Friends of MSOE:

Senior Project Day at MSOE is a long-standing tradition. It 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 as part of Senior Project Day.

Senior Project Day is a day of 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 Sue Miller, executive secretary, by Aug. 5 to be considered for the 2018–2019 academic years. 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
miller@msoe.edu

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 2017–2018 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.

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

Student Projects Schedule and Building Locations

Guests are encouraged to park in Viets Field, 1305 N. Broadway, free of charge on May 25 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.

Pages 4–7

Civil and Architectural Engineering and Construction Management Department
Saturday, May 19, 2018 | 8 a.m.–noon
Campus Center, lower level, 1025 N. Broadway

Pages 8–11

Rader School of Business
Projects not on exhibit

Page 12

Humanities, Social Science and Communication
Projects not on exhibit

Pages 13–32

Electrical Engineering and Computer Science Department
Friday, May 25, 2018 | 11 a.m.–2:30 p.m.
Walter Schroeder Library and Werwath Mall,
500 E. Kilbourn Ave.

Pages 13–17

Biomedical Engineering Projects
Friday, May 25, 2018 | 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.).

Pages 33–55

Mechanical Engineering Department
Friday, May 25, 2018 | Noon–3 p.m., Campus Center, Todd Wehr Auditorium, 1047 N. Broadway

Pages 61–67

School of Nursing
Friday, May 25, 2018 | 10 a.m.–noon
Campus Center, Ruehlow Nursing Complex, first floor, 1025 N. Broadway

Pages 68–75

Physics and Chemistry Department
Friday, May 25, 2018 | 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.

Section One

FACULTY ADVISORS

Christine Brotz (E)
Dave Grassl (H)
Robert Lemke (A)
Jamie Radomski (P/F)
Dr. Jeong Woo (CM)
Dr. John Zachar (S)

TEAM A

Michael Boehmer (CM)
Taylor Heideman (ME)
Joseph Oswald (ST)
Miya Preston (ME)
Hunter Ring (CM)
Joey Trevis (EE)

TEAM B

Corey Andersen (EE)
Erik Billstrom (ME)
Mitchell Hickmann (ME)
Max Morache (ST)
Brian Mueller (CM)
Maxwell Kemp (EE)

Civil and Architectural Engineering and Construction Management Senior Design Student Projects

Section 1: Public Market with Housing
Clients: Bank First National, City of Manitowoc
Student Teams: A, B, C

The City of Manitowoc wishes to reintegrate the downtown with housing and other visitor attractions. The proposed site is on the Manitowoc River in the heart of downtown Manitowoc. The site is presently utilized mainly for the summer outdoor farmers market and other public events on occasion. The city would like to see a proposal for a year-round public market that is both flexible for seasonal activity and allows a residential component above or as part of the public market. The ideal solution would have enclosed parking, a river walk and possible boat docks that would be able to coexist with the public market. The students will need to design the market and adjoining housing and ensure that it is marketable and operational. A budget will need to be determined once the students determine the number of possible units and public market size. The hard cost construction budget is $100 per square foot.

TEAM C
Megan Fugitt (ME)
Ben Mahrer (EE)
Andrew Miller (CM)
Michelle VanBuskirk (ST)
Alex Vetroczky (CM)
Trevor Symbal (ME)

Section Two
FACULTY ADVISORS
Christine Brotz (E)
Josh Halvorsen (CM)
Michael McGeen (A)
Doug Nelson (P/F)
Jeff Saunders (H)
Bob Schumacher (S)

TEAM D
Braden Andryk (ST)
Clinton Garris (CM)
Becky Guzman (EE)
Greg Lisowski (CM)
Dylan Sobczak (ME)
Brandon Wenzel (ME)

TEAM E
Abigail Allen (EE)
Sean Barron (ST)
Patrick Collins (ME)
Michael Ochoa (CM)
Jacob Paiser (ST)
William Westfall (CM)

TEAM F
James Beeson (ME)
Sam D'Amato (CM)
Catherine Faulkner (CM)
Zachry Grant (ST)
Luke Muller (EE)
Joel Reed (ST)
Evan Rogers (ME)

Section 2: Grace Commons
Clients: Tarantino, Capri Communities
Student Teams: D, E, F

Grace Evangelical Lutheran Church is located on roughly 80 acres on County Line Road just west of 41/45. Tarantino & Co. is acquiring roughly 39 acres on the east side of the site to build a senior campus with independent living, assisted living and memory care components. There are several site and topographical challenges including an existing county-owned storm detention basin, pocket wetlands, existing tree line, and elevation changes of about 25 feet. The development will be a combination of three- and one-story buildings connected to gain efficiencies including staffing and food service. There will be underground parking under the independent living building with a 1:1 ratio of parking stalls to independent living residents. The client has proposed a preliminary space program. The project will include support spaces, independent living, assisted living and a CBRF-memory care component. There will be over 150 housing units.

Construction Budget: $27,000,000
Development Budget: $35,000,000

Section Three

FACULTY ADVISORS

Susan Becker (A)
Shauna Boyer (CM)
Dave Grassl (H)
Doug Nelson (P/F)
Doug Sauer (E)
Dr. John Zachar (S)
Alex Phillips (E)

TEAM G

Mason Baudhuin (ST)
Holly Denfeld (CM)
Kelsey Hailey (ME)
Spencer Kamke (EE)
Anna Rowe (ME)
Garrett Willems (CM)

TEAM H

Yazeed Almazyad (ST)
Owen Burnikel (EE)
Nicholas Ferguson (ME)
Mary McFee (CM)
Jake Landry (ME)
James Ring (CM)

TEAM I

Julian Christiansen (ST)
Andrew Hahn (ST)
Patrick Mucharski (ME)
Colton Neabling (CM)
Hannah Wassmann (ME)
Brent Wilcox (CM)

Section 3: Mixed Use Development with Apartments Above Offices and/or Retail

Client: Selzer Ornst
Student Teams: G, H, I

This project calls for the demolition of the current Selzer Ornst site and creating a 3–5-acre mixed use development. The site fronts State Street and the client may acquire additional land to achieve the proposed acreage. The client is looking for the most marketable and efficient development layout with the most number of units that also create a sense of community. The ideal project includes enclosed parking, tenant amenities such as a fitness area, movie/party room and some green space. The initial hard cost construction budget should be at $110 a square foot. A demo cost should also be added to the development budget. The students should look at recent Wauwatosa housing developments for market and design ideas. This include State Street Station, Eschelon Apartments, the Reserve and the Reef Apartments.

Civil Engineering
Senior Projects

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

TEAM A
Gage Christiansen (CM)
Stephen Hauser (ST)
Trey Horbinski (ST)
Andrew Mackensen*
(WR/Envi)
Jonathan Giera (WR/Envi)
George Manesiotis*(CM)
Micahel Schmidt (ST)
Paul Wichmann (ST)
**Indicates Project Manager*

Military Ridge Trail Bridge Design, Springdale Street, Mt. Horeb, Wisconsin

Client: Wisconsin Department of Natural Resources-Parks and Recreation and The Friends of the Military Ridge Trail

Major Task Team A: Students will analyze potential designs for removing and replacing this former railroad bridge over SR Bus 18 in Mt. Horeb. The existing bridge requires lead paint remediation and one option is to remove the bridge, remediate it off site and replace the bridge with a new bridge. Students will develop a design to perform this task with special attention to budgeting and scheduling. Springdale Street is one of two major access points into the Village from Highway 18.

Major Task Team B: The Military Ridge Trail is a mostly gravel/limestone multi-use trail stretching 40 miles from Verona, Wisconsin on the eastern terminus to Dodgeville, Wisconsin on the western terminus. The trail uses previously existing railroad bridges for its many stream crossings. Many of these bridges are in need of upgrades due to aging and wear. Students will inventory bridges and prioritize the upgrade of all parts of the trail infrastructure. Preliminary bridge designs, schedules and projected costs need to be part of the plan.

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

TEAM A
Ryan Flores (CM)
Jordan Guth* (CM)
Elizabeth Hilby (ST)
Kelsey Murzyn (WR/Env)

TEAM A
Joseph Fassbender* (CM)
Richard Kapungu Jr. (ST)
Taylor Patterson (WR/Env)

Wastewater Influent Structure Design

Client: Village of Grafton Utilities, Grafton, Wisconsin

The utility recently performed a facility planning process and identified a new headworks facility as a high priority, near-term project. Students will be responsible for equipment selection of grit removal, screening, flow measurement and pumping. A new building to house all of this equipment will be designed with all of the specialized needs of the equipment. A detailed budget and schedule design will be part of the process.

Rader School of Business

Undergraduate Management Internship Experience

Students: **Marcel Bruns, Johannes Oschinsky**

Company: **Krones**

Project: The focus of this project is on the reduction of the overall throughput time based on the spare part business. Main causes of the long lead time have to be identified by using process optimization tools. Next, solutions of the detected problems have to be proposed. This should support the Krones Inc. vision of reducing the throughput time to a 7-day time period. The implementation of the proposed improvements is an element of the project to a certain level. Short-term improvement should be implemented as far as possible. The project is divided in two main parts including two students. Johannes is responsible for the shop floor containing warehouse, logistics and shipment. Marcel is responsible for the office floor, containing the order creation, order management and purchasing department.

Student: **Lea Buchholz**

Company: **KHS Waukesha**

Project: Currently, the estimation of build times at KHS USA Inc. vastly depends on previous experience of certain employees. This leads to inaccurate estimation, which leads to inaccurate delivery lead times, which in turn leads to a dissatisfied customer; sometimes costing the company millions in penalties. An accurate estimation can lead to the company knowing its capacity better, and estimate better lead times, keeping current capacity in mind. The project asks to extract the lead times out the ERP-System and create a database to analyze the historical performance on different projects. Goal is to create charts giving a good visual of historical comparisons of times, and to disinter various avenues for improvements.

Student: **Tim Engel**

Company: **HellermannTyton**

Project: Analyze and re-slot Romeoville Pallet Racking, Very Narrow Aisle (VNA), Deep/non-standard locations,

Picking Module and the Miniload ASRS. Working with Romeoville and Milwaukee staff to consider SKU placement based on sales velocity, shipment configuration (ie. pallet, carton or package), storage media type and material handling equipment type (ie. reach truck, turret truck and order pickers).

Student: **Merve Guenes**

Company: **HellermannTyton**

Project: The Good Hope manufacturing site is approximately 200,000 square feet of manufacturing and storage space that produces more than 40,000 finished good pallets each year. There are two primary types of material flow in the factory—finished goods leaving the press to the shipping dock and work in progress (WIP) goods to the packaging cell. The offline packaging project is shifting the mix of finished goods and WIP. The purpose of the project is to provide recommendations or the best performing options to improve material handling based on safety, investment, operating cost, performance and utilization. By the end of this project (end of May 2018) an analysis on the current state of HT material flows will be provided as well as a technology review of material movement and practices. The combination of input from key stakeholders, the technology review and a system model will help to create a recommendation plan describing a future state on the greatest performance based on safety, investment, operating cost, performance and utilization.

Student: **Gresa Krasniqi**

Company: **Strattec**

Project: The purpose of the project is to analyze and document the process in the 315 ton Die Cast area. Propose and create a list of documentations for the 315 ton Die Cast area by observing the processes and interviewing the quality department, supervisors and operators. Secondary success measures will include documentation and visualization of the process. Third, recommendations to improve the work flow can be made.

Student: **Felix Kuekenhoener**

Company: **KHS Waukesha**

Project: This thesis researches on improving the inner material transport process at KHS in order to make it more efficient and effective. Doing so the current state is going to be defined and analyzed. Moreover, recommendations for improvement will be designed based on the findings from the current state analysis. The objective focuses on the process steps starting with the collection of the required material, from the inventory control department, to the transportation and delivery of the material to the designated inbound drop zones, and finally the collection and routing of any outbound material from the production zones to the next process steps as called out on the shop order. The staging process within the production zones and the process steps executed before the actual inner transport starts from inventory control are only partly considered in this thesis and subject to recommendations for improvements in the future.

Student: **Lennart Rieckmann**

Company: **KHS Waukesha**

Project: Controlling and automating the workflow of Specialty Tools and Fixtures at the KHS Waukesha Plant by utilizing the ERP System. Implementing different storage locations by employing Lean Management Principles, creation of a database and developing a process of tracking the specialty tools and fixtures as well as to reverse engineering them. Afterwards, executing the developed process by sampling each production area to help performing the procedure.

Student: **Christian Volp**

Company: **KHS Waukesha**

Project: Increasing efficiency of the material flow by implementing a standardized parts staging concept, and organizing the work places at KHS USA Inc. Waukesha, while considering Lean methodology. Many parts get lost in the staging process of the Process Technology Department. Once parts leave the Inventory Control area they are no longer traceable. The Inner Transport team of material handlers delivers the parts to the main assembly hall where they are dropped off as more or less complete shop order deliveries in the inbound zone of each department. Currently, there

is no standardized method used to stage the parts for good availability at the point of assembly. Therefore, many parts disappear or haven't been received from inventory yet. This leads to long sort and search times for parts as a result. Another cause for the loss of parts is the poorly organized work places in the department. It is the task of the intern to improve and secure the material flow in the Process Technology Department by establishing a standardized staging method and by redesigning the workplaces in a more efficient way by considering Lean Management and 5S.

Humanities, Social Science and Communication Department

User Experience and Communication Design Senior Projects

Student: **Mengwei Tang, B.S. User Experience and Communication Design**

Company: **UX/UI Designer at Concurrency**

Faculty Advisor: **Dr. Tammy Rice-Bailey**

Mengwei works with the Concurrency UX team to achieve User Experience excellence for Concurrency's clients. User experience and user interface design play a crucial and unique role at Concurrency. While some companies place User Experience under the wings of a Creative or Marketing Department, Concurrency's User Experience team resides under the wings of Productivity and Collaboration. Under the wings of Productivity and Collaboration, the UX team facilitates a wide range of services for all departments at Concurrency. Because User Experience encompasses so many fields of discipline, it is extremely helpful for small teams to become as efficient as possible. We achieve this through standardizing a UX process. At Concurrency we've done this with a very high rate of project success and accuracy. This doesn't mean that our UX process is immovable or doesn't have room for improvement, but it ensures that we continually have billable project work and that our UX team continues to grow. At Concurrency we have fairly high levels of involvement in a range of different types of projects. Two of the major project areas we service are SharePoint and Modern Applications. These types of projects generally have larger budgets and longer life-cycles.

Student: **Alexandria Dyszelski, B.S. User Experience and Communication Design**

Company: **Lead Designer at the Center for BioMolecular Modeling, MSOE**

Faculty Advisor: **Dr. Nadya Shalamova**

Alexandria maintains the CBM website and develops content for CBM's wiki sites, social media, and course notebooks.

