J2. To measure the probiotic efficacy, tight junction (TJ) proteins, which play a major role in intestinal barrier function, will be tagged with fluorescent antibodies and analyzed under a fluorescence microscope.

## **Process Optimization of a Novel Pectin-based Oxygen Therapeutic Production for Industrial Scale Up**

Currently, there is no available hemoglobin-based oxygen therapeutics for human use in the U.S. The purpose of this research was to develop a novel pectin hydrogel-based oxygen therapeutic. There were four main criteria for developing the oxygen therapeutic: size, morphology, stability, and functionality. An electrospray setup was used to create biconcave-shaped capsules. Firstly, varying concentrations of 6-10% pectin were tested to determine an optimized formulation. An 8% pectin concentration was determined to be the optimal concentration, as it produced

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Sysmex America

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biconcave-shaped hydrogel capsules that were between 6-10 micrometers in diameter. Secondly, the process parameters of voltage, height, and flow rate were optimized for industrial scale up using Design-Expert for experimental design and statistical analysis. Thirdly, the stability of capsules was investigated by observing the degradation time in a controlled solution. Lastly, encapsulation efficiency of hemoglobin was determined to be 98%. These findings suggest proof of concept for a novel oxygen therapeutic.

**TEAM**

Waterbugs

**TEAM MEMBERS**

Carolyn Czerniak  
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Hydrotech Innovation LLC  
Dr. Jason He  
Virginia Tech

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Seed Grant,  
Hydrotech Innovation LLC

**Microbial Fuel Cell**

The goal of the microbial fuel cell (MFC) team this year was to perform feasibility testing with two MFCs created by last year's team. One of these cells has an anionic exchange membrane and the other has a cationic exchange membrane. The team was able to prove functionality using a multimeter and DO probe to measure electrical output and calculate BOD reduction. While BOD reduction was proven to be successful with a wide variety of testing parameters, electrical output was suboptimal. As testing continues, the team will work on adjusting parameters to increase the electrical power output of the cells and to prove industrial feasibility.

Notes: