WESTERN MICHIGAN UNIVERSITY
College of Engineering
and Applied Sciences

S E N I O R D E S I G N
E N G I N E E R I N G
C O N F E R E N C E
A P R I L 2 0 , 2 0 2 1
As Dean of the College of Engineering and Applied Sciences (CEAS), it is my pleasure to welcome you to the 68th Senior Design Engineering Conference. Please join us in congratulating our students for the successful culmination of their work in their senior design projects. I invite you to attend our students’ virtual presentations to learn about their work and the exciting things they have accomplished. Senior design projects allow students to test their knowledge in a real-world setting. In most cases, this work is completed for a company through an industry sponsor. What you will see are the results of student teams designing, building, and testing in their respective disciplines. We are so very proud of our students and their efforts. Today is a day to celebrate. Today is a day to acknowledge perseverance and dedication. Today is our senior design students’ day. Please enjoy this special day for our students, faculty, and staff.
Contents

Chemical and Paper Engineering................................................................. 2

Civil and Construction Engineering.......................................................... 7

Computer Science.................................................................................... 12

Electrical and Computer Engineering...................................................... 16

Engineering Design, Manufacturing and Management Systems .............. 21

Industrial and Entrepreneurial Engineering .......................................... 25

Mechanical and Aerospace Engineering.................................................. 27
 ALTERNATIVE SUPPLIERS OF RADIO FREQUENCY (RF) OVENS FOR CRACKERS

Kellogg’s produces multiple cracker and biscuit products. These products are sometimes baked in 2 stages to develop good eating quality and shelf-stability of the product. Radiofrequency (RF) technology is utilized in the second stage of baking.

Kellogg's is looking for alternative technologies for post-bake drying. The main objectives to reach this end goal are to develop an understanding of cracker processing, RF technology, process demands, and design standards.

We will identify alternative suppliers of RF ovens worldwide and alternative technologies, prepare mass and energy balances for an RF oven, calculate the total cost of ownership for the equipment, and develop a best value option analysis and an economic analysis for alternative suppliers and technologies.

Team Members:
Jay Bradstreet
Julia Burk
Eliza VanZweden
Kaet Teunessen

Sponsors:
Terry Andren, Kellogg Company
Brian Bartley, Kellogg Company
Nicole Remily, Kellogg Company

Faculty Advisor:
Dr. James Springstead

COMPUTER SIMULATIONS OF FORMING OF FIBER NETWORK ON A PAPER MACHINE

Papermaking has two important processes for the removal of water. One is the formation of a fiber network on a forming section in a paper machine, while the other is a wet press on the fiber network. A developed lattice-Boltzmann lattice-spring method is utilized to simulate the two processes. The lattice Boltzmann method is used to mimic fluid behaviors via modeled fluid particles streaming and collision processes, while flexible fibers are discretized as solid particles connected by harmonic springs. In our simulations, a large number of individual flexible fibers settle on a filtering wire by gravitational force in fluid and form a natural fiber mat. A pressure pulse combination of shoe and roll presses is imposed on the fiber mat. The results of fiber solid concentration, paper thickness, and moisture content of the fiber mat as a function of time during pressing are shown and analyzed. Rewetting phenomena and sweet plots are studied and examined.

Team Members:
Omar Aly
Ian Geiger
Landon Haight
Andrew McCabe
Zac Weber

Faculty Advisor:
Dr. Dewei Qi
GENERATION OF ELECTRICITY FOR A PHARMACEUTICAL PLANT
A pharmaceutical plant in Holland, Michigan has recently been informed that their electricity provider will be shutting down in 3 to 4 years. The facility has tasked our team with designing an in-house process to produce all of their power. To meet the facilities requirements of 60 MWh, a power plant fueled by natural gas is of interest. A cogeneration cycle has been chosen in order to increase the overall efficiency of the power plant. The facility also has expressed interest in the possibility of utilizing renewable resources for some or all of its energy needs. In order to determine the best option for the facility, a feasibility study with a sensitivity analysis will be conducted.

Team Members:
Tyler Banas
Tyler Fleming
AJ Henry
Emma Ross
Tyler Weckerle

Faculty Advisor:
Dr. Said AbuBakr

DESIGN A LARGE-SCALE MANUFACTURING FACILITY FOR PRODUCTION OF A TRIVALENT FLU VACCINE USING A NON-EGG-BASED EXPRESSION SYSTEM
This new method of producing flu vaccines using insect cells will eventually replace the egg-based process for influenza vaccines due to potential adverse reactions to current vaccines, as well as the ability to more promptly react to an influenza pandemic. The vaccine created will follow the World Health Organization's recommendations and will be delivered to the North American market only. The number of doses will be based on historical data of primary vaccine manufacturers. The manufacturing process will include everything from vial thaw to purification and final formulation and packaging will take place onsite.

Team Members:
Blake Blanchard
Jessica Johnson
Hunter Ridenour
Connor Young

Faculty Sponsor:
Dr. James Springstead
CONCEPTUAL AND COMPARATIVE DESIGN OF DILUTE ACID AND HOT WATER PRETREATMENT PROCESSES FOR PINE WOOD

Woody biomass such as pine is a promising alternative to fossil fuel resources for the production of fuels, chemicals, and materials. However, the utilization of pine wood is hindered by the structural recalcitrance. An effective pretreatment can overcome the structural recalcitrance of pine wood through partially removing hemicellulose and lignin. This project is to conceptually design the dilute acid and hot water pretreatment processes for pine wood chips and compare these two processes in terms of safety, overall efficiency, energy consumption and economic feasibility. Towards achieving this goal, this project will leverage published data to design the process flow diagrams (the pretreatment, the acid-base neutralization, the solid/liquid separation, the recycling of water, the recoveries of dissolved hemicellulose sugars and lignin), conduct material and energy balances, and conduct economic analyses (cash flow, economic metrics, utilities). This project will also evaluate whether hot water pretreatment would be more economically feasible and advantageous over the dilute acid pretreatment.

**Team Members:**
Xinyi Koi  
Crystal Le  
Meijun Lu  
Chelsy Wagiu

**Faculty Advisor:**
Dr. Qiang Yang

EXTRACTION OF CARBON DIOXIDE FROM ATMOSPHERE

The goal of this project is to model an efficient and economic design for the capture and sequestration of carbon dioxide (CO2) from the atmosphere. The process of extracting CO2 from the air involves many unit operations. The most important unit used in a direct air capture plant is a series of fans that draw in ambient air and push it through an aqueous solution with which carbon dioxide can be captured. This is so that the CO2 molecules can be separated from heat and known chemical reactions. Using a series of reactions, this project will optimize a process that can remove CO2 from the atmosphere in order to generate a pure CO2 stream that can be reused or sequestrated as well as regenerating important reagents. This process is an important step in maintaining a controlled global climate in an economically viable way.

**Team Members:**
Ridha Alhussain  
Abdulaziz Alsweilem  
Hamed Al rashidi  
Mohamed El mustafa Khalid Eisa  
Ethan Powers

**Faculty Advisor:**
Dr. Qingliu Wu
COMPARISON OF BIOMASS TO BIO-OILS REACTOR SYSTEMS
The aim of this project is to develop a novel reactor system by combining biomass (corn stover) pyrolysis and coal pyrolysis together to reduce the cost and increase the efficiency of producing bio-oil, while still benefitting from the biodiesel produced from coal pyrolysis. To accomplish the goal, our team of engineers will conduct an economic analysis to determine the benefits. The team will compare the capital savings in dollars per pound mass of bio-oil of the combined reactor pyrolysis versus the traditional direct conversion pyrolysis to produce bio-oils.

Team Members:
Matthew Butera
Adam Farran
Ethan Getgood
Daeson Loi
Shan Khai Liew

Faculty Advisor:
Dr. Abdus Salam

DESIGN, COMMISSIONING AND INSTALLATION OF A WATER TREATMENT SYSTEM TO REDUCE CARBON DIOXIDE LEVELS
The objective of this project is to decrease the concentration of incoming CO2 in the feedwater supply to the Water For Injection (WFI) system at the Zoetis B156 facility. With the addition of a Membrane Degasification (MDG) system, the amount of CO2 being fed into the WFI skids will be significantly decreased. The water that is being used for this facility is purchased from the City of Portage, Michigan. There are currently two WFI skids purifying water. Because of the high concentration of CO2 found in the water from Portage, the two skids are operating more often than designed. In addition, these skids are spending too much time purging water. With this new MDG system in place, the two WFI skids will not need to run simultaneously anymore. These skids are currently running at about 10 gallons per minute. With the new MDG system in place, the skids should be able to operate at design capacity of 15 gallons per minute, meaning that the system will be able to produce an additional 10 gallons per minute.

Team Members:
Erika Childress
Debra Czerniakowski
Emily Odisher

Sponsors:
Matthew Grimm, Zoetis
John Wright, Zoetis

Faculty Advisor:
Dr. James Springstead
MANUFACTURING THE NEXT GENERATION OF VACCINES: NON-EGG BASED PLATFORM FOR INFLUENZA VACCINES

Conventionally, animal cells are the primary cell lines for vaccine production. In the case of the trivalent influenza vaccine, it has been common practice to use chicken eggs; because of its well-known effects, this approach is approved worldwide, but it still has its drawbacks. The egg-based cell line has allowed fast delivery of the vaccine to patients every year as new strains appeared. However, this operation greatly depends on the current egg supply which may become unavailable due to any incident directly related to the chicken population, such as a bird flu outbreak or weather constraints. Additionally, there are many people that are allergic to eggs, reducing the number of individuals capable of taking this vaccine. In response to these drawbacks of traditional vaccines, our facility is attempting to replace the traditional egg-based vaccine with one that is made using other animal cells, such as Chinese Hamster Ovary (CHO) cells or insect cells. This vaccine is made with the alternative non-egg-based process and will have the same potency as the egg-based vaccine for active immunization against Influenza.

Team Members:
Alejandro Gabriel Amarante Lapaix
Beatriz Farias
Gabriella Gomez
Diana Hernandez
Carlos Olivero

Faculty Sponsor:
Dr. James Springstead

MANUFACTURING THE NEXT GENERATION OF VACCINES: NON-EGG BASED PLATFORM FOR INFLUENZA VACCINES

Historically, the trivalent influenza vaccine has been mass-produced by using cells from chicken eggs as a basis for the development of the vaccine. However, there are some drawbacks to using egg cells as a basis, such as a non-consistent supply of the egg cells due to a possible bird flu outbreak and possible allergenic reactions from patients due to egg and bird feather allergies. Due to a new regulatory precedent, alternative bases have been explored with FDA approval. An alternative to using egg cells is to use Chinese hamster ovary (CHO) cells, which are cheaper and do not have the drawbacks that egg cells inherently have. The objective of this project is to design a plant to produce a cell-based vaccine that can be used as an alternative to traditional egg-based vaccines.

Team Members:
Iylani Syafiah Binti Amiruddin
Lexi Hockman
Andrew Stong
Shaoan Xi

Faculty Advisor:
Dr. James Springstead
SUPERSTRUCTURE DESIGN FOR THE 100TH STREET BRIDGE OVER US-131
The existing bridge encountered several collisions due to a low clearance between US-131 and the bridge. Thus, an effective redesign was necessary. The superstructure component of the bridge was successfully designed, while implementing comparisons of prestressed concrete and steel girders. Traffic volumes and common vehicles axel types were studied to establish bridge dimensions and load requirements. While mainly considering construction and structural design, a traffic control plan was also successfully obtained to safely re-route traffic throughout the construction process. Construction schedules, cost estimations, and useful quantities were also considered to complement bridge design and site logistics.

Team Members:
Arturo Logrono
Thomas Ranck
Levi Rowan
Dirk Smith

Sponsor:
Tanya Pawlukiewicz, Michigan Department of Transportation, Grand Region Transportation Center

Faculty Advisor:
Dr. Yufeng Hu, PE

WATER MAIN DESIGN FOR THOMAS FARMS RESIDENTIAL COMMUNITY
A 40-acre parcel of land located in Dewitt township was purchased and developed into residential housing. Hydraulic analysis and other design work for the development were performed using Innovyze InfoWater and ERSIGIS to produce a water main design. A preliminary cost estimate and preliminary construction schedule for the water main distribution system was developed using the RS-Means database and Microsoft Project. The installation of this water main system ensures that all the residences have an adequate source of water and fire protection. Its addition will also be extending the existing system creating additional tapping locations for potential community growth.

Team Members:
Viola A. Dagadu
Jacob Drake
Joshua Janovsky
Jerrod Wade

Sponsor:
Gary Wozniak P.E., Lansing Board of Water & Light

Faculty Advisors:
Dr. Decker B. Hains, PhD, PE, PMP, F.ASCE and Dr. Hexu Liu
STRUCTURAL DESIGN OF A NEW CONCESSIONS BUILDING FOR FOREST HILLS PUBLIC SCHOOLS

Concessions buildings serve as the hub for all sports complexes, so it is extremely important that one can serve its community to the fullest. Structural design software such as Revit, Risa 3D and Tekla Tedds were utilized to design beams, columns, lintels, bearing walls, retaining walls, and footings to ensure the safety of the community. Design begins with analyzing how loads will act on the new concessions building, then by following a top to bottom and side to side approach while designing all structural elements. Ensuring the safety of all community members who use the concessions building is the highest priority of all structural engineers.

Team Members:
Joe Belka
Cesar Hernandez
Jean-Luc Lachance
Jarrett Nuyen

Sponsors:
Amanda Ruffing, PE
Ryan Eversole, PE
TowerPinkster

Faculty Advisors:
Dr. Xiaoyun Shao, PE and Dr. Upul Attanayake, PE

ALPENA BLAIR STREET PIER REDESIGN PROJECT

The Blair Street Pier in Alpena, Michigan needs to be replaced. Rising sea water and high storm surges are battering coastal infrastructure, and this pedestrian pier in Lake Huron is no exception. The project included a design of pier pilings, a pier scour analysis, and the design of superstructure elements. An engineer's cost estimate and life-cycle cost analysis were also performed. The project is permitted by the United States Army Corps of Engineers (USACE) and the Michigan Department of Environment, Great Lakes & Energy (EGLE). The completed project will be a resilient pedestrian pier that will last for generations.

Team Members:
Alex Bliss
Paul Foor
Kyle Getchell
Dylan Remelts

Sponsor:
Dustin Black, Michigan Department of Transportation (MDOT) Alpena Transportation Service Center (TSC)

Faculty Advisors:
Dr. Yufeng Hu, PE and Dr. Xiaoyun Shao, PE
MEDICAL SERVICE FACILITY SITE DEVELOPMENT IN PORTAGE, MICHIGAN

Efficient planning consists of studying an area and adapting available space to the community’s needs. A medical service facility was proposed by the City of Portage to accompany a new senior center being built. A plan was developed for the facility site incorporating sufficient space for parking, a drive-thru lane for the pharmacy, and to allow proper drainage for storm runoff. Given dimensions of the building, two site layout plans were developed using AutoCAD. Traffic analysis and pavement design were performed along with stormwater runoff design and storage calculations.