Electrical Engineering and Computer Science Department

Biomedical Engineering Senior Projects

TEAM MEMBERS
Ali Alhamoud
Hadyah Alkhabaz
Alex Leininger
Caitlyn Moran

FACULTY ADVISOR
Dr. Icaro dos Santos

Advanced Infant Monitor

This project is being undertaken to design a monitoring device for the parents and/or guardians of infants under the age of one. The design will be a onesie that uses a pulse oximeter and resistive cords to collect data on the infant's heart rate, blood oxygen saturation levels and breathing pattern while they are asleep. This device is designed to take advantage of the latest infant monitoring technologies and codes and will employ emerging phone application technology to maximize the user experience and the parent and/or guardian's understanding of the medical information.

TEAM MEMBERS
Eman Alhamzah
Rakan Alharbi
Mikayla Landowski
Michael Meilicke
Margaret O'Neill

FACULTY ADVISOR
Dr. Charles Tritt

Artificial Blood Evaluation System (A.B.E.)

The goal of this project is to design a device that will be used to measure the oxygen transport capabilities of an artificially encapsulated hemoglobin solution. This device will measure the oxygen content and the oxygen saturation of hemoglobin and use these values to calculate the partial pressure of oxygen in the solution. This can be done by exploiting the spectrophotometric differences between oxyhemoglobin and deoxyhemoglobin. The values determined by this device will be used to plot the oxygen saturation curve for the encapsulated hemoglobin.

TEAM MEMBERS
Ashley Boros
Shannon Fox
Zach Simpson
Brett Wagner
Adam Wright

FACULTY ADVISOR
Dr. Icaro dos Santos

Athletic Head Impact Monitor

With sports-related mild traumatic brain injuries (mTBI) occurring at an estimated rate of 2–4 million per year, we developed a device that will monitor the accelerations of the head during the play of soccer. Rapid head rotation, which is quantified as a combination of linear and angular acceleration, is thought to cause mTBI by shearing brain tissue and straining axons in tension. For this reason, we developed a multi-sensor system to monitor both linear and rotational accelerations of the head. This device utilizes micro-electro-mechanical systems (MEMS) technology including a tri-axial accelerometer and a tri-axial gyroscope

to measure linear acceleration and angular velocity, respectively. The angular velocity measurement is used to derive angular acceleration and both the linear and angular acceleration measurements are used to complete an analysis of the head impact. The data is acquired using an mbed LPC1768 microcontroller and is wirelessly transmitted to a computer for further analysis. Researchers can use this device to complete longitudinal studies in the development of knowledge of the long-term consequences related to mTBI.

TEAM MEMBERS
Kevin Banks
Drew Brawner
Quin Krisik
Joy Lees
Neil Naughton

FACULTY ADVISOR
Dr. Icaro dos Santos

Electrooculography-Based Assistive Human Computer Interface for Speech-Impaired Quadriplegics

The goal of this project is to help patients suffering from quadriplegia and speech impairment to regain greater independence in their daily living (i.e. turning off and on lights, adjusting fans, and communicating) using an electrooculography (EOG)-based human computer interface.

TEAM MEMBERS
Zainab AlSadeer
Jimmy Carrington
Parker Fortier
Elizabeth Moenck

FACULTY ADVISOR
Dr. Charles Tritt

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Rader School of Business

Endotracheal Tube Placement Assessment Device

The goal of our project is to improve current endotracheal tube (ETT) placement assessment techniques, primarily for pediatric use. Currently, the main method of assessing ETT placement is via direct visualization using X-ray radiation, an ionizing form of radiation. Other methods of checking ETT placement include bronchoscopy, capnography, an esophageal detector device, and an ultrasound imaging device—all of which have unique limitations. The primary benefit of this project is to reduce the number of X-rays required to monitor the placement of the ETT within the patient. An additional objective is to meet the existing 90 percent accuracy physicians have when placing the ETT when unaided by direct X-ray visualization. Our device involves using force sensitive resistors with monofilament line attachments to act as vibrissa to detect the advancement and correct placement of the ET tube.

TEAM MEMBERS
Hashem Alsayid
Aleah Boehlen-Joosten
Mina Gaffney
Kendall Krohn

FACULTY ADVISORS
Dr. Icaro dos Santos
Dr. Larry Fennighkoh

Hospital Alarm Simulation System

Alarm fatigue occurs when a person is frequently exposed to an excessive number of alarms and subsequently becomes desensitized to the alarms. Desensitization to these alarms can lead to longer response times when tending to a patient or even missing important alarms altogether. The objective of this project is to develop a sound library that features simulated hospital alarms as well as a sound system for the School of Nursing simulation lab. This system will allow the nursing staff to control a standalone application via MATLAB to simulate hospital conditions that most often induce alarm fatigue in hospitals. Simulating these conditions will help nursing students better understand a hospital environment as well as help train them to identify which alarms are more important than others while other alarms are present.

TEAM MEMBERS
Mustafa Alhamoud
Riya Chaudhari
Elizabeth Kolanczyk
William Mattison
Matthew Thomas

FACULTY ADVISOR
Dr. Charles Tritt

SPONSOR
Dr. Tim Ridolfi

Imaging and Analysis of Post-Op Total Mesorecetal Excision Specimens

Total Mesorectal Excision, a surgical procedure used to treat colorectal cancer—the third most common cancer in both men and women—currently suffers from a lack of well-defined quality standards. Our goal is to aid in the creation of technical standards by providing quantitative data characterizing the surface texture of excised specimens. Specimens with a more uniform surface texture generally correlate with higher quality of surgery. Surface texture is not the only means of characterizing quality of surgery; however, it is a viable method and will be the focus of this design. It is important to note that though surface texture is often reviewed when trying to evaluate quality of surgery, we are not aware of another method that quantitatively measures the surface texture.

TEAM MEMBERS
Tucker Ahl
Mohammed Al Qanber
Anthony Paonessa
Thomas Reid

FACULTY ADVISOR
Dr. Charles Tritt

Open Source Medical Device Design

Through observation of the maker and hobbyist markets, it was determined that there was a lack of open source options that could be used to develop medical device type instrumentation for personal use. Many of the devices that were available and could be manipulated by users in this market were one-dimensional and could only be used to incorporate a small number of medical applications. Therefore, to fill this void in the market, our task is to create an open source medical device development platform that

could be used in the following ways:

1. A user can attach a sensor, and that sensor can be used to record a biological signal. The open source nature of the platform would allow for a variety of sensor types to be used.
2. The data acquired by the sensor would be properly processed, using filtering, amplification, digital signal processing, etc. to produce the desired digital signal of the user.
3. The data would be displayed to the user in a meaningful way.

The user would also be able to alter the process done in step 2 by loading their own source code, or by choosing different source code found in a software library associated with the platform. The goal of the project was also to incorporate the AMR mbed development microcontroller systems as the main processing component of the platform because of its capability to connect to the web and act as an IoT device.

TEAM MEMBERS
Fatima AlFaraj
Matt Hannula
Melina Lynn

FACULTY ADVISOR
Dr. Charles Tritt

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Oxygen Concentrator for Developing Countries

The goal of this project is to develop an oxygen concentration system to address the need for medical oxygen in the developing world market. There is a need for medical oxygen in all institutions that provide care to patients suffering from a variety of acute and chronic conditions. Our project uses pressure swing adsorption, an existing technology that increases the oxygen content of air from 21 percent to around 95 percent by removing nitrogen. To meet the specific needs of the market in question, targeted improvements are applied to an existing concentrator. Inlet air is dehumidified using a desiccant, an improved power supply provides battery backup and clean power during power outages and brownout conditions, and an intuitive user interface displays oxygen concentration and service information to the user.

TEAM MEMBERS
Elizabeth Nie
Samuel Schweizer
Sabrina White
Rachel Whitehead

Pacifier for Assessment of Non-Nutritive Sucking

Infants who have an underdeveloped non-nutritive sucking reflex often have problems feeding, which could lead to other health problems, such as aspiration. Evaluation of non-nutritive sucking can be indicative of an infant's

FACULTY ADVISOR
Dr. Icaro dos Santos

readiness for oral feeding, as well as give insight into the development of the infant's central nervous system. Currently, it takes a highly qualified person to measure oral facial ability of an infant to determine if they are demonstrating proper sucking reflexes. We will instrument a common infant pacifier with two pressure sensors to monitor the suction and expression phases of the non-nutritive sucking reflex of an infant. This information will then be transmitted to a computer where a clinician can assess the infant's development.

Computer Engineering and Software Engineering Senior Projects

TEAM MEMBERS
Samuel Conroy (CE)
Samuel Hallerman (CE)
Joshua Peters (SE)
Jonathon Wenzel (CE)

FACULTY ADVISOR
Dr. Darrin Rothe

Algae Bloom Web Portal

This project concerned developing an IoT buoy system that can collect lake data from buoys, sending the data from the buoys to a database server. From there, users can access a web service that allows them to download the data to be analyzed. This project was brought to us by Dr. Derek Riley, an MSOE software engineering faculty member, as a delegate for a colleague of his, Dr. Sanders, who is part of a research team that takes this data and analyzes it to better understand and predict algae blooms.

This project was split between two teams: a software team and a hardware team. Our team is the software team, handling the creation of the database, sending the data from the server to the database and the creation of a web application for accessing the database.

TEAM MEMBERS
Allison Clemens (SE)
Cody Haws (SE)
Erika Kubowitsch (SE)
Matthew Schladweiler (SE)
Jonathan Sonderman (SE)

FACULTY ADVISOR
Dr. Christopher Taylor

Amazon Sellers

As a business owner, its essential to understand your customers, and selling on Amazon is no different. Amazon Sellers are provided with a huge amount of data about their products and sales, but many can't afford the time or effort needed to turn that data into useful information. A majority of the products created to help sellers are either bundled as large, expensive packages or inconvenient one-off tools. Our team created a web application built on customizable

SPONSOR
Dr. Bradley Dennis

and modular components that caters to smaller, non-corporate sellers by giving them accurate and helpful insights without a massive time investment.

TEAM MEMBERS
Riley Byrnes (SE)
Bobby Getka (SE)
Paul Rekowski (SE)
Blake Stacks (SE)
Tyler Wells (CE)

FACULTY ADVISOR
Dr. Gerald Thomas

Beef Stew

Beef Stew

Beef Stew is a database reporting application that serves reports using data aggregated from a database to clients via the web. A user can create, modify, and distribute reports based on data from their database using a simple, easy-to-use web portal. A user can also customize what components are available to use when building a report to suit their needs. Beef Stew allows a user to extract knowledge from the raw data stored in their database.

TEAM MEMBERS
Trevor Dickson (SE)
Jacob Gralinski (SE)
Cal Harden (SE)
Man Ching Kung (SE)

FACULTY ADVISOR
Dr. Christopher Taylor

SPONSORS
Colleen Ball
Shelly Fite

Brief Assistant Website

The Brief Assistant website is designed to help citizens correctly fill out the necessary paperwork for their court case.

A person who loses in a Wisconsin circuit court may ask the Court of Appeals to review the case. When an indigent person loses a civil case (e.g. a divorce or eviction case), he or she may have to file "pro se", that is, file an appeal without a lawyer.

An appellant's Initial Brief summarizes the facts of the case and the applicable law and explains why the Court of Appeals should reverse the circuit court's decision. After the Initial Brief has been filed, the respondent, or the winner of the circuit court case, might need to file a Response Brief, which outlines why what the appellant said in the Initial Brief is wrong. After the Response Brief is filed, the appellant can then fill out a Reply Brief that rebuts statements made in the Response Brief. Most pro se appellants/respondents have never seen a brief document, yet they are expected to prepare one that complies with the Court of Appeals' strict, detailed rules governing the form and content of such documents. A violation of the rules may cause the Court of Appeals to reject the brief or

impose sanctions on the appellant/respondent or his/her attorney.

The purpose of the Brief Assistant website is to help pro se appellants, respondents, and attorneys prepare an Initial Brief, Reply Brief, and/or Response Brief. The website explains the parts of a brief, asks the user a series of questions about their case, and refers the user to helpful resources. After all questions are answered, a draft brief will be generated in a format that complies with the Court of Appeals rules, which can be downloaded or emailed to the user.

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SPONSOR
The Ostfalia University of Applied Sciences, Wolfenbuttel, Germany

Ostfalia University of Applied Sciences

IoT Buoy

The objective of this project is to develop a low-cost buoy that will measure and log water conditions from inland lakes. Once this data is sampled, it is transmitted to a laptop onshore where algae bloom could then be detected. The data sample would help the scientists predict whether there is a green-algae bloom or a blue-green algae bloom. This buoy is specifically being developed for Eagle Spring Lake and for the weather conditions surrounding this lake. This implies that this buoy would be running for six months in the calendar year because algae simply won't grow under colder weather conditions.

The size of the market will be limited to research facilities who would like to receive sample data of the water conditions to then predict algae bloom or blue-green algae bloom. There are certainly other similar products out there such as FlowCam, which monitors contamination levels and calculates biovolume and cell size distribution. It determines the concentration and performs life cycle analysis of the algae. The algae is classified based on user-defined parameters. Our buoy is very similar in the sense that there are parameters being used to determine algae growth but our parameters are limited to temperature, brightness, and water clarity. This project was done in collaboration with and sponsored by the Ostfalia University of Applied Sciences in Wolfenbuttel, Germany.

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Kronus—Smart Digital Clock

Kronus is a smart digital clock system for use in MSOE classrooms. It shows the time on a large, bright display so students can easily see it from any seat in any classroom. In addition to the time, Kronus displays various widgets. These

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widgets include the weather, messages from the professor, a progress bar for quizzes and exams, and more. Any number of these widgets can be displayed as configured by the professor who can log in to Kronus using their MSOE credentials and choose the widgets they would like to display. Professors can also save and load configurations before class. The clock system that MSOE currently uses is not only inaccurate, but is also expensive and difficult to maintain. Kronus is easily configurable at a central location and the added widget features provide extra utility; but the main focus of Kronus is providing accurate and reliable time. Most MSOE clocks do not display the correct time, which causes time management issues for students and professors. Kronus connects to a national time server to get the correct time within a few seconds, ensuring that anyone at MSOE will be seeing the correct time.

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Lucidify

The objective of team Lucidify's senior design project is to solve the problem of Spotify's lack of user data transparency, as the service does not display to users any data about their listening habits other than recommended songs, which may or may not correlate with what they were listening to most recently.

Team Lucidify plans to build a music analytics and recommendation engine that funnels data from Spotify's (and other) developer APIs to build a meaningful web "dashboard" that Spotify (and perhaps other streaming service) users can logon to and review their listening habits and a web of their friends' listening habits. Furthermore, the application will be able to recommend public user-generated playlists to the user based on their average, calculated song-related metrics (i.e., dance-ability, energy, acoustic qualities). All of this will be presented in a graphical way using cluster graphs and radar charts.

The primary audience for this application will be Spotify users, as they will use those credentials to log in to the site. There are some similar products on the market that use Spotify data to graphically show how artists are related, but there are no products that make a graph to display a ranking of genres on a per-user basis.

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Marinade

Marinade is an educational integrated development environment for ARM assembly and C with a built-in architecture simulator. The simulator allows the user to view how memory and bus values change during program execution. It will be configurable with single-cycle or pipelined architectures. All configurations will allow the user to step through machine code instructions, modify registers and memory and show a highlighted hardware execution path.

Additionally, the pipeline simulator will illustrate hazard management and pipeline stalling. To enable more educational aspects, a performance analysis tool and data visualizer was incorporated that characterizes machine code performance for single-cycle and pipelined architectures; including memory access penalties. To allow interaction with the simulator, a set of virtual memory mapped input and output devices was included, such as 7-segment displays, toggle switches, LEDs, and a tone generator. The project was built using existing open-source technology libraries and the use of highly-innovative visualizations to simulate system operation.

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Motorcycle Communications & HUD Overhaul—Raidervision

The system is a heads-up display that shows navigation and communication data in an easy to read format. The HUD will display information such as lobby name, engine RPM, fuel level, ground speed in miles per hour, and current users talking in the lobby. The system also allows motorcycle riders to communicate with each other wirelessly over moderate distances without relying on standard cellular or satellite communications. Users will control the system through voice commands and buttons on the handlebar.

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Project Bullseye

Project Bullseye aims to even the playing field in the game of darts. With a motorized dartboard and dart tracking cameras, we can track the position of a dart thrown at the board in real-time and real space. Then, using that trajectory, we are able to extrapolate the path of the dart to find where the dart will eventually land. This allows even the worst players to land a bullseye every time or just give them a bit of help to compete against a stronger player.

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Synchronized Speaker System

Our project looks at ways to improve home audio system setup by introducing a universal speaker synchronization system that would allow speakers of multiple brands to seamlessly connect and synchronize with the audio transmitter wirelessly. This would, in turn, allow the user to set up a home wide stereo system based on their preferred quality and budget. Wired speaker systems continue to have the problem of tedious set up or concerns about cable management. Wireless solutions exist, but these either are limited to proprietary speaker models, or can only transmit sound to up to two speakers. Our product can wirelessly transmit to any amplified speaker of any brand, to at least three endpoints.

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WMSE
Dedicated Computing

Vinyl Record Digitization

Since the invention of phonographic records, it has been possible to record, listen and share music. But since the invention of the vinyl record in 1951, the way music is recorded and distributed has evolved. To listen to the latest hits of the modern day, it is as simple as opening Spotify or YouTube and listening to the artist of your choice. The issue with these digital streaming services is that they can only produce audio that was recorded in a digital format, leaving the vintage vinyl behind.

With the idea presented by WMSE, our goal is to revive classics that were originally and exclusively recorded on vinyl. Through a non-contact method to prevent damage to the records, the team intended to make a process to record vinyl faster than real-time so that large collections can be digitized quickly. With many large libraries and radio stations having hundreds if not thousands of records sitting on their shelves collecting dust, it is time to bring these unique and invaluable pieces of art back to life.

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Wisconsin Legal Aid Finder

The legal system is complex, expensive, and may require assistance to navigate successfully. For many who cannot afford legal assistance, finding help can be daunting. Wisconsin Legal Aid Finder is a mobile-friendly website that assists citizens seeking legal services. Our mission is to increase the accessibility of legal aid and successfully provide the information an individual needs to request legal assistance.

Through collaboration with our sponsors, Wisconsin Legal Aid Finder will direct users to the legal agencies that are eligible to provide free or low-cost services based on the specific situation. In addition, this application allows agencies to easily update their constantly changing service information. Overall, this application not only assists people in need of legal help, but also reduces the amount of phone calls and unsuccessful visits to legal clinics, and improves the chances of individuals successfully receiving the legal help they need.

Electrical Engineering Senior Projects

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1073 Series Solid-State Gain Selector Switch Replacement

The Neve™ 1073 Class A audio microphone preamplifier is a high-quality device that has been in use since the late 1970s for audio amplification. The high-quality output is achieved with a gain selector switch utilizing impedance matching. However, this switch is prone to mechanical wear and is expensive to replace. In a studio environment, the mechanical wear issue occurs very often. Therefore, the team has created a low-cost, long-lasting alternative that provides the same audio quality. Once installed, the team's solution will be visually indistinguishable from the original. To operate the team's solution, the user turns the knob to the desired gain, telling the microcontroller to set a certain "path' for the audio signals to travel through the preamplifier. Each one of these "paths' is a resistor network. The team's solution lives almost entirely on a custom designed PCB, with a connected knob that is physically modified to fit into the hole left by the old gain selector switch.

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Milwaukee Brat House

Acme Arcade Company

Vintage arcade games are heavy, expensive to repair, and prone to fail with parts exceeding life cycle—causing businesses to lose revenue. With the Acme Skill Roll, we have modernized the classic Bally Skill Roll game. This game is less expensive than the original, allowing it to be highly competitive with existing games. The new game is smaller in size and weight, but still provides the same high-quality entertainment value as the original.

The Acme Skill Roll consists of several levels of gameplay, composed of scoring positions and obstacles on each. Starting with a quarter input to the game, gameplay is advanced by moving the quarter from level to level with the use of an actuator. An input switch controls the force provided to the actuator indicated by a scrolling array of LEDs. The score will be tallied as the player progresses through the game. If the player reaches the final level a win condition position is presented. If they reach this winning position, they are rewarded with audio and visual stimulation. If they don't, the game is over.

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Argonne National Laboratory

Argonne Acoustic Levitator

The Argonne Acoustic Levitator project focuses on improving the stability, power-efficiency, and usability of an existing 3-axis acoustic levitator designed for use by Argonne National Laboratory in the application of pharmaceutical X-ray spectroscopy. Levitation is useful in spectroscopy because it eliminates any barriers around the particle being levitated. Working together, mechanical and electrical senior design teams aimed to implement new functionality that would create a more robust system for Argonne.

The electrical engineering team design includes feedback from a piezoelectric film that measures the pressure of the field and uses that feedback to fine-tune an impedance matching network for the system. This network optimizes the acoustic pressure for each axis, therefore creating more stable particle levitation. Additionally, automatic system control is implemented and accessible via a GUI. The GUI simplifies user control while also eliminating risks of potential user error in the complicated start-up and shut-down procedures. The new design also includes rudimentary particle position control for the purpose of cycling through multiple samples during the spectroscopy process.

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Automated Lithium-ion Battery Cell Tester

Milwaukee Tool has requested an Automated Lithium-ion Battery Cell Test Fixture that will perform AC internal resistance (ACIR), DC internal resistance (DCIR), and voltage measurements on up to 100 cylindrical cells. These tests are presently performed using separate systems and/or hand-held meters. The aim of this project is to automate these tests into one sequence, allowing the user to perform other lab duties simultaneously, while achieving accuracy and resolution that is equivalent to the current solutions. The solution is a LabVIEW based test system comprised of the three measurement subsystems as well as a 3-axis drive system, which allows for individual connection to each cell. All test measurements are to be stored into an Excel spreadsheet.

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Kenall Manufacturing

Brake Detection and Awareness

The Brake Detection and Awareness system monitors speed information from the OBDII port located in all vehicles. Data gathered on vehicle speed is than compared over a period of time to achieve a differential speed. The differential speed data can then be used to estimate the braking intensity at any given point in travel. This "intensity" level can be mapped to an array of LEDs to display a braking percentage at every iteration of braking.

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Conservation Sensor Platform

The Conservation Sensor Platform (CSP) is a unit designed to meet Reserve Protection Agency's need for a modular wildlife sensor platform that is solar-powered, low-maintenance and can gather data from multiple inputs to stream over a wireless network. This data can include temperature, humidity, pressure and high definition video. The modularity of the project allows the operator to choose

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Reserve Protection Agency

the sensors that best meet their needs and their budgets. Units are built to operate day and night in the South African climate and have minimal impact on the local flora and fauna.

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Team Rockbottom
Nowhere To Go But Up

Custom Battery Emulator

Devices that are not connected to the grid will have their power source consisting of a DC battery providing electrical energy to the system. These devices cannot be tested under the conditions of a normal battery as every battery is different in terms of charge and it would create a great variance in the results. To test battery operated devices, a battery emulator is an effective instrument capable of measuring enough data for many applications such as numbers for a data sheet or verifying the device performance at a distinct state of charge. Battery emulators are expensive and have limited DC voltage output. Even on the lower end of the price range, the least expensive battery emulators still cost around $1,500 to purchase. The cost increases if additional testing features are needed. And while battery powered devices in industry have DC voltage outputs ranging from 9 to 24 volts DC, most modern emulators only output up to 15 volts DC before adding on extra costs.

Our team is working to create a battery emulator that is cheap and efficient, costing $500 and outputting as close to 24 volts as possible. The unit comprises of three main subsystems: a power subsystem, a software subsystem and a buck converter. Using a combination of these three subsystems with other auxiliary components, the end goal of the project is to be able emulate at least one type of battery to show how a tested device would work under different states of charge.

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Gary: The Automatic Toilet Cleaning Robot

Cleaning a toilet is a time-consuming task that can be tiring, requires bending and kneeling, and exposes one to both bacteria and harsh chemicals. It can be a difficult task for persons with disabilities or a bad back or joints. Additionally,

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the bathroom presents an untapped area in the home automation sector.

We endeavor to build a scrubbing robot that can effectively clean a toilet with less human labor than current methods require. This device will be an automatic solution that runs on a user-selectable schedule and requires minimal maintenance beyond the initial setup.

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Improved High-Performance Game Controller

The Nintendo GameCube controller, like many modern controllers, can cause injury after extended use, making them difficult to use by professional and casual players due to the unnatural way they are required to be held. The controllers are also challenging to use by people with limited hand and finger movement because of their restrictive design. Optimal play is often impossible due to errors reading the user's inputs correctly. The solution is an arcade style box controller utilizing an Arduino Mega 2560 that uses digital inputs to mitigate input latency and fix analog input errors. The controller's 21 buttons can be remapped by the user using an Android phone app to create a personalized controller and can be used on the Nintendo GameCube and any Windows PC.

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Milwaukee Tool Heated Glove

There is a need for an electrically heated set of work gloves to provide safe, lasting comfort in cold weather. This solution uses a carbon fiber heating element, powered via a lithium polymer battery that is controlled using an Atmega328p microcontroller. Insulation for the gloves is provided by aerogel, a state-of-the-art low weight material with a minimal thermal conductivity. The gloves can reach temperatures of up to 150 degrees Fahrenheit with an intuitive user interface, which allows the user to select the desired temperature. The gloves supply heat under rigorous working conditions, providing comfort and luxury for the hand-held tool user.

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Modular Exercise Bike Control System

Exercise bikes can produce unsuitable levels of workload for cardiovascular training causing improper exertion, which leads to fatigue and longer recovery times. There are a few available existing solutions, but these options are expensive and proprietary. For those solutions, the control system is built into the equipment and cannot be changed or replaced by the user. Our solution is a modular heart-rate controlled system for an exercise bike.

The Modular Exercise Bike Control System is an add-on device designed to attach to most popular personal stationary bike brands with manual resistance control. Using a wireless heart rate monitoring feedback control system, the resistance is adjusted automatically based on the user's desired training level and current level of fitness. Doing this allows the users to optimize their exercise sessions when using the exercise bike.

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NASA Robotic Mining Competition Autonomous Control System

The NASA RMC is a competition where university-level students research, design and build a mining robot that traverses a Mars-like simulated terrain.

The mining robot must be able to excavate resources (primarily regolith) from the terrain and return the resources to a collector bin. The NASA RMC has a point-based system. Of all the graded sections autonomous motion is the most difficult and highest scored component. MSOE participates in this competition but the current design does not feature autonomous motion capabilities. This project consists of two sensor systems; one will provide the initial localization and orientation of the robot in the competition arena and the other system will provide navigation information to include object detection, depression detection and distance traveled.

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Nytewave Sleep Machine

In this fast-paced world, a growing number of people, from small children to adults, find falling asleep be a more daunting and frustrating task. Research has shown many benefits to receiving sufficient sleep including better overall health, increased memory recall and decreased anxiety levels. No two people are built the same and therefore, it is important to consider that sleep habits vary. Some people

find silent environments to be most comforting for them to fall asleep in; while others may enjoy hearing their favorite song as try to fall asleep. For some, the most effective solution might be even the slightest of distractions to re-direct their attention from any irritating and persistent thoughts, to a place of ease and comfort.

Because most people at some point in their lives have trouble sleeping, hundreds of inventions have been developed toward aiding in insomnia-like tendencies including sound machines, humidifiers, light stimulation devices and many more. No such creation, however, has ever combined the sensory elements of sight, smell and sound into one device, allowing any user options for creating a comfortable sleep environment tailored toward their needs. Our project is a sleep machine combines these elements to create a comfortable sleep environment depending on the individual's needs.

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CRG Systems

Plastic Distribution System

Manufacturing plastic packaging and products requires a multitude of fillers, additives and different plastics. Materials in storage silos are constantly rerouted to create different recipes. Unreliable, costly, and physical contact solutions have been used to verify the correct connections from the silos to the plastic lines. Our solution intends to use Radio Frequency Identification (RFID) on a robust, industrial RS-485 network to effectively verify connections. Modbus, an industrial standard communication protocol, was incorporated into the project to allow for easy integration with existing customer systems and OEMs.

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Polaris State-of-Health (SOH) Lithium-Ion Battery Monitoring System

Lithium ion-battery technology, found in automotive and consumer electronic applications, usually do not provide state-of-health (SOH) monitoring. In the electric car industry alone, the need for lithium ion batteries is projected to increase by 172 percent. Knowing when the battery will fail is imperative for these applications.

This project is an online SOH solution that monitors the health of a lithium-ion cell and provides early warning of

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failure to facilitate its replacement before system operation is affected. This SOH solution is intended to be connected to the cell and will indicate a cell's SOH with the use of two different methods; coulomb counting and electrochemical impedance spectroscopy. If either of the methods indicate that the cell is unhealthy, a message will be sent to a controller notifying the operator of the cell's status.

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Qi SolarPak

Students occasionally forget their phone chargers at home and their phones die during the day. However, students rarely forget their backpack. The Qi Solarpak eliminates students' problem of forgetting to charge their phones by incorporating a wireless phone charger into a standard backpack. The Qi Solarpak has three main subsystems, a lithium ion battery pack with integrated charger and over-current protection, a Qi wireless transmitter and photovoltaic panels to provide ancillary energy to the battery pack.

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J.F. Brennan Company

Remote Operated Underwater Surveyor

J.F. Brennan Company Inc. of La Crosse, Wisconsin is a marine construction company that performs surveys on a variety of underwater structures. The purpose of the project is to provide a multi-purpose, shoreline-deployable mobile platform to aid J.F. Brennan in their hydrographic surveying related to underwater inspection, construction, and remediation projects. Ideal assignments are for scour inspections, confined spaces, deep-water inspections, or deployment in any condition unsafe for diver entry.