Team Members:
Sabrina Carvajal
Mariana Faleiro
Chase Oberlander
Aimee VanWalbeck

Sponsor:
Jack Michael, AVB, Inc.

Faculty Advisors:
Dr. Valerian Kwizigile, PE and Dr. Hexu Liu

RED ARROW HIGHWAY AND UNION PIER IMPROVEMENT PROJECT

Union Pier has become one of many destinations for tourists in Michigan, but the roads leading to it were not particularly tailored for pedestrians and the storm sewer system became inadequate. A road diet was implemented to make the area more tourist friendly by redesigning the roads and adjusting aspects of the intersection for pedestrian safety. Storm sewer calculations were also performed. With less vehicles on the roadway, the locals and tourists of Union Pier can navigate through the area uninterrupted by the Red Arrow Highway and the storm sewer upgrade will contribute to the safety and ensure the longevity of the area.

Team Members:
Adel Alazmiy
Faisal Alsoufi
Abel Bay
David Young

Sponsor:
Kevin A. Stack, P.E., Berrien County Road Department

Faculty Advisors:
Dr. Jun-Seok Oh, PTOE and Dr. Valerian Kwizigile, PE
DESIGN OF 2-STORY PARKING STRUCTURE IN ALPENA, MICHIGAN
Additional parking was needed to accommodate the growing population and business popularity in downtown Alpena, Michigan. A two-story parking structure at the corner of 2nd Avenue and Water Street was designed using structural analysis software. The parking structure design included spaces for over 100 vehicles and had to account for the owner’s requirement that all or part of the structure could be easily converted into office space in the future should the parking needs of downtown Alpena change.

**Team Members:**
Bailey Edwards
Jack Dell
Nick Winston
Mariya Al Balushi

**Sponsor:**
Dustin Black, Yellow Brick Foundation

**Faculty Advisors:**
Dr. Valerian Kwigizile, PE and Dr. Upul Attanayake, PE

ABBY FARMS MULTI-USE SITE DEVELOPMENT
The owner of a 195-acre property located in Pavilion Township, Kalamazoo County, Michigan was interested in developing the site to create a multi-use site. The multi-use site includes several individual industrial lots, a multi-family development, and a new road running through the property connecting Sprinkle Road and O Avenue. Several engineering skills were utilized to develop the site layout, cost estimation, and design alternatives. Alternatives include the design and cost estimation for two different road layouts: a single road that will service both proposed uses and two separate roads that will service the industrial and multi-family uses separately.

**Team Members:**
Kegan Gibson
Emily Grunewald
Mazen Ibrahim
Lynn Vega

**Sponsor:**
Spencer O’Dell, AR Engineering

**Faculty Advisor:**
Dr. Valerian Kwigizile, PE
RE-DEVELOPMENT OF KALAMAZOO’S EMERALD PARK
The City of Kalamazoo wants to upgrade Emerald Park to better suit the community’s needs by making the park more accessible and neighborhood friendly. The upgraded park design includes a new gazebo and picnic area, restrooms, playgrounds, walkways, and a soccer field. Engineering software was used to design and analysis alternatives for the City. Cost estimates and preliminary construction schedules were also completed.

Team Members:
Muteb Alshammari
Abdulmoshen Ghorman Alshehri
Ayman Abdullah H Alturaik
Fahad Abdualaziz A Alzhrani

Sponsor:
Patrick McVerry, City of Kalamazoo Parks and Recreation Department

Faculty Advisors:
Dr. Yufeng Hu, PE and Dr. Osama Abudayyeh, PE

INTERSECTION IMPROVEMENT AT SPRINGPORT ROAD & RIVES JUNCTION ROAD IN JACKSON COUNTY MI
The evaluation of an intersection in Jackson County included possible upgrades to the intersection of Rives Junction Road and Springport Road for safety improvements, which has been the subject of a higher-than-expected rate of crashes. Options included an analysis of a sustainable intersection improvement that reduces wait times for traffic, which would reduce the carbon emissions from vehicles. The traffic on Rives Junction Road had to stop and wait for traffic on Springport Road, which had a free flow condition. The best option to improve these issues of the intersection was to design a roundabout.