The R.O.U.S. is designed by a mechanical engineering team with maximum modular functionality in mind to allow J.F. Brennan to modify it to meet the needs of every project. It can traverse the toughest underwater conditions with its aggressive wheels and power provided by modified waterproof bilge motors that were sized and tested to fit the special operating conditions. In conjunction with the electrical engineering team, the R.O.U.S. is fitted with lights and a camera that can communicate to the user, on shore or aboard the boat, via the R.O.U.S. application. The control system will operate with differential steering

to increase maneuvering capabilities. The fully functioning R.O.U.S. will be delivered for use at J.F. Brennan post-graduation.

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Split-Handed Trackball Mouse and Keyboard

Currently on the gaming market there does not exist an input device that is split-handed and simultaneously has a trackball for movement, specifically designed for the left-handed or ambidextrous user. This was a problem that was set out to be rectified this academic year; the knowledge obtained at MSOE was put together with research in order to accomplish this. The use of technologies such as Bluetooth and standard keyboard and mouse were brought together and used to create a prototype. The prototype connects wirelessly to any PC running a Windows operating system and is recognized as a standard input device.

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Leonardo DRS

Three-Phase Motor Current Measurement

Conventional techniques for sensing the current draw of a motor use current transformers or Rogowski coils. These solutions are often expensive and complex, or insensitive to product weight and size requirements. Our team, along with our sponsor, want to change this using an anisotropic magneto-resistive (AMR) sensor.

Using the AMR sensor allows the current draw of a motor to be sensed accurately while taking up a small amount of space and, for a sensor capable of measuring 400A, weighing less than a typical laptop. The sensor sits on top of a printed circuit board that has a bus bar with u-shaped geometry mounted on the back. The bus bar is then inserted into the power line of a motor. Using the equivalent of a Wheatstone bridge, a current proportional to the motor current is generated and output from the sensor. Using a resistor and an analog to digital converter (ADC), the current can be converted to a useful digital output. This digital output can then be used in a larger automated system to indicate the status of the motor.

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Milwaukee Tool

Tracking Headlamp

Workers and hobbyists need headlamps to assist in dark work environment and Milwaukee Tool would like to offer tracking features to their existing headlamp design. The Milwaukee Tool Tracking Headlamp is designed to illuminate and remained fixed on a specific target location even while the operator's head moves. Tracking is accomplished by incorporating a 9-axis inertial motion and magnetometer sensor. The device will also be able to sense the ambient light and provide adjustment to automatically change the intensity of the LED lamps. The device will have a user selectable mode between red LED non-tracking and white LED tracking modes. The headlamp is designed to cast light for at least 120 minutes with a fully charged Milwaukee Tool REDLITHIUM® battery. The tracking headlamp is attachable to a hard hat and meets IP54 and safety standards.

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UV-C LED Water Purification

The UV-C LED Water Purification system is a project focused on providing clean, purified drinking water to users that lack the means and resources necessary to install and maintain traditional, large-scale water purification systems. Traditional water purification systems typically rely on expensive, replaceable filters or require large amounts of energy to sanitize drinking water. These systems generally require a great deal of maintenance as well as access to a constant, high-power energy source, which is not always feasible in under-developed areas. Other low-energy solutions exist but provide no user feedback to ensure that water quality meets worldwide standards.

This project addresses the needs of users in under-developed areas by treating water in two stages, by using a gravity-fed slow sand particulate filter and through ultraviolet (UV-C) water purification technology, while also containing an independent power supply using photovoltaic solar cells.

Mechanical Engineering Department

Industrial Engineering Senior Projects

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Rockline Industries

Rockline Industries is a family-owned, private label manufacturer of wet wipes, facial wipes, coffee filters and baking cups. Founded in 1976, Rockline has grown from a 35-person company to an over 2,000-person global organization. Rockline's corporate headquarters are in Sheboygan, Wisconsin, with additional facilities in Arkansas, New Jersey, England and China.

To maintain profitability in a competitive market, Rockline needs to reduce logistical costs, which represent about 25 percent of its total costs. Most of the logistical costs are tied to transporting their highest volume raw material—substrate. The team sought to increase the average square yards per trailer by 10 percent and reduce logistical costs by 5 percent. This goal required adherence to transportation and production constraints. Through the iterative use of the quantitative analysis approach, the team developed a spreadsheet tool that provides recommendations for the diameters of substrate to purchase. The operational objective within the tool was to maximize the percentage of floor space coverage (the ratio of floor space covered by substrate to total area). According to the tool, the diameter with the highest percentage of floor space coverage was 48 inches using square packing. Upon implementation of our recommendation, Rockline Industries could save more than $340,000 per year. The recommendation provides an average increase in square yards of substrate per container of 33 percent and decrease in annual logistical costs by 26 percent.

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Aurora

The team worked with Aurora St. Luke's Medical Center's Food and Nutrition Services department to improve the service level of the food delivery process by increasing the number of trays delivered to the patient in less than the promised 45 minutes. The department desired to have

90 percent of the meals delivered within 45 minutes. The team conducted time studies and observations of each part of the process, which helped validate the data from the electronic ticket tracking system. After gaining a full understanding of the current state, the team went through a brainstorming session to create possible recommendations for improvement. The group ranked these recommendations and created the alternatives used in the pilot. The analysis of the pilot determined the influence of the alternatives on the process. The results helped to create the final short- and long-term recommendations. The short-term recommendations included introducing cross training to the system, creating standard operating procedures for delivery, updating the goal board, introducing building cards for each cart, and organizing the cart storage area. For long-term recommendations, the team recommended updating the ticket promotion system to include additional promotions, as well as adding tickets scanning and carts to the system along with a remodel of the kitchen area. Short-term recommendations had a cost avoidance of one ambassador and a net present savings of $90,864.56 over a five-year period, with less than a month payback. Long-term recommendations had a projected cost avoidance of four ambassadors, with a projected net present saving of $153,514.73 over a five-year period with a payback period of about two years.

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Sjoberg Tool and Manufacturing Corp.

Sjoberg Tool and Manufacturing Corp. is a sheet metal fabrication company located in Hartland, Wisconsin that recently acquired a new customer that increased production levels dramatically. Sjoberg purchased a new facility ("South Facility") to hold the new customer's finished goods. With an overcrowded Main Facility and no room for expansion, Sjoberg asked the team to assess how to better utilize the South Facility in terms of the feasibility of moving operations related to the new customer. The goal was to decrease operation lead time by at least 20 percent, decrease parts travel distance by at least 20 percent, and increase the space availability at the Main Facility by at least 15 percent. The team sorted all new customer part numbers and divided them into 10-part families based on their routings. The team also calculated the storage needs of Sjoberg's finished goods. The team built an MPX model to understand the processes at the Main Facility, determine the future state at the South

Facility and determine what machines should be moved. The team's final recommendations were to move all operations related to the New Customer except for laser cutting, to decrease batch sizes for all part families by 67 percent, and to keep the South Facility as is. The expected results of this project are a 60 percent reduction in lead time, 55 percent reduction in distance traveled, and 5 percent increase in space availability at the Main Facility. The team calculated a Return on Investment (ROI) of 133 percent over a three year period and a payback period of 0.67 years.

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Direct Supply Manufacturing

Direct Supply is a distributor of senior living products to both individuals and long-term care facilities. Currently, they are developing a new wheelchair armrest device designed to track the long-term care resident's behavior when getting into and out of the wheelchair to predict potential medical events. Although a prototype has been built, data collection and field testing were required to determine standards for movement into and out of the wheelchair. The team collected data with elderly volunteers on the force applied to each armrest and the amount of time spent getting into and out of the wheelchair. Statistical analyses were performed on the data to investigate whether age, gender and left/right hand dominance could be used to predict the time and peak force applied to the armrests. While the analysis found that age and gender were statistically associated with peak force and age had a slight association with time taken when exiting the wheelchair, the analysis also indicated that there were additional factors impacting time and peak force beyond those measured in the study. Therefore, the model alone could not accurately predict each outcome, and a more intensive study was recommended to determine the remaining influential factors and their effects on time and force. The team also recommended wheelchair design changes based on behaviors noticed during observation, including adjustment of armrest sensor placement and addition of sensors to the seat of the chair. Finally, data collection methods were documented and provided to the client for future field testing of the prototype.

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Pedal for Progress—World Bike

People in developing nations depend upon basic methods of transportation such as homemade carts and buckets to move crops, people and water. This lack of reliable and modular transportation in conjunction with privation of economic opportunity make these people particularly susceptible to drought and other disasters. World Bike offers a solution to this problem through a multi phase project utilizing the expertise of mechanical engineering and industrial engineering students. The objective of the project is to provide an affordable means of transportation to people in economically underdeveloped areas of the world that they can build, service and maintain themselves. Ultimately, this human-powered vehicle would stimulate economic growth in the target region of Northern Ghana.

TEAM MEMBERS
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Rexnord Corporation

Rexnord Corporation, a manufacturer of elastomeric couplings, requested the assistance of a senior design team to facilitate a two-quarter long defect reduction project. Six Sigma and the five-phase DMAIC process, Define, Measure, Analyze, Improve, and Control provided a framework for narrowing down the top causes of scrap and addressing them. Historical production data was used to discover that the overall monthly scrap rate had increased 63 percent between April and May of 2016. A void-like defect called carrot marks accounted for 25 percent of the sources of scrap, and the objective was to reduce its scrap rate by 50 percent. After brainstorming and narrowing down the most likely causes of carrot marks, data was gathered on the top factors. Extensive statistical analysis showed that low mold temperatures and short mold preheating times were likely associated with carrot marks. To ensure sufficient preheating time, the team recommended that Rexnord install interlocking, time-activated oven doors. An estimated net present value of up to $35,000 over five years was calculated. After seeing parts scrapped for seemingly minor defects, the team also recommended further enhancing the definition of what level defect severity warranted rejection. Finally, it was important that Rexnord analyze and improve their inspection process and then monitor scrap by each operator using control charts to promote a quick response to future quality issues.

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Maybar Manufacturing

This project was conducted for Maybar Manufacturing, a company that creates machined parts for the food industry. This project focused on the implementation of a Universal Robots UR-5 Collaborative Robot into operation 40 for part 21286-12, where the robot was placed on a cart to be used for loading, unloading, and starting a Computer Numerical Control (CNC) machine. The purchase of the robot was to help compensate for labor shortages and reduce the need for mandatory overtime. To complete this project, the end-of-arm tooling, staging system, and program for operating the robot were designed and built, and a process capability analysis was completed to validate the system's ability to operate without error when loading and unloading the CNC machine. Because of this project, multiple factor productivity associated with operation 40 for part 21286-12 increased by 101 percent with a net present value of $1,970.

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Kohl's

Store layout and desk design play an important role in providing the best possible customer experience at Kohl's. A large portion of the customer experience involves being served in a timely fashion by a sales associate. Kohl's has hypothesized that relocating Customer Service Desks to the front of the store and combining customer traffic into fewer banks could positively impact customer experience. Quantitative or qualitative analyses, however, had not yet been used to validate this theory. Our MSOE team was chosen to provide these analyses. The team's hypothesis was that the flow of queues will likely change between different layouts and combinations of the service banks. To test this hypothesis, we chose to develop key queueing metrics to place all alternatives on the same standard. Using Discrete Event Simulation, we compared the current design layouts to proposed alternatives regarding average queue duration, maximum queue duration, and server utilization. Comparison of key queue metrics illustrated the superiority of the Mega Combo alternative. This option achieved the lowest average queue duration and lowest average maximum queue duration; server utilization remained constant. In our paper, we will show how these conclusions were derived. Further, we will present accompanying recommendations to enhance the customer experience.

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FORCE America

The purpose of this project was to apply industrial engineering methods to specific focus areas of the wire harnessing department of FORCE America: scheduling to improve resource availability coordination, evaluating ergonomics to quantify and reduce risk of carpal tunnel syndrome and organizing the tool storage areas to decrease employee search time. MPX modeling led the team to conclude the department had enough tooling; the lack of resource availability stemmed from scheduling production. The team conducted an interview with the production scheduler to understand the process of creating a viable production schedule and the inputs considered. An ergonomic evaluation was used to quantify the risk for developing carpal tunnel syndrome. A study determined the average time it took employees to locate hand tools. To improve scheduling, there were two options proposed with shorter development times to increase resource availability when needed. Two options with longer development times were proposed to increase the accuracy of the processing time estimates. Educating employees on preventative methods through training posters and programs was proposed to address ergonomics; purchasing different tooling options would eliminate the force required to complete a manual crimp. Lastly, the team proposed a new coordinate system and labeling for the tool storage area. FORCE America implemented the new coordinate system and labeling, asked the team to storyboard some of the new scheduling tools, and asked the team to develop the training posters and training program. After implementing the new coordinate system and labeling on the tool storage area, there was a 50 percent reduction in the search time for hand tools and the team received positive feedback from employees.

TEAM MEMBERS
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CTSI

To turn new and innovative medical research into interventions for patients, the researcher's side of the process must be continuously improving. Regulatory approvals come with any medical research and can cause many problems, both for researchers and the Pilot Program Manager. On the researcher side, it often takes a substantial amount of time to complete them. As a result necessary funds are not available at the beginning of the

Just-in-Time period (JIT) (Dec. 1 to March 31). From the manager's perspective, time is wasted figuring out the needs for each project team. Our team wanted to increase the percentage of project teams that receive their funds by the first day of the JIT period from 0 to 50 percent and reduce the time managers spend determining each team's status. Define-Measure-Analyze-Improve-Control (DMAIC) gave the team a structured approach to problem-solving. Interviews and analysis provided valuable insight. The team recommended implementing a centralized data management system. Researchers at the Medical College of Wisconsin (MCW) use a software product called Research Electronic Data Capture (REDCap), which also fit the needs of the team. In using this software, the centralized data management system could be created. The purpose of the tool created in REDCap was to gain an understanding of specific approvals for each project, as well as act as a repository for required approvals. A framework for the solution was developed and submitted to the REDCap Administrator. By implementing the proposed framework for the REDCap software, the approval stage of the research process should dramatically be reduced.

TEAM MEMBERS
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KHS

The primary focus of this project was to help KHS improve their environmental footprint by analyzing the waste produced and developing a tool to track waste in the organization. The team gathered waste utilization data, created time series plots—as well as a Pareto chart and graphical summaries—to determine the primary wastes of interest. The team then created a tracking tool using Excel with VBA programming. This tool was developed to help KHS better communicate and employees better understand the waste progression. The tool would allow for data storage as well as graph creation to depict the current state of individual waste types, i.e. gas, water, and electric consumption. The tracking tool was largely inspired by the cost sheet already used by the Accounts Payable department, supporting a more seamless transition from the current process. This new system would allow KHS to communicate improvements and progress with stakeholders of the company. The team also created an information dissemination tool to share updates about initiatives occurring at the facility. The tracking tool provides a more efficient means for KHS to store and present data.

The communication tool will be displayed on televisions throughout the facility; in addition, a quarterly newsletter will be sent to stakeholders. Finally, the team assessed the importance of recycling bins. KHS employees will have access to more recycling bins, which will help improve the company's environmental footprint and morale.

Mechanical Engineering Senior Projects

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Baja SAE Competition

The objective of the Baja SAE competition is to give engineering students real-world experience by building an off-road recreational vehicle. For the 2017–18 school year the team has been tasked with designing and building the braking, steering and suspension systems for the vehicle that began development in the past academic year. With the help of an underclassmen club, the team will compete in the Baja SAE Kansas competition at the end of May. The main goal of the Baja SAE senior design project is to design, build and test three separate vehicle subsystems; braking, steering, and suspension. Each subsystem must be as affordable, lightweight, safe, and effective as possible as necessitated by their usage in this year's competition vehicle.

All three subsystems aim to reduce weight and comply with all 2018 Baja SAE competition rules. The braking system team also wants to keep driver comfort in mind. The steering team set out to design a system that provides safe, predictable motion with easy controllability. The suspension team focused on strength, endurance and weight.

The braking team settled on four floating calipers, a 90° hanging brake pedal, tandem master cylinder, and a single proportioning valve. The steering team selected a rack and pinion steering rack with a quick release steering wheel. The suspension team choose unequal length a-arms in the front and a 3-link trailing system in the rear for the suspension systems.

Acknowledgement: Special thanks to Macco New Berlin, The Tool, Die, and Manufacturing Association of Wisconsin; Sussex Tool, Trace-A-Matic, Andrew Trujillo, and the MSOE SAE Chapter.

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NASA Project VEGGIE

NASA's project VEGGIE currently requires astronauts to manually water plants as they grow. Due to the full experiment schedule aboard the ISS, an autonomous watering system is highly desired. Team Biospace and Cem Yazici investigated methods of autonomous watering during the 2015–2016 and 2016–2017 academic years, but no successful prototypes were ever produced. Drawing on Biospace and Yazici's work, new design concepts have been developed through research and a battery of crop experiments. Both the "expansion-based" and "timed" watering concepts utilize a discrete volume water delivery mechanism, an important simplification from Biospace's and Yazici's designs. As final crop experiments are performed, one design concept will be chosen and integrated into a system with the discrete volume delivery mechanism, allowing for complete crop cycle testing.

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NASA In-Situ Resource Utilization

The goal of this project is to develop a proof of concept design for a process for the collection of material in the form of loose iron-nickel (Fe-Ni) regolith, by the means of in-situ resource utilization, on the asteroid 16-Psyche towards a feedstock for an Ultrasonic Additive Manufacturing (UAM) process that incorporates molding, hot rolling, heat treating and storage of the magnetically collected Fe-Ni regolith. The UAM process uses heat and pressure to bond thin layers of metal foil together, allowing the material to be milled into usable parts. The process requires thin foil strips to be produced from the collected Fe-Ni material to be used in the UAM process. The manufacturing process to create the final feedstock to be used in the UAM process will be powered by a multi-mission radioisotope thermoelectric generator (MMRTG) and does so in the local environmental conditions found at Asteroid 16 Psyche. The All-Terrain Hex-Limbed Extra-Terrestrial Explorer (ATHLETE) system, currently under development by NASA's Jet Propulsion Laboratory, was chosen as a possible transportation system that could be used to provide the process with mobility about the surface of 16-Psyche. Experimental work will be done to analyze the process of molding the collected material by compression along with further work into designing a rolling prototype to demonstrate how material can go from a particulate form to a usable foil material for a UAM process.

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S3L HYDAC Skid-Steer Automatic Self-Leveling

The purpose of this project was to design, prototype, and test a fully hydraulic bi-directional skid-steer self-leveling system. A skid-steer is a small motor-driven, fluid-powered machine with a wide range of applications including material handling, earth moving, and construction. There is a lift arm (boom) that extends out from the body of the machine. A bucket (or other optional attachment such as a pallet-fork) is attached to the end of the boom. There are four hydraulic cylinders. Two that lift and lower the boom and two that tilt the bucket. Self-leveling refers to automatically maintaining the bucket (or attachment) orientation without operator intervention. In other words, as the operator raises the boom, the bucket angle will automatically change to maintain the original angle throughout the lift motion. Bi-directional self-leveling refers to the ability to maintain the angle during both raising and lowering of the boom. For this project, a medium frame skid-steer loader was considered. The primary performance requirement was a bucket angle tolerance of eight degrees throughout the lift and lower strokes of the boom. The final solution is a machined manifold with 14 HYDAC cartridge valves integrated into the existing hydraulic system of a Wacker Neuson SW-20 Skid-Steer.

Acknowledgement: Special thanks to HYDAC and Wacker Neuson for sponsoring this project.

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MSOE Angry Snails—ASME Student Design Competition

In the summer of 2018, the world's greatest soccer players will meet in Russia to compete in the FIFA World Cup. Considering this worldwide event, ASME has challenged teams of undergraduate engineering students from around the U.S. to compete in a modified soccer match. The modified soccer match will feature four opposing teams playing "soccer" with tennis balls against each other on the same field at the same time. The team's solution consists of a main attack robot and a sub team of smaller robots to play defense. The chassis of the main attack robot is made from A513 steel tubing and forms a hexagonal footprint that is 36 cm x 36 cm. The main attack robot will be powered by two 12-volt batteries supplied by Milwaukee Tool, controlled by 2 Arduino Megas, and use an "X-drive" drivetrain with four omni-wheels to achieve holonomic movement. A gating mechanism was designed to allow for consistent capture of the tennis ball and accurate ejection from the robot

when commanded. A shooting mechanism, inspired by the "rainbow" move in soccer, will eject the tennis ball from the robot at speeds of up to 7 m/s using a flywheel to accept the ball and shoot it out of the top of the robot. Using this shooting style, the angle of the shots is adjustable, marking a distinct advantage over short opponents and opponents who can shoot only along the ground. The components for the shooting mechanism, chassis and gating mechanism were laser-cut by Dynatect Manufacturing.

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SPONSORS
ASME Milwaukee Chapter
Milwaukee Tool
Misumi USA
Tanis Inc.

CICERO

MSOE Cicero—ASME Student Design Competition

A soccer theme is the topic of the ASME Design Competition 2018 in spirit of the FIFA World cup. The task is to design and build a "team" of robots to compete against three other teams in a modified four-way soccer competition. A remote-controlled vehicle based on a highly maneuverable platform with a lithium polymer (LiPo) power source was designed. Aluminum extrusion was used to create the frame of the robot, and custom wheel mounting surfaces were created from aluminum plates. These wheel mounting plates were then used to create the drivetrain for the robot. Using an Arduino microcontroller, which provides individual power and control to the chain driven mecanum wheels, a fast response time with high level of speed and maneuverability, is obtained. To "shoot" the "soccer ball" (tennis ball), a brush collector mechanism was designed. The shooting mechanism was designed to have the cylindrical brush collect and shoot the tennis ball to minimize design complexity and increase shooting reliability. The collector is powered by a 12v motor through a gearbox capable of running the collector brush at 600+ RPM. To accommodate the unique roller wheel design of mecanum wheels, a custom program was written on the Arduino as to provide appropriate control from two joysticks on the wireless transmitter.

Acknowledgement: Special thanks to our sponsors.

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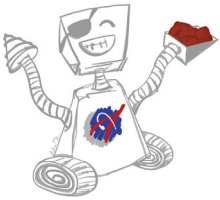

Material Handling—NASA Robotic Mining Competition

This project is in correspondence with the NASA Robotic Mining Competition Team. In an effort towards innovation and space exploration, NASA has tasked students all over the country with designing and fabricating small, off-world mining robots. All this in the hopes of mining icy chunks of the material known as regolith. Regolith, much like the dirt found on earth but void of any organic substance, is the key to harvesting water found on mars. We have decided to focus on the material handling portion of this task. Material handling consist of the collecting, holding and dumping of the icy regolith. To do this we have designed a drilling bucket that will simultaneously collect and hold the material to be dumped. A retainer will be set at the bottom of the bucket to help scoop the regolith during collection and can be fully opened during dumping. To remove the regolith from the bucket an extruder at the top will push down releasing the dirt. A linear actuator will be used to adjust the angle of the system and an elevator will push it into the ground.

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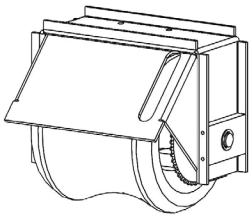

Space Pirates Drivetrain Team—NASA Robotic Mining Competition

The NASA Robotic Mining Competition is a facilitator for college students to generate ideas on how to achieve In-Situ Resource Utilization on Mars. The goal is to create a robot that can dig up the icy regolith below the surface of Mars, which could provide water, oxygen and fuel for future missions on Mars. The main competition goal is to traverse the arena from an arbitrarily chosen position to the digging zone, approximately 7 meters away, and then mine the icy regolith simulant, which is in this case gravel with an average diameter of 2 cm. The purpose of the team is to develop “next-generation” technology for MSOE’s competition team to use the following year, which is open to all students at MSOE. The drivetrain sub-team is responsible for creating a system for the robot that can maneuver through the basalt-like surface regolith to the digging zone while avoiding obstacles such as rocks (10-30 cm in diameter and 3-10 kg) and craters (maximum of 30 cm in height and width). The weight of the drivetrain, a dust resistant design, as well as dust free operation of the robot have been carefully considered as these factors influence a better score in competition and ultimately a better design for actual implementation on a Mars robot.

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Power Coil Developments—Figure Skate Boot

Over the recent years, hockey skates have evolved greatly with respect to the materials used to increase performance while reducing weight. Since hockey is a high speed, endurance requiring sport, advancements in producing more force transferred to the surface with the same amount of energy could increase the performance of the athletes. During a natural stride of a hockey player, there is a compressive force at the beginning of the stride and an extension of the leg and ankle at the end of the stride. This motion lends itself to be enhanced by a mechanical device that can store energy in the compression of the foot and use it in the extension at the end of a players' stride. A "Power Coil" was developed, which consists of a custom-dimensioned torsional spring that attaches to the sides of a hockey boot. This spring will work in conjunction with the motion of a deflecting hockey boot to naturally store and provide energy within each stride. The design considers the weight, size, stiffness of the coil, material properties, as well as how it will adapt and feel when attached to a hockey boot.

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Holographic Acoustic Levitator

The Acoustic Levitator Project is a three-year venture to design a device that produces pressure waves strong enough to stably suspend particles, such as water droplets, in mid-air. Levitation is achieved by vibrating our transducers at 41kHz creating ultrasonic standing waves between the horn and reflector surfaces in each axis. The acoustic levitation device will be used for X-ray spectroscopy in Argonne's Advanced Photon Source laboratory, due to its ability to eliminate interference or contamination of a particle caused by containers generally used to house these samples. Modern designs for acoustic levitators do not meet the stability or time requirements needed to use in ANL's Advanced Photon Source for accurate measurements. The current team is tasked with optimizing and improving the previous year's three-axis acoustic levitator to produce stable particle levitation for extended period use in ANL's Advanced Photon Source. With the objective of stability and time of levitation, MSOE has developed a three-axis levitator that can float particles as small as 100 micrometers in diameter for at least 5 minutes.

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Additive Subtractive Hybrid Machine Team

The purpose of this project was to provide a proof of concept which demonstrates the feasibility of implementing an additive-subtractive hybrid machine into the model and pattern making industry. Currently, large scale models are made by placing and gluing sheets of material by hand into a near net shape model, which can then be CNC machined to its final desired shape. Long open and set times for industry standard adhesives are necessary to position the several-feet-long components into their final position. While this production method is effective in its result, it is a time-consuming process, taking weeks for large projects just to block out the near net shape. Since CNC machining technology is widely established, our goal is to provide a scalable, autonomous solution for generating a desired near net shape using cubes of material. To facilitate the quickest block placement speed, the solution developed utilizes an XYZ stepper to limit travel time between individual block placement locations and pneumatics for both the feeding and placement motions. The placement head uses the 3-2-1 fixturing principle to align the blocks consistently with the least amount of contact points. To adhere the blocks, cyanoacrylate was chosen to exceed the strength requirements and meet the handling time necessary. The adhesive will be applied through spraying the cavity where the block will be placed.

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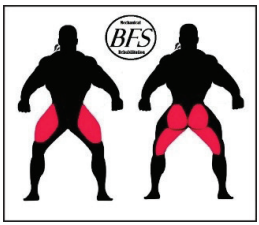

Team BFS—Assisted Sit-to-Stand Machine

The goal of the assisted sit-to-stand therapy machine is to strengthen the targeted muscles used in the sit-to-stand motion and to demonstrate the correct technique to the user. The machine focuses primarily on the strengthening of the muscles in the lower extremities of the body – gluteus, hamstrings, calves and quadriceps. In addition to strengthening the lower extremities, the machine is built to properly activate the back and core muscles required in the sit-to-stand motion, as this is difficult to achieve through the current physical therapy methods. A secondary focus of this machine is to encourage proper trunk movement during the motion. Due to the variable seat height and weight resistance, the machine is friendly to users of a wide range of heights and weights. By strengthening the targeted muscles and teaching the user the proper sit-to-stand motion, the machine promotes decreased rehabilitation time and an overall higher quality of life for physical therapy

patients who have lost the ability to stand on their own. To achieve this, a geared five-bar linkage was created to mimic the correct path of motion for the waist. In addition, a simple foam roller seat was created and attached to this linkage, and a simple encased weight stack with pulleys was used to apply the assistive force to the machine. The main material used for the machine will be low carbon steel, and the linkage will include two pulleys. The weight stack of the machine is made of low quality iron and will mostly be donated by the Kern Center. Upon completion, the machine will be capable of correctly implementing muscle activation patterns in the sit-to-stand motion.

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Dominican Republic Cocoa Bean Drying Chamber

The cocoa bean drying chamber is meant to aid Dominican Republic cocoa bean farmers by improving the bean drying process dependability and reducing waste crop lost to mold. Long rainy seasons in the region inhibit the traditional drying process, which uses the sun to dry cocoa beans. The team has designed a biomass furnace, Stirling engine, enclosed table, and an automated agitator to facilitate active drying, which results in an improved drying chamber.

The developed cocoa bean drying chamber is designed to use a biomass furnace and Stirling engine to force treated air through an enclosed drying chamber. Air will flow through the chamber at 650 cubic feet per minute and will be used to decrease the cocoa bean internal moisture content from 56 percent to 7 percent over a five-day period. The drying chamber is designed to have a bed surface area of 64 square meters with the capacity to dry 260 kg of cocoa beans.