Team Members:
Hesah Alrandy
Nate Baughman
Berkan Sahin
Derek VanOrman

Sponsors:
Angela N. Kline, P.E.
Bret Taylor, MSCE, P.E.
Joe Bentschneider, P.E.
Charlie Briner, E.I.T.
Jackson County Department of Transportation

Faculty Advisors:
Dr. Jun-Seok Oh, PTOE and Dr. Valerian Kwigizile, PE
EDUCATION AR
In a world filled with tons of websites and basic portals for students and educators to work with, there is a standard paradigm of how knowledge is transferred. Web technology has reached across the world and connected it through many different devices and the most common of these is a phone or laptop. Using a device with a camera and internet connection to the Education AR webpage allows you to view tasks, answers, and models in the world all there ready to help you learn in a more exciting manner. Another aspect of the Education AR webpage is its control panel allowing educators to upload their own models, tasks, and answers and using them with the webpage. Sometimes learning can be hard to visualize or work on when you’re reading a dry textbook so Education AR reaches for the next level of interactability and learning achievement meaning a better experience for visual learners. The finalized product will open up education to a new avenue of learning and insight, it may even open up gateways to a more common user experience within the realm of augmented reality.

Team Members:
Marcus Durette
Morgan Hill
Ricardo Quiroga

Faculty Advisor:
Jason Johnson

WORKFLOW WEB APP
The frustration that follows the impracticality of an outdated workflow app is truly infuriating. An updated workflow app can vastly improve production and organize documents. This app will give users complete control to implement tasks and organize all parts of a project.

Team Members:
Kahlil Cole
Richard Graziano
Mike Pitsch

Faculty Advisor:
Guan Yue Hong
MSP430 PID TEMPERATURE CONTROLLER
Metallurgical processes require precise temperature control, yet industrial temperature controllers are costly to purchase. Software for an industrial temperature controller was developed in C and deployed to an MSP430 microcontroller. The software provides an interface with which to designate the desired temperature, monitor changes in temperature, and set the tuning parameters for the proportional, integral, and derivative terms. The completed software will reduce the cost of temperature control in metallurgy and other industrial operations.

Team Members:
Macallister Armstrong
Jeremy Evans
Anthony Kirkland
Lorand Mezei

Faculty Advisor:
Mr. Colin MacCreery

FIRE SCENE ACCOUNTABILITY APP
The Fire Scene Accountability App is intended to be used by fire departments as they are responding to incidents. This allows them to keep visual notes of a fire scene in real-time. This is intended to replace a rudimentary physical version of this system and allow the fire response teams to focus on the job at hand. The application keeps a log of the activity at a fire scene that will be emailed, along with any pictures the user may take, to the user to aid in the report writing process. The goal of this system is to provide a simple and efficient solution to keeping a detailed log of everything that happens on the scene of an incident.

Team Members:
Mitchell DeJonghe
Darryl Lee
Yashar Tukhfatullin

Sponsor:
Doug Meyers

Faculty Advisor:
Jason Johnson
COLLEGE MACHINE SHOP TRACKER
The precision manufacturing facility within the Western Michigan University gets many project requests making it challenging to track its progress. Thus, it is crucial for the client to have a tracker system that implements the kanban board. Kanban board is a project management tool designed to visualize project progress and maximize efficiency. “College Machine Shop Tracker” helps the administrative staff commit to the right amount of work at the right time. The web application was created using React. Faculty members and the students will be able to submit their project requests, and the staff can start working on the project while tracking it.

Team Members:
Pratiksha Adhikari
Aashray Shrestha
Jyoti Shrestha

Sponsor:
Allin Kahrl
College Machine Shop
Engineering Design, Manufacturing and Management Systems
Western Michigan University

Faculty Advisor:
Dr. Wassnaa Al-Mawee

RICHLAND AREA COMMUNITY CENTER CLASS BOOKING SYSTEM
Paper-based tracking systems used for programs offered by community centers are outdated and often unintuitive, resulting in a slow and difficult class check-in process. A web-based application has been developed to replace the need for such systems. The application allows for check-in at the time of class meetings, and usage tracking and enrollment management from an administrative perspective. The application is written in Java and utilizes the Spring framework to drive the back end. The project is ultimately designed around user-friendliness to provide a singular portal for program administration and class check-in that is fast, concise, and easy to use.

Team Members:
Kira Hamelink
Shane Johnson
Samuel Lothamer
Christian Van Tassel

Faculty Advisor:
Dr. Steven M. Carr
EVALUATION OF STATE-OF-THE-ART NLP DEEP LEARNING ARCHITECTURES ON COMMONSENSE REASONING TASK

Commonsense reasoning is a critical component of effective natural language processing applications in the real world, such as speech to text technology. Thus, a website that differentiates sensical and nonsensical English statements was created. Different models of transformers, such as GPT-2, RoBERTa, and ULMFiT, were trained and implemented to carry out three different subtasks: when given two statements, the system chooses the more sensical statement, decides which of several pre-generated explanations of nonsensicality is the best, and ultimately generate its own explanation. The completed model will provide tools that aid in creating more accurate models for natural language processing, specifically commonsense reasoning, in the future.

**Team Members:**
Ang Thongsheng
Brackenbury Nathan
Lee Justin
Lim Anson

**Faculty Advisor:**
Dr. Elise DeDoncker

OIT WEB APP

Tech support personnel are frequently asked to make high-level account changes for end-users but granting Administrative access to low-level employees invites unnecessary security risks. An Administrative Access program was created using Java, XML, and LDAP to allow front-end tech support personnel to grant higher-level permissions to end users’ Cisco Webex and Microsoft 365 accounts, such as the ability for a user to stream content on their Webex account. This tool allows tech support personnel to assist end-users with high-level problems without requiring full administrative access.

**Team Members:**
Andrew Hazlett
Stanley Ritsema
Nicholas Warriner

**Sponsor:**
Office of Information Technology
Western Michigan University
1903 W Michigan Ave
Kalamazoo MI 49008-5206 USA
FLEXIBLE WIRELESS ECG MONITORING DEVICE
Electrocardiogram (ECG) test is used to detect life-threatening cardiovascular diseases. It records the electrical activity of the heart and displays an electrocardiograph. Traditional ECG monitoring devices require skin preparations and wires, which make them uncomfortable. They are also not ideal for remote or continuous heart monitoring. A flexible, portable, and wireless ECG monitoring device was developed to solve these issues. The device consists of dry electrode sensors, a comfortable chest belt, and a flexible printed circuit board capable of processing and transmitting an ECG signal to a smartphone for display.

Team Members:
Ruth Bahre
Yonatan Beyene
Feysel Mohammed

Sponsor:
WMU Center for Advanced Smart Sensors and Structures

Faculty Advisor:
Dr. Massood Atashbar

INERTIAL MEASUREMENT UNIT BENCHMARKING SYSTEM
The Inertial Measurement Unit Benchmarking System is designed to benchmark inertial sensors with the use of a programmable motion table. A test circuit board is used to interface between a chosen sensor and a MATLAB based data collection program running on a computer.

Team Members:
Zain Ahmed
Noah Boot

Sponsor:
Stryker Corporation

Faculty Advisor:
Dr. Janos Grantner
A SCREEN PRINTED SENSOR TO DETECT ESTROGEN LEVELS IN LIQUIDS
As technology advances, extended space travel becomes closer to reality than a dream. However, there are concerns over the effect space has on personal health. A wearable sensing system could be used to detect hormone levels of astronauts as they are completing space missions. Varied materials have been investigated to be used to develop an estrogen sensor that can be fabricated from a screen-printing process, and a sensor made from graphene and mesoporous carbon paste has been prototyped and tested. This investigation shows a working prototype device and analysis with conclusions regarding its implementation and further development recommendations.

Team Members:
Marie Bridges
Alex Whipple

Sponsor:
Michigan Space Grant Consortium, University of Michigan

Faculty Advisor:
Dr. Massood Atashbar

SNOWMOBILE RIDER INDICATOR
The snowmobile rider indicator is a durable device mounted to a snowmobile or other off-road vehicle to improve trail safety. This device displays a member’s position in a group to other trail riders on a seven-segment display and includes a hazard and safety light in times of distress. The light will flash the SOS sequence in Morse code.

Team Members:
Johannes Christensen
Nick Ferrand
Tom McCaffrey

Sponsor:
Brian Fadden

Faculty Advisor:
Dr. Damon Miller
SWEET MANUFACTURING ELECTRONIC STEERING
This project consists of the design of a tunable electronic steering system that interfaces with Sweet Manufacturing’s current use of torsion bars. The design is able to electronically adjust the gain of the input/output torque rather than swapping out physical torsion bars in the steering system.

Team Members:
Jacob Bolhuis
Thomas Goldenbogen
Adam Sander

Sponsor:
Dr. Richard Hathaway, Sweet Manufacturing

Faculty Advisor:
Dr. Ralph Tanner

VELOCITY ELECTRIC MOBILITY PLATFORM
The goal of this project is to help fill a gap in the micro-mobility sector by creating a competitive cloud-connected platform. The project shall design, build, and evaluate the basic motor control blocks for a first prototype of a micro-mobility device. This design includes a performance control module to drive a motor, GPS, and cellular connectivity for remote monitoring and the implementation of algorithms necessary for a comfortable user experience. The final intent is to have a unique embedded solution that can be optimally tuned and iterated on for future flexibility.

Team Members:
Austin Gilbert
Aaron Sluiter

Sponsor:
Velocity Research

Faculty Advisor:
Dr. Janos Grantner
WMU SUNSEEKER TELEMETRY AND LIGHTING SYSTEM
The new Sunseeker solar car for 2021 requires a custom electrical unit that can provide wireless telemetry information, record CAN-based operational data, and control vehicle lights. Critical car telemetry information includes battery state-of-charge and cell voltages, various car temperatures, car speed, and both instantaneous solar energy and car energy consumption. This and other data is transmitted via a 900 MHz wireless signal while the vehicle is in motion, but also have the ability to transmit data over Bluetooth and/or Wi-Fi when the vehicle is stopped or charging. The unit also provides local non-volatile data storage for post-race download and a GPS device that can provide time and location information.

Team Members:
Noah Bishop
William Miceli
Stephen Rumley

Sponsor:
Western Michigan University Sunseeker Solar Car Project

Faculty Advisor:
Dr. Bradley Bazuin

AUTOMATED DEFECT DETECTION FIXTURE
This project is an automated part inspection fixture that inspects parts from a manufacturing line for visible defects. To accomplish this, the fixture uses computer vision to analyze photographs of the part to search and detect defects. The defects are categorized and judged as to whether they meet acceptable criteria. Once the part is judged, it is returned to the manufacturing line to be outputted or scrapped and the data will be stored in a SQL server. Having an automated system will improve data traceability and production throughput by efficiently storing defect information.