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The COOL Team—Formula Hybrid Battery Cooling System

The Society of Automotive Engineers (SAE) Formula Hybrid competition is an international event held annually at the New Hampshire Motor Speedway. Following the first-place finish of the club team at the 2017 competition, the club team has built a completely new car for the 2018 competition. The function of the senior design teams is to act as the Research and Development team for the 2019 vehicle. The cooling system design is based off the 2018 vehicle design but will not be considered by the club team for implementation until the 2019 school year. The main

task of the battery cooling system is to design a simple air cooling system that will appropriately cool the batteries of the 2019 Formula Hybrid vehicle. There were two main goals that the COOL Team set out to achieve: first, keep the batteries running in the safe operating temperature range and second, maintain the batteries at the peak performance temperature. The goals were reached by designing a simple air cooling system that included the CAD design, mathematical model, and CFD analysis, which were all done in Soildworks, MATLAB, and Ansys, respectively. A battery bench test was used to acquire temperature data from the batteries to compare with the mathematical model. The principles of heat transfer, computational fluid dynamics and numerical methods were all used heavily throughout the battery cooling system project.

Special thanks to our advisor, Dr. Schaefer, and the members of the Formula Hybrid club team, especially Jacob Gamble, Jacob Wood, and James Moy.

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Bailey Walsh

FACULTY ADVISOR
Dr. Mathew Schaefer

Control Freaks—Formula Hybrid Control Strategy

Formula Hybrid is an annual competition that is part of the Society of Automotive Engineers (SAE) Collegiate Design Series. The competition was founded by Dartmouth's Thayer School of Engineering in 2006. The competition challenges undergraduate and graduate students to design and build a formula-style electric or plug-in hybrid that will compete in a series of static and dynamic events. After passing a mechanical and electrical technical inspection, competitors put their designs to the test by competing in the acceleration, autocross, and endurance events.

The Hybrid Control Strategy senior design team developed a control strategy specifically tailored to compete in the endurance event. The endurance event tests how well competitors manage the provided on-board energy; therefore, the team designed a control strategy that found the balance between vehicle speed and engine efficiency. To accomplish this the team implemented three main features: battery overheat prevention, driver LED feedback interface, and output torque control.

Acknowledgement: Special thanks to our advisor, as well as Dr. Richard Dykowski and Vivian Mickelson.

TEAM MEMBERS
Lucas Bednarski
Brandon Byal
Michael Cordes
Nicholas Vang

FACULTY ADVISOR
Dr. Richard Dykowski

Formula Hybrid Engine Integration and Optimization

The Formula Hybrid Engine Integration and Optimization team's objective was to modify and calibrate a 2012 Honda CBR250R engine for use in the competition vehicle. To accomplish this, the team was split into two sub teams: calibration and hardware. The calibration team utilized a dynamometer donated by Rockwell Automation to calibrate the CBR250R engine. This included design and fabrication of custom mounting hardware for the engine for testing, determination and fabrication of a coupling interface to the dynamometer and development of dynamometer control strategies. TunerStudio and a programmable ECU were used to vary the fuel and spark input for different engine speeds and load conditions. This team also converted the engine to run on E-85 to understand the performance gains provided by the alternative fuel. The hardware team's purpose was to design a component to increase engine performance that complies with the rules of the Formula Hybrid competition. The sub team designed and implemented a variable geometry air intake on the engine. The standing wave caused by the intake valves opening was utilized to force more air into the engine when the wave resonated back down the intake to the valves. The length of the intake dictates the resonant frequency of the wave. An intake runner and control mechanism were developed to actuate the intake to the required lengths.

TEAM MEMBERS
Juan Casiano
Chris Gloeckle
Nick Herche
Rob Lancaster
Paul Stran
Paul Weibel

FACULTY ADVISOR
Dr. Luis A. Rodriguez

NFPA Fluid Power Vehicle Challenge

The NFPA Fluid Power Vehicle Challenge is designed to expose students to fluid power in a competitive setting that combines an existing technology, i.e. a human powered vehicle, with fluid power. Students must use hydraulics, instead of chains, to transfer the energy from pedaling into forward motion. The vehicle design will be evaluated based on performance in three events: a sprint race, an endurance time trial, and an efficiency challenge. The competition took place on the Danfoss campus in Ames, Iowa from April 10–14.

TEAM MEMBERS
Arush Arora (ME)
Jonathan Ashley (ME)
Adam Hay (CE)
Christopher Kataura (EE)
Nicholas Longfield (EE)
Derek Runner (ME)
Mason Startz (ME)
Eli Streeter (ME)
Nicholas Wallach (ME)
Jacob Wetzel (ME)

FACULTY ADVISOR
Dr. Subha Kumpaty

Keeping It Wheel—Kinnickinnic Trash Wheel Project

Clearwater Mills LLC plans to develop a trash wheel for the Kinnickinnic River in Milwaukee after success with their first and second trash wheels in the Baltimore area. However, the Kinnickinnic River is different than Jones Falls. The Kinnickinnic River experiences full freeze overs in the winter, large amounts of flooding and reverse flow. Thus, adaptations must be made to the existing trash wheel design to better fit Milwaukee and other future cities. The requested design changes are to implement a method to clear debris from the front of the conveyor, redesign the solar array and ensure that the entire system itself can be remotely monitored with an online application. With the analysis complete, a series of models will be created and a full proposal will be submitted to the Harbor District of Milwaukee and Clear Water Mills LLC with the recommendations of the team.

TEAM MEMBERS
Blake Campshure
Desarae Echevarria
Cody Johnson
Joseph Martinez
Michael Maurer
Nathan Sliefert

FACULTY ADVISOR
Dr. Prabhakar Venkateswaran

Team SWEPT – The Windmill Project

This project was broken down into three core components. The first is a self-governing windmill mechanism that will help illustrate how the self-governing feature of a windmill functions. Next, a pump display mechanism will be created to show how the rotational movement of the windmill blades transmits the work needed to drive an underground pump to retrieve water from a natural aquifer. Lastly, a water feature will be decided upon to illustrate the applications of water on a 19th century rural farm. Additionally, a rotary encoder will be coupled with a variable frequency drive pump that will output water to the water feature proportional to the wind speed of the environment.

TEAM MEMBERS
Adam Brust
Michael Matheson
Angel Montoya
Mike Nedza
Sydney Studebaker

FACULTY ADVISOR
Dr. William Farrow

STEM Powered by Wind

Team STEM Powered by Wind was contracted by Old World Wisconsin, the world's largest museum dedicated to rural life, to create an exhibit that would connect STEM education to rural history. The evolution of wind energy on farms is the ideal topic to connect both fields. With the collaboration of another MSOE group (Team SWEPT), a plan was developed to portray the past and present applications of wind energy. Team Powered by Wind focused

on the present application, wind farming, an alternative means of producing clean electrical energy. Wind energy, a form of solar energy, is caused by irregular heating of the earth's atmosphere, resulting in pressure gradients that allow natural flow to occur in the form of wind. Using the wind turbine technology, a goal was set to develop a hands-on experience for young students to explore and learn about wind turbine technology. As a result, the team designed a highly interactive multisensory exhibit that includes a large-scale fan as a wind source and electronic handheld wind turbines.

Acknowledgement: Special thanks to our sponsor Old World Wisconsin.

TEAM MEMBERS
Niklas Dedler
Thomas Konkol
Brain Rewolinski
Nicholas Russart
Andrew Trzeciak

FACULTY ADVISOR
Dr. Mohammad Mahinfalah

MILWAUKEE TOOL ADVISORS
Simon Gall
Drew Wyler

Milwaukee Tool Reciprocating Tool Lifetime Test Fixture

This design project, provided by Milwaukee Tool, is to design a lifetime test fixture for a Milwaukee Tool Super Sawzall®. This is accomplished by creating an automated test fixture that will load the tool only in the cutting/return stroke of the blade with a load that simulates real world materials (ex: wood, steel pipe, etc.). The current method for testing is performed by hand. This leads to inconsistencies with the testing data. Test fixtures are a way to purge uncertainties and error from testing. Design objectives were set for the test fixture to define loading, tool mounting, fixture interface and safety level. The testing must be done with minimal modifications done to the saw. The test fixture should be able to hold the tool safely and damp excessive or interfering vibrations. The loading on the saw shall be as realistic as possible, as well as consistent. The fixture should be able to withstand 60,000 cutting cycles (about five saw lifetimes) with minimal maintenance, and most parts of the fixture should have a much higher lifetime.

TEAM MEMBERS
Jason Julius
Brad Phoenix
Kayla Thilges

FACULTY ADVISOR
Dr. Mathew Schaefer

Remotely Operated Underwater Surveyor (R.O.U.S.)

J.F. Brennan Company Inc. of La Crosse, Wisconsin is a marine construction company that performs surveys on a variety of underwater structures. The purpose of the project is to provide a multi-purpose, shoreline-deployable mobile platform to aid J.F. Brennan in their hydrographic surveying related to underwater inspection, construction and remediation projects. Ideal assignments are for scour inspections, confined spaces, deep-water inspections, or deployment in any condition unsafe for diver entry. The R.O.U.S. is designed with maximum modular functionality in mind to allow J.F. Brennan to modify it to meet the needs of every project. To accomplish this the frame was engineered with 8020 extruded aluminum components. The R.O.U.S. can traverse the toughest conditions encountered underwater with its aggressive wheels and power provided by modified waterproof bilge motors that were sized and tested to fit the special operating conditions. In conjunction with the electrical engineering sub-team, the R.O.U.S. is fitted with lights and a camera that can communicate to the user onshore or aboard the boat. The control system will operate with differential steering to increase maneuvering capabilities. J.F. Brennan plans to fully implement the use of the R.O.U.S. into their surveying fleet.

TEAM MEMBERS
Abigail Born
Charlotte Kroc
Nico Luebbe
Dylan Meyer
Casey O'Connor

FACULTY ADVISOR
Dr. Nathan Patterson

Team B.E.N.—Device to Assist a Child with Spinal Muscular Atrophy

Our client, Ben, is a middle school student who suffers from Type 2 Spinal Muscular Atrophy, which has led to the loss of motor neurons in his spinal cord thus leaving Ben wheelchair bound. Ben and his family struggle with moving Ben in and out of his wheelchair when not at home, particularly when staying at hotels and traveling. The objective of the project is to provide Ben and his family with a device that can assist with Ben's transitions to and from his wheelchair when they are vacationing. The device consists of a rolling frame that supports Ben's weight and a lifting mechanism consisting of a custom designed winch and pulley system. The device is modular and lightweight to allow for easy storage and transportation. The frame is constructed with 80/20 aluminum extrusion and is an A-shape to maneuver over and around Ben's wheelchair. The winch and pulley system

improve user interaction with the device and decreases lifting time and device weight compared to the clients' current lifting device. The device is easy to assemble and maneuverable about standard hotel rooms.

Acknowledgement: Special thanks to the MSOE Rader School of Business for their generous $500 donation.

TEAM MEMBERS
Muortadh Alamri
Adam Allchin
Grant Eckhoff
Jonathan Martin
Paul Nicholas
Cody Pumala

FACULTY ADVISOR
Dr. Mark Daugherty

PV Bike Team 1

PV Bike Team 1 was given the task of designing a bicycle that would use an electric drive system in conjunction with photovoltaic cells. The team utilized a recumbent style tricycle design with a battery powered electric assist. The solar panel could then be used to charge the battery system and provide extended range. To keep the bicycle footprint small the solar panel was top mounted, doubling as a roof. The relatively high additional mass due to the solar panel was offset by the low center of mass of the recumbent style, and the tricycle frame added stability. Legal constraints mandated that the bike could not have more than three wheels or exceed 20 mph if operating under full electric power. Brake lights were also required. Additional project objectives included using two battery banks enabling one to charge while the other was in use and ensuring the frame could support least 50 lbs of cargo. The team overcame budgetary constraints by purchasing an old tandem tricycle frame that was converted to the desired recumbent style, and sourcing used components wherever possible. Stability and structural analysis was conducted to ensure the design would be safe, and the electrical system included an emergency fail safe. Further analysis was conducted for other major components, such as the drivetrain and steering, to ensure functionality. The net result was a single passenger recumbent tricycle with electric pedal assist that could be reasonably used for urban commuting, or bike packing, with an extended range due to the solar panel.

Acknowledgement: Special thanks to Sunvest Solar for their generous contribution of two solar panels for use in this project.

TEAM MEMBERS
Jacob Binash (ME)
Nick Crumbaugh (ME)
Matt Fiddes (ME)
John Maniscalco (ME)
Logan Kupferman (EE)
Samantha Schuemann (ME)
James Shipp (EE)

FACULTY ADVISOR
Dr. Anand Vyas

PV Powered Cycle Team 2

A Photo-Voltaic Powered Cycle was created for Mechanical Engineering Professor Mark Daugherty. Quality Function Deployment decision matrix was used to create the tricycle with flexible solar panels. MATLAB analysis was completed to ensure stability, center of gravity, and stopping distance. An existing tricycle was purchased, redesigned, then analyzed with the Finite Element Method in ANSYS. Also, in ANSYS, Computational Fluid Dynamics method was employed to find aerodynamic forces. Battery size was determined through analysis and testing of energy requirements for the in-hub motor, which assists the rider. Analyses are validated with experimental results where time and equipment permitted. A scale model was set in a wind tunnel to find aerodynamic forces. Tests were done to observe solar panel performance. Theoretical properties of the frame material were used to analyze the redesigned frame to ensure safety. The stopping distance was found by testing at top speed. The center of gravity was measured by weighing the bike at each wheel. The cycle can reach a top speed of 20 mph and has a cargo capacity of 150 lbs.

Acknowledgement: Special thanks to Plexus Corporation, JBI Bikes and KAPCO Metal Stamping for generous financial and technical support.

TEAM MEMBERS
Abdulrahman Alzahrani
Joseph Doyle
Jacob Frey
Andrew Makurat

FACULTY ADVISOR
Dr. Richard Dykowski

Self-sealing Frack Plug

One of the most vital components of any fracking operation are the fracking plugs that assist with the fracturing of the rock bed that contains the oil or natural gas. These plugs are sent down the well and subsequently set into the steel casing of the well using a setting tool. Once firmly set in place and confirmed to be sealing off the rest of the well, fracking fluid is pumped down the well and pressurized to a range of 8,000–10,000 psi. The plug's main design goal is to withstand this pressure, causing the fluid to expand out into the surrounding rock formations, eventually fracturing the hard rock and shale outside of the well casing. Once a well is fracked the plugs are drilled out, the remains of which are pumped out with the oil or natural gas, and the operators move on to the next site. The purpose of this project was to redesign a frack plug in a way that would

make it appeal to industry leaders by 1) reducing the plug length and 2) adding a self-sealing module to the inside of the plug, allowing it to seal itself without needing a ball to be pumped down to it. The plug needed to withstand a maximum pressure of 10,000 psi and accommodate a 4.5 in. diameter well casing. Two slip rings were combined on one end of the plug, which effectively reduced the length of the plug when comparing it to the existing plug at Cornerstone's facilities.

Acknowledgement: Special thanks to our project sponsor Cornerstone Composites.