Team Members:
Austin Killman
Kevin Mitchell
Jake Winkler

Sponsor:
FEMA Corporation

Faculty Advisor:
Dr. Lina Sawalha
AUTOMATIC SPEED-ADJUSTMENT TREADMILL
This project is to retrofit a treadmill with a motion-detecting sensor system along its side, which will monitor the user’s pace during use and adjust the treadmill belt speed accordingly. This enables the user to safely run on the treadmill with varying speed, without having to manually adjust its speed. With applications ranging from medical use to augmented reality, to everyday fitness, this treadmill upgrade can greatly increase usability for a low cost.

Team Members:
Lionel Lwamba
Nick Siciliano
Justin, Whitaker

Sponsor:
Dr. Timothy Michael, Department of Human Performance and Health Education, Western Michigan University

Faculty Advisor:
Dr. Steve Durbin

EEG FLEXIBLE SENSOR
WMU researchers in the Center for Advanced Smart Sensors and Structures (CASSS) needed an electroencephalograph (EEG) sensor that could be worn for an extended period of time. The Flexible EEG Sensor is a 3D printable sensor that can read electroencephalographic waves without giving long-term use strain to the wearer. In addition to comfort, the EEG sensors must also be accurate and are benchmarked against commercially available ones.

Team Members:
Evan Fadanelli
Mohit Patel
Adam Schuhknecht

Sponsor:
Dr. Massood Atashbar, WMU Center for Advanced Smart Sensors and Structures (CASSS)

Faculty Advisors:
Dr. Massood Atashbar and Tony Hansen

GREENHOUSE MONITORING SYSTEM
A greenhouse monitoring system (GHMS) was developed to maintain the required environmental variables. The GHMS maintains the temperature, light, and humidity through the use of a networked system of sensors under microprocessor control. The goal is to use a logical code sequence to monitor various interdependent variables in the greenhouse. The sensors in the module work in relation to each other to attain the best environmental conditions.

Team Members:
Falah Almutairi
Ibrahim Qahtan

Faculty Advisor:
Dr. Dean Johnson
SNOW REMOVING WHEEL WELL
One of the most common issues associated with driving in snowy and icy road conditions is build-up in the wheel wells of a vehicle. If neglected, this build-up can be difficult to remove and potentially dangerous. Although this snow and ice can be removed by scraping or kicking, the manual removal process can be tedious (and sometimes extremely cold!). This demonstrates the need for a snow-removing wheel well device. Experiments were performed on simulated wheel wells to test and analyze various snow removal mechanisms and develop feasible prototypes were developed. The long-term benefits of the snow-removing wheel well design are: a more convenient method of clearing wheel wells, improved driving conditions, and reduced vehicle maintenance in winter weather.

Team Members:
Ahmed Alhazmi
Ryker Diekema
Brahim Gudah

Faculty Advisor:
Mr. David Middleton, IDSA

CREATION OF AN ONLINE ENGINEERING MANAGEMENT DEGREE PROGRAM
The impact of COVID-19 has shown us how viable virtual learning can be to both the students and the universities. An online engineering management bachelor’s degree program (BSEM) is being developed at WMU. Design parameters were identified to meet the need for this degree: 1) entry point at year three of the program, 2) resource-neutral, 3) ABET-accreditible (technology program), 4) meet all WMU degree requirements, 5) attractive to military and non-traditional students, and 6) viable for degree-completion. With the growing demand for engineering management students and minimal need for physical labs, along with only a handful of such programs across the U.S., an online program allows for broader participation by students regardless of their geography or demands on their time. We built a prototype online BSEM program based on interviews with stakeholders, research on existing programs, and the application of our design parameters to best meet the needs of the prospective students.

Team Members:
Maalik Crim
Rylan Kline
Joseph Smith

Faculty Advisor:
Dr. Larry Mallak
BOXING AND LUBRICATING PROCESS IMPROVEMENT
A local industrial hinge manufacturer is working on increasing productivity for two in-house processes, box assembly, and hinge cap lubricant application. The company’s long-term corporate goals are to reduce cost by producing more product in-house, while increasing total throughput. However, SELECT Products Limited has a short-term goal of increasing productivity in the two processes. Time and motion studies, cost analysis, and replacement material research were conducted to understand the current conditions and develop process recommendations. From the initial designs and findings, process improvement concepts were refined and supplied to the company for their implementation.

Team Members:
Reid Miller
Tim Wittenborn
Jacob Krueger

Sponsor:
Tim Vermeulen & Mike Anderson, SELECT Products Limited

Faculty Advisor:
Dr. Tim Greene

IMPACT TESTING OF GOLF BUNKER SAND
Bunker sand on a golf course is imperative to the course playability and quality. Thus, having a quality sand that can endure varying climates and moisture levels while maintaining consistent gameplay is fundamental. Tour grade sands were analyzed based on certain American Foundry Society (AFS) testing standards to determine play consistency at varying moisture levels. Based on test results, recommendations for consistent bunker play were identified.