TEAM MEMBERS
Pamela Lieberman
Ray Schwartz
Cole Sterk

FACULTY ADVISOR
Dr. Nathan Patterson

3D Play-Doh Printer

This project combines the technical capability of additive manufacturing with the colorful creativity of Play-Doh. The goal of this project is to show the capabilities of 3D printing with ceramic materials, such as the plasticine that makes up Play-Doh. Phase 1 of the project involved testing for the material properties of Play-Doh. Phase 2 used the data gained from phase 1 to design the nozzle and mixing chamber of the printer, as well as refit the printer for newer parameters. Phase 3 of the project tested the printing process and observed how plasticine behaves in the 3D printing process. This project's findings will be useful as more ceramics are incorporated into the field of additive manufacturing.

MSOE/Fachhochshule Lübeck Thesis Projects

Thesis Title: Research, Selection, and Design of Resonating Horns for Improved Acoustic Field Properties in a Three-Axis Levitator

Student: Taylor L. Davitz

Faculty Advisor: Dr. Michael Sevier

Thesis Title: Design and Analysis of a three-speed automatic Bicycle Gear Hub

Student: Niklas Dedler

Faculty Advisor: Dr. Nebojsa Sebastijanovic

Thesis Title: The Feasibility of a Variable Mass, Variable Thrust Co-generative Propulsion System Exploiting In-Situ Resource Utilization for Low Gravity Field Navigation

Student: Michael E. Hinaus

Faculty Advisor: Dr. Nebojsa Sebastijanovic

Thesis Title: Design and Analysis of a Magnetic Handling Device for a Robotic Regolith Collection River on an Asteroid

Student: Benjamin T. Jensen

Faculty Advisor: Dr. William Farrow

Thesis Title: Design of Adjustable Rear Suspension for Baja SAE Vehicle

Student: Aaron Koepke

Faculty Advisor: Dr. Mathew Schaefer

Thesis Title: Design and Analysis of a Coupling Device for Use in a Reciprocating Saw Life Cycle Test Fixture

Student: Thomas M. Konkol

Faculty Advisor: Dr. Mohammad Mahinfalah

Thesis Title: Testing and Optimization of an Exo-Skeleton for People with Cerebral Palsy

Student: Nico Luebbe

Faculty Advisor: Dr. Robert Rizza

Thesis Title: Application of Pedal Assist with Regenerative Braking on a Fixed Gear Bicycle

Student: Jonathan N. Martin

Faculty Advisor: Dr. Michael Cook

Thesis Title: Exploration of Additive Manufacturing and 3D Printing Processes and the Effects on Vibratory Properties of Materials

Student: Connor C. McGill

Faculty Advisor: Dr. Nebojsa Sebastijanovic

Thesis Title: Design and Optimization of a Steering Linkage System for the MSOE Baja Vehicle

Student: Sascha Meyer

Faculty Advisor: Dr. Nebojsa Sebastijanovic

Thesis Title: Analysis and Optimization of a Multi-Input Lifting Drive

Student: Casey O'Connor

Faculty Advisor: Dr. Mathew Schaefer

Thesis Title: Investigating the Application and Use of Flash Soldering
Student: Cody James Pumala
Faculty Advisor: Dr. Mathew Schaefer

Thesis Title: Super Sawzall Orbital Function Test Fixture Rack and Pinion Design
Student: Brian J. Rewolinski
Faculty Advisor: Dr. Mohammad Mahinfalah

Thesis Title: Optimization of the Frame of a Photo-Voltaic Powered Tricycle
Student: Samantha Schuemann
Faculty Advisor: Dr. Anand Vyas

Thesis Title: Devising a Method to Utilize an Automated System to Retract and Extend Solar Panels
Student: Mason F. Startz
Faculty Advisor: Dr. Daniel Williams

Thesis Title: Biometric Design Optimization of an Underwater Vehicle Using Computational Fluid Dynamics
Student: Kayla M. Thilges
Faculty Advisor: Dr. Nathan Patterson

Thesis Title: Optimization of Suspension Parameters for 2018 MSOE SAE Baja Vehicle
Student: Andrew Thomas Trzeciak
Faculty Advisor: Dr. Nebojsa Sebastijanovic

Thesis Title: Improving the Productivity of a Corrugated Die Cutter: An Investigation of Dynamic Loads on the Electric Drive Motor

Student: Hans H. Waldoch

Faculty Advisor: Dr. Daniel Williams

Thesis Title: Design and Optimization of the Steering Gearbox and Steering Wheel Connection

Student: Yannick Walz

Faculty Advisor: Dr. Nebojsa Sebastijanovic

School of Nursing

Summer 2017 Senior Projects

STUDENTS
Megan Faanes
Karissa Kaul
Nelisha Patel

FACULTY ADVISOR
Christine Olson, RN, MSN

Providing an Educational Toolkit to Homeless Shelter for use within the Hypertension Population

Research suggests there is a high prevalence of hypertension within the homeless population related to lifestyle behaviors, diet, and barriers to care. Many people within the homeless population do not have constant hospital access or a primary provider they see on a regular basis. This leads to gaps and inconsistencies in not only patient care, but in patient medical records as well. This project was created to provide a toolkit for the homeless population to better track their blood pressures regardless of where they are receiving care, and to help them understand lifestyle changes that will reduce their blood pressure, and prevent cardiac disease.

STUDENTS
Maria Sorrentino-Magnuson
Jessica Vogel

FACULTY ADVISOR
Christine Olson, RN, MSN

Developing an Educational Toolkit Regarding Delayed Bathing in Healthy Newborns at Birth Center

The World Health Organization recommends delaying a newborn's first bath for 24 hours after birth; the Association of Women's Health, Obstetric and Neonatal Nurses recommends waiting eight hours; yet standard practice for local hospitals is to bathe newborns within the first two to three hours of birth. Delayed bathing has been shown to improve thermodynamics, glycemic control, maternal bonding, breastfeeding rates and overall patient satisfaction. The goal of this project was to review relevant literature and provide the birth center we are working with an educational toolkit to support this evidence based practice change. A power point presentation was provided for staff education, along with a nurse's break room bulletin and face-sheet for expecting parents who were visiting the birth center.

STUDENTS
Cassandra Housh
Emma Joubert
Daniel Marchillo

FACULTY ADVISOR
Christine Olson, RN, MSN

Developing an Educational Toolkit to Increase Participation in Unit-Based Shared Governance

The shared governance model is an approach to include direct patient care nurses in policy development and improving standards of practice. The purpose of unit-based shared governance is to decentralize decision-making and problem-solving through partnership, equality, accountability and ownership. Bedside nurses are not participating in shared governance because they do not value participation in governance, lack knowledge about the function of shared governance, and prefer to remain solely at the bedside. Through the use of Kotter's change theory, an educational toolkit would be implemented to increase staff knowledge about unit-based shared governance. The desired outcome would be increased knowledge, value, and participation in unit-based shared governance.

STUDENTS
Lindsey Adamczyk
Emily Epifanio
Hailey Tyznik

FACULTY ADVISOR
Christine Olson, RN, MSN

Creating a Toolkit to Differentiate Delirium from Dementia

Delirium is classified as an acute phase of confusion. It is often short-term and reversible within a month or less. Whereas dementia is a global impairment of intellectual function and cognitive decline that is generally chronic and progressive. While both involve cognitive changes, delirium can also have physical and emotional manifestations. Delirium affects around 50 percent of elderly patients (age 75 and older) who are admitted to the hospital. According to research, in this population 30-40 percent of these cases are preventable. Throughout the U.S., about 12.5 million patients that are treated in the ICU will experience delirium. Treatment costs are in the billions. This project sought to create a toolkit to remind and encourage the proactive efforts for early identification and treatment of delirium.

STUDENTS
Natalie Creegan
Sarah Ewert
Rachel Vegter

FACULTY ADVISOR
Christine Olson, RN, MSN

Educational Tool: Importance of Accurate Patient Weights

The overall purpose of this project is to provide an educational tool to the unit so that health care workers can reduce errors caused by inaccurate weights. The problem identified was the measurement process resulting in an inaccurate weight, which may lead to medical errors, especially medication dosing mistakes. Our intervention is to create an educational tool (Power Point and evaluation quiz) to accurately educate hospital staff on proper

standardized ways to obtain patient weights. Our general outcome is to prevent weight based errors. Our objectives include: proper demonstration of how to zero a bed, proper demonstration of obtaining a weight in kilograms, accurate explanation of the importance of obtaining an accurate weight, and the detrimental adverse effects that result from inaccuracy.

STUDENTS
Nathaniel Silgen
David Stasiewski

FACULTY ADVISOR
Christine Olson, RN, MSN

Environmental Service Application's Impact on Patient Satisfaction

The purpose of this project is to investigate the relationship between quality control metrics and increased patient control over his/her room cleanliness via the environmental services application. Improving the patient experience can lead to more favorable outcomes for the patient, family, hospital and staff. Patient perceptions are manipulated through the use of an interactive in-room patient messaging system linked to the environmental services (EVS) department. This communication tool allows for the additional housekeeping needs of a patient or family member to be addressed within the same day. The success of the environmental services application will be judged based on data-generated by the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) surveys. More specifically, we will look at improvements in top box scores as an indicator of a successful rollout of the (IPC) system message. If successful, we will work with our affiliate to develop and implement a system-wide tool. This tool for change will focus on ensuring better patient orientation and education on the use of the IPC system. Our recommendations are designed to educate hospital employees, not individual patients. This allows hospital staff to customize the education delivery based on their assessment and judgment of individual patient acuity.

STUDENTS
Dawn Briant
Leshia Kimble

FACULTY ADVISOR
Christine Olson, RN, MSN

Developing an Educational Toolkit to Reinforce the Policy Regarding Single Use Pressure Bags

Preventing infection is the number one goal throughout hospitals all over the world. The acuity of patients on an intensive care unit is high, which results in patients being at a higher risk for infections. Based on personal observations throughout Froedtert Hospital's Intensive Care Units, pressure infusion bags are being used multiple

times on different patients. According to the manufacturer, Ethox -Medical, the Infu-Surg pressure Infusion bags are disposable and for single patient use, which helps prevent hospital acquired infections, control cross contamination and improve patient outcomes. Froedtert has a policy in place that indicates that the set-up system for patients with transduced lines should be changed every 96 hours. A brochure reinforcing Froedtert's policy and the risk involved in not following the policy was created as a guide to assist the nurse educator in educating staff. This change focuses on increasing collaboration among care providers to ensure policy is being followed, seeking and identifying manners of prevention and early intervention services, reducing the rate of hospital acquired infections and CLABSIs, providing an educational tool in the form of a brochure to nurse educator to educate nursing staff on correct disposal of pressure infusion bags according to the manufacturer and including instructions to properly label infusion bags with patient name, date and disposal date.

Fall 2017 Senior Projects

STUDENTS
Marissa Gersbrein
Renae Matysik
Meghan Suminski

FACULTY ADVISOR
Ruth Widder, DNP

Tip Sheet for Float Staff

The purpose is to provide information to nurses who float to a local unit and are unfamiliar with the unit's routine. The tip sheet will provide reminders of unit's work flow, special contact numbers, and where specific care items can be located.

STUDENTS
Cherry Calara
Ann Gatbonton
Hali Peterson

FACULTY ADVISOR
Ruth Widder, DNP

Assessing the Risk of Complicated Grief

The project's objective was to improve outreach bereavement care to individuals at risk of complicated grief at a local hospice. A tool was created to assess individual risk factors of complicated grief.

STUDENTS
Erin McCormis
Kathryn Tice

FACULTY ADVISOR
Ruth Widder, DNP

Teaching Tool for Use of Multisensory Rooms in Mental Health Therapeutic Milieu

Teaching tool designed to educate staff on the use of the sensory room in a mental health therapeutic milieu. The tool will educate staff specifically about the indication, implementation, and benefits specific to the room. It was designed to aid in the recovery of individuals, primarily those with moderate to profound cognitive impairment, receiving treatment at a mental health facility

STUDENTS
Amelia Braman
Ashley Casper
Brittany Robakowski

FACULTY ADVISOR
Ruth Widder, DNP

Use of a Rounding Tool to Improve Patient Satisfaction in the Emergency Department

Surveys show a higher rate of patient dissatisfaction in the emergency department's waiting room of a local hospital as evidenced by patients leaving before being seen. The group developed a rounding tool and instructional handout for nurses to implement involving monitoring and updating patient's health status throughout the wait. The goal is to improve patient satisfaction during this phase of their emergency department visit.

STUDENTS
Jiaping Chen
Mai Lee
Kala Sanders

FACULTY ADVISOR
Ruth Widder, DNP

Using Meditation for Stress Management in School Age Children

A relaxation tool for school age children was developed to help them cope with stress at school. The project entailed guided mediation with accompanied music. Research has shown that meditation has helped improve stress levels and enhance emotional stability among school age children.

STUDENTS
George Ademi

FACULTY ADVISOR
Ruth Widder, DNP

Educating ICU Nurse Managers on Nurse Burnout Prevention and Recognition

Burnout is a culmination of behavioral and emotional impairments experienced by ICU nurse, caused by prolonged exposure to high levels of work related stress. The severity of stress is strongly associated with the actions of the nursing managers. The purpose of the project is to educate ICU nurse managers on burnout prevention strategies and recognition of early burnout signs and symptoms.

STUDENTS
Katelyn Ammon
Cayla Golsteyn
Neil Magtoto

FACULTY ADVISOR
Ruth Widder, DNP

Providing Education to Health Care Providers Regarding the Baby Box and Safe Sleep for Newborn Infants

The incidence of SIDS and co-sleeping deaths in the Milwaukee area are among the highest in the nations. Education will be provided to health care providers who work with newborn infants, regarding the Baby Box and safe sleep, with the ultimate goal of increasing caregivers' education, and reducing the high rate of infant mortality in the Milwaukee area.

STUDENTS
Maria Bintz
Ashley Fozio
LeAnne Likins

FACULTY ADVISOR
Dr. Debra Jenks

Home Infection Stops Here

A quick access flip book for home infection control in oncology patients was developed. The flip book provides information regarding lines, wounds, nutrition, and other information for patient safety and infection prevention.

STUDENTS
Ana Busalacchi
Claire Ciszewski
Mariana Garcia Perez

FACULTY ADVISOR
Dr. Debra Jenks

Stop! Gown Up? Is Handwashing Enough?

This project is a synthesis of the Center for Disease Control's (CDC) new recommendations for contact vs. universal precautions based on the epidemiological presence of MRSA. A policy and flowsheet to address compliance in the hospital setting was developed.

STUDENTS
Rebecca Fetter
Ryan Kuhn
Sarah Pellico

FACULTY ADVISOR
Dr. Debra Jenks

Increasing Participation in the Use of Advance Directives Among the African American Population.

This project is about increasing participation in decisions made pertaining to end of life preferences in African American Population with a focus on advanced directives. We propose a change regarding the delivery and education by increasing health care involvement within the African American community.