Team Members:
Brandon Crutcher
Justin Kirk
Josh Lewis

Sponsor:
Jeff Cieplewski, Weaver Golf and Sports Turf Solutions

Faculty Advisor:
Dr. Sam Ramrattan
DATA ANALYSIS AND COMPARISON OF RAPID CASTING TECHNOLOGIES
Rapid casting technology is the development of a product directly from CAD software to a casting process. The commercially available additive method, 3D sand printing, has been compared to a developing subtractive additive method. The subtractive additive method makes the casting mold using machinable ceramic, while 3D printing develops the mold layer by layer using silica sand bonded by furan. Each method was tested using an aluminum casting alloy. The processes were analyzed by part quality, time to market, and cost. By comparing the results of the two, an analysis is given as to which process exceeds the different criteria.

Team Members:
Colin Devenish
Kara Stevens
CJ Treadway

Sponsor:
Tooling and Equipment International (TEI)

Faculty Advisor:
Dr. Sam Ramrattan

MOBILE HYDRAULIC FLUID CONDITIONING PROJECT
Hydraulic fluid degrades as it is used within machinery, frequently requiring fluid replacement or reconditioning. Many existing mobile fluid conditioning systems only filter the fluid or regulate temperature, not both. Combining heating and cooling capabilities to a filtration system, as well as adding autonomy, restores and extends the use of hydraulic fluid and related equipment. A new hydraulic fluid conditioning system was designed and built to improve the lifespan of a hydraulic system reducing operational costs and decreasing machine downtime.

Team Members:
Bill Ridge
Robert Bader
Spencer Rochowiak

Faculty Advisors:
Dr. Alamgir Choudhury and Dr. Jorge Rodriguez

TRUCK BED: AN INNOVATION IN STORAGE
Pick-up trucks today are loaded with technology and features to make the truck more capable, luxurious, and efficient than ever before. However, truck beds have virtually stayed the same over the past several years. This lack of innovation highlighted the need for a redesign to accommodate current and future pick-up truck consumers needs. Based on consumer insight, updated truck bed accessories were designed to address changing needs.

Team Members:
Chase Blossom
Daniel Mozel
Jordan Roberts
Michael Sanfillippo

Sponsor:
Billy Farrell, General Motors, Light Truck Parts

Faculty Advisor:
Mr. David Middleton, IDSA
DESIGN DECISIONS RELATED TO THE COST OF MANUFACTURING
Constraints and techniques used in the manufacturing industry have a significant impact on the cost to end-users. A new display located at Floyd Hall was created as an educational tool to help illustrate how design decisions affect manufacturing cost. Several prints and parts were created to demonstrate the cost implications with increasing tolerances and complexity. Many of the specifications were suggested by local companies and past experiences with difficult to manufacture features. This learning tool will help current and future students understand how design specifications affect manufacturing costs and help design with intent to manufacture more cost-effectively.

**Team Members:**
Reed Holzgen
Adam Ledvina
Nathan Slocum
Corey Stout

**Faculty Advisor:**
Mr. Michael Konkel

VERSATILE HOME WORKSPACE ENVIRONMENTS
Since the outbreak of COVID-19, many individuals around the world have experienced a shift from traveling to a traditional workplace or school, to needing a functional home workspace. Lacking a distinction between work and relaxation in a physical space can cause decreased productivity and overall longer workdays. Models of the workspace environments were created based on the perspectives of surveyed potential users. The goal of the project was to design an effective home workspace that utilizes sensory cues, in conjunction with versatile physical features, to seamlessly transform an environment from a living space into a workspace that fuels productivity.

**Team Members:**
Noah DeLano
Kayli Holmes
Gunnar Raedle

**Faculty Advisor:**
Mr. David Middleton, IDSA
DEVELOPING A PROCESS TO REDUCE WARRANTY CLAIMS AT AN RV MANUFACTURER

Tracking warranty enables companies to identify undetected product or manufacturing-related problems, and the information collected is often vital to developing processes to prevent reoccurrences. Forest River RV is currently interested in reducing their warranty claims. The warranty claims data and current manufacturing processes were evaluated to identify areas for improvement using root-cause analysis. From the analysis, a greater understanding of the nature of warranty claims was obtained and an improved inspection process was developed.

Team Members:
Abigail Lee
Jonathan Shay
Colin Whitman

Sponsor:
Forest River RV

Faculty Advisors:
Dana Hammond and Dr. Jim Burns

CUTTING EDGE OFFICE LAYOUT APPLICATION

To plan an office layout, a company must use many designers and computer programs which can be costly and time consuming. Steelcase’s goal is to create one simple program that will help customers optimize an office layout by assigning areas to each different space within the facility. These spaces are determined based on their relation to one another, such as a private office being placed further from a social break room. Steelcase then plans