STUDENTS
Heather Hansen
Hannah Pacey
Joseph Terry

FACULTY ADVISOR
Ruth Widder, DNP

Implementation of Family Presence During Resuscitation

The purpose of our project is to educate the nurses in intensive care units regarding current evidence on best practices regarding the presence of family during resuscitation.

STUDENTS
Hayley Dotson
Ashley Flower
Hannah Schlagel

FACULTY ADVISOR
Ruth Widder, DNP

Routine Gastric Residual Evaluation in NICU Infants: Does This Practice Have Merit?

Current research brings to light a potential inconsistency with the nursing standard of evidence-based practice when routinely evaluating gastric residuals. The goal of this project is to reconcile practice with research, which indicates that routinely checking gastric residuals does not produce significant benefit and may in fact cause significant harm.

STUDENTS
Breanna Simmons
Annie Wendt
Molly Wendt

FACULTY ADVISOR
Ruth Widder, DNP

Community Overdose Prevention Education

The focus of this project is on increasing awareness of the opioid epidemic and increasing the use of naloxone in community settings. Instructional material was created for community health nurses to be able to provide a seminar on opioid abuse, its relevance to the community, along with prevention strategies for incoming college freshman during new student orientation week.

Physics and Chemistry Department

BioMolecular Engineering Senior Projects

TEAM
Four of Hearts

TEAM MEMBERS
Alexandria Cook
Gabriel Garcia
Kassidy Girmscheid
Peyton Tebon

FACULTY ADVISORS
Dr. Gul Afshan
Dr. Eryn Hassemer
Dr. Matey Kaltchev

INDUSTRIAL ADVISOR
Dr. Farhan Rizvi,
Aurora Health Care

FOUR OF HEARTS

Developing a Method to Characterize the Mechanical Properties of Human-derived Cells

One in four deaths in the United States result from heart disease. Chamber remodeling, ventricular compliance, and fibrosis are the major factors responsible for the malfunction and failure of the heart. While therapeutic approaches to managing these conditions vary by patient, medications like statins are often prescribed as a common remedy. Statins are a class of prescription drugs used to inhibit production of low-density lipoprotein (LDL) by blocking the cholesterol synthesis pathway. The macroscale impact of statins contributes to lower blood pressure and thus decreased risk of heart attack, stroke, and heart failure; however, the impact on the heart cells and tissue are not well-documented. The goal of this project is to develop a standard protocol for the characterization of the elasticity of cardiac fibroblasts. The solution developed uses the atomic force microscope (AFM) to measure the forces between the probe and cell surface via contact indentation. The collected force data is then analyzed in MATLAB through an algorithm by implementing the Brush Model to calculate Young's modulus, elasticity. By understanding the cellular impacts of statins and other commonly used drugs, physicians can make informed decisions to improve patient care.

Acknowledgement: Special thanks to our faculty and industrial advisors, as well as De'Jorra Gilmore, the Biomolecular Engineering Program, Physics and Chemistry Department and Rader School of Business.

TEAM
Big Bacillus

TEAM MEMBERS
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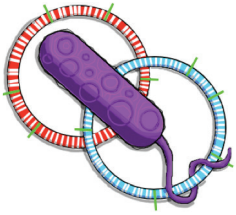

GeneFunc—A Bioinformatics Bacterial Comparative Genome Analysis Tool

As antibiotic resistance becomes an ever-increasing problem, regulations look to aid in stemming the tide of antibiotic resistant bacteria. The U.S. Food and Drug Administration (FDA) has passed Guidance For Industry (GFI) #213 which exercises the judicious use of chemically synthesized antibiotics in farm feed. However, the agricultural industry now has a serious need for alternative antibiotics to ensure animal health and effective growth. In the search for alternatives, naturally derived antibiotics are a topic of research, and *Bacillus* strains show significant promise due to their antibiotic tendencies. Yet, the addition of *Bacillus* to farm feed can only stop so many harmful bacteria to the livestock. So the question was asked: Can *Bacillus* be improved. Different strains of *Bacillus* can produce different and naturally derived antibiotics that have the potential to be combined and produced in a single strain. Comparative genomics methods provide an avenue to accomplish the goal of *Bacillus* antibiotic aggregation. Current methods of comparative genomics solve for genomic similarities by linking common genes between multiple organisms. This sole focus on genetic similarities unfortunately limits contemporary methods through the removal of vital information that can be found in genetic differences. Additionally, these similarities are presented in a counterintuitive manner as current visualization tools are crowded and overwhelming. Team Big Bacillus aims to create a comprehensive and intuitive web app, GeneFunc, to classify genes using novel comparative methods. The program will also highlight and identify genes that are exclusive between the organisms as they remain relevant in the comparison. The bacteria *Bacillus subtilis* and *Bacillus cereus* are to be used as exemplars for GeneFunc, as they are widely used for the production of antibiotics. With the success of a new and intuitive comparative genomics visualization and comparison method, geneticists can theoretically design a new bacterium to produce desired non-chemically synthesized antibiotics without producing other unwanted or unnecessary compounds. This research can potentially provide users additional insights into the field of comparative genomics.

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Force Mapping Analysis of the Medtronic CoreValve

Transcatheter Aortic Valve Replacement (TAVR) is a minimally invasive procedure in which patients with severe aortic stenosis receive an artificial aortic valve. Approximately 30 percent of patients who undergo TAVR and receive the Medtronic CoreValve experience conduction abnormalities following the surgery. This occurs due to excessive pressure exerted by the CoreValve on cardiac muscle fibers. The focus of this project was to analyze the radial force distribution of the Medtronic CoreValve to determine the force exerted over time. Data collection consisted of two major phases: (1) testing phase without fluid flow and (2) testing phase with pulsatile fluid flow in a silicone heart model. Two different aortic valve inserts – no calcification and medium calcification—were used for comparison. The collected force data will allow The Broken Hearts to propose a redesign of the Medtronic CoreValve that will reduce or eliminate postoperative conduction abnormalities for patients who undergo TAVR.

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TEAM
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Optimization of B Cell Culture for HLA Extraction

Advancements in biotechnology and health care have allowed for the development of improved patient care methods such as organ transplantation. Patients with improperly functioning organs are able to obtain healthy alternatives from potential donors, but before a transplant, it must be ensured that a recipient will not reject the donated organ. Tools known as HLA typing kits are used to compare individuals for transplant matches using specialized Human Leukocyte Antigen binding properties. The antigens needed for these kits are extracted from B cells, but current cell growth and extraction protocols are not generating sufficient amounts to keep up with customer demand. Team CODE is focused on optimizing B cell culture protocols to

best produce these antigens. Through testing various growth factors, culture environments, and media component variations, the team aims to develop a culture protocol that will produce the greatest possible HLA yield.

TEAM
Flow Pros

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Designing a Protocol for Cell Culture in Microfluidics

Microfluidics is a multidisciplinary field that focuses on the precise conditions of flowing extremely small volumes of liquids, in which the deliberate manipulation due to their properties at these quantities allows for diverse applications, such as encapsulation. Microfluidic encapsulation is an approach which excels in cases which require low sample volumes, such as isolating cells for genetic engineering, providing vessels for drug delivery, or aiding as a barrier to increase cell survivability.

Current methods of encapsulation are either expensive, difficult to obtain, or inefficient. The Flow Pros are acting in an attempt to produce an affordable and repeatable method for encapsulating cells. In the case of this project, algal cells are being encapsulated, however, the process could be extended to using any other type of cell which is small enough to appropriately fit within the microchip being used.

Team Flow Pros began by forming water-in-oil single emulsions in order to familiarize ourselves with the concept of microfluidics and the process of operating the microfluidic pump and microchip. This preliminary work revealed a lot of information that assisted the team in developing the double emulsions that were eventually investigated. The double emulsions that the Flow Pros have been developing include the following reagents: Chlorella vulgaris algal cells, carboxymethyl cellulose, sodium alginate, D-Mannitol, Alga-Gro freshwater media, and HEPES buffer solution.

The object of formulating a protocol for encapsulating algae with microfluidics will serve to provide reproducible results for applications such as isolating such cells for screening and manipulation in applications for biofuels. Standardized protocol development will also allow for easy conversions for different cell lines for future applications, such as encapsulating mammalian cells before cryopreservation, or delivery of cell therapy into a patient. In addition to providing accurate reproducibility, standardization of this procedure will also lead to improved cost effectiveness and reduced wasted resources.

TEAM
Fowl Play

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Probiotic Modulation of Immune Response via Chicken Gut Cells

With antibiotic resistance on the rise, the FDA has restricted the use of antibiotics in the livestock industry and businesses are looking for ways to promote healthy livestock using alternative methods. The goal of team Fowl Play is to establish a poultry ileum intestinal epithelial cell line from a 20-day-old chick called PIE-20 as a model to test novel probiotic *Bacillus* strains. The team will continue the work of the 2016–2017 senior design team M.I.R.A.C.L.E in the first objective by establishing a sustainable PIE-20 cell line for a reasonable testing period. The second objective is to determine the genes involved in the intestinal immune response and measure their expression through real time PCR. The third objective is to introduce the novel *Bacillus* strain into the PIE-20 culture for comparison of the immune response changes to determine the efficacy of the probiotic strains.

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TEAM
Genome Busters

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Development of a Comparative Genomics Tool for *Bacillus subtilis*

Bacillus subtilis is a gram positive bacterium that is used in multiple industries as an antimicrobial-producing food additive. It has no known harmful effects to humans or livestock and is widely studied in both industrial and academic settings. As such, *Bacillus subtilis*-related products make up a third of the $16 billion bioinformatics-product market. Because each *Bacillus* bacterium has a different genome and therefore different antimicrobial producing genes, it is desirable to compare the genomes of more than one *Bacillus* bacterium and possibly create a synthetic genome which requires a tool to compare these genomes. Currently, no easy visualization tool exists for the comparative analysis of two bacterial genomes, for information about specific genes must be synthesized from multiple sources, namely NCBI databases and peer-reviewed journal articles that describe the genes. This project focused on the development of a web-based visualization tool that allows for comparison of two *Bacillus subtilis* genomes, specifically their respective antimicrobial-

producing genes. Such a tool can potentially be used to create a synthetic *Bacillus* genome, encompassing all genes of interest. Our visualization tool was based upon the work of last year's Polymorphs Senior Design team. Two bacterial genomes are displayed concurrently, as well as a menu listing constituent genes of the genomes. A gene identification algorithm was developed to locate genes, with gene locations being visible on the displayed genomes. Furthermore, this visualization tool allows for comparison by color-coding both similar and unique genes between the genomes. Further work will focus on expanding the functionality of our code base and implementing the features that we have deemed necessary for a useful comparative analysis tool: accurate identification/location of genes; linking gene data to NCBI and other databases; and a summary feature that will display the similar and dissimilar genes between the two genomes.

TEAM
Methane to Protein

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Designing a Facility to Convert Methane into Bioprotein

Current research and methods into creating proteins for animal nutrition are costly and still relatively new. There is a global need for more affordable protein for animal consumption. Protein sources will remain in high demand, making a cheaper production facility a very profitable investment for animal farms. While outside the scope of the project, it is important to note that resource scarcity and population growth may play a big role in developing more interest in cheaper products. A growing population will put more strain on resources, such as wheat or soybeans. The goal of this project was to evaluate the feasibility of a whole cell aquaculture feed production facility utilizing methane as a feedstock, and biomass propagation via fermentation of the methanotroph Methylomicrobium buryatense 5GB1. Methanotrophic organisms produce a whole cell product through fermentation, which has a good nutritional balance for animal feed and can be used as a means to consume the greenhouse gas methane. The methanotroph strain Methylomicrobium buryatense 5GB1 is used in this model due to the striking resemblance between the mass composition of the microbe and standard compositions of aquaculture feeds. The growth of M.buryatense is favorable due to its natural ability to grow in harsh environments with fluctuating temperatures, salinity, and pH levels. The facility is will be designed using the SuperPro Designer software because it has an extensive database of materials, operation

costs, and automatically sizes and prices equipment for accurate material interactions and economic analysis.

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MFC Energy

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Scaling up the Microbial Fuel Cell for Wastewater Treatment

Traditional methods of wastewater treatment are effective, but tend to be costly and require high energy input. This is especially true for small beverage companies with high COD content wastewater, which incurs fines when treated industrially. These companies would benefit greatly from an on-site, biological water treatment method. In this project, microbial fuel cells were analyzed as a cost-saving and environmentally friendly alternative to traditional wastewater treatment methods. The design choice for this project was to make two identical lab-scale microbial fuel cells (volume of 180ml) differing only in the choice of membrane. One of the microbial fuel cells was constructed using a cation exchange membrane and the other using an anion exchange membrane. This project focused on optimizing lab-scale microbial fuel cells and working out scale-up equations using the found parameters, but future work using these findings could be used to test microbial fuel cells at a larger scale. The microbial fuel cells are currently created with affixed bacteria, with power generation testing being performed. Expected flow rates for our initial size are 3 ml/hr, power output around 30 mW/m^2, and COD removal above 95 percent. Further optimization and scale up will continue to maximize coulombic efficiency as the size increases. Optimized specifications on the smaller scales are meant to decrease the drop in efficiency from the increase in size. As for now, power, flow rates, resistances, and basic organic waste removal percentages are being attained and laid out. The final research is hopeful in designing a standard for a preferred industrial scale microbial fuel cell for efficient wastewater treatment.

TEAM
X-Pectin

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Development of an Oxygen Therapeutic through Hemoglobin Encapsulation of Pectin-Oligochitosan Hydrogel Microcapsules

Given the complexity of matching and sustaining available resources to patients in need of blood transfusions, this project sets out to simplify an approach to vascular oxygen circulation and provide both a feasible and sustainable solution. In examination of erythrocyte properties and morphology this team has carried out continued work on the development of a biconcave hydrogel microcapsule with encapsulated hemoglobin through testing of various hydrogel preparations. Team X-Pectin investigated an alternate approach to developing a biocompatible oxygen therapeutic through determination of hemoglobin encapsulation efficiency, improvement of capsule stability, and optimization of production parameters based on hemoglobin-encapsulated pectin-oligochitosan hydrogel microcapsule prototypes. Prototypes were developed with the intention of creating a universal type, pathogen-free, long-term storage product that alleviates the current global blood shortage. After the final product was generated, a standard curve was developed to determine hemoglobin encapsulation efficiency, which corresponded to 97.3 percent with a standard deviation of 3.6 percent. Although the encapsulation efficiency is exceedingly favorable, more research is needed on the final product. Like any new drug development, a product must first be approved by the U.S. Food and Drug Administration (FDA) before being deemed safe for human use via extensive human clinical trials; this is an important consideration in the future advancements of the product. By further developing pectin-oligochitosan hydrogel microcapsules through determination of hemoglobin encapsulation efficiency, improvement of stability and optimization of production parameters, the team further matured the final process of generating the product, in which the efficiency of the produced microcapsules are maximized, for both a feasible and globally sustainable solution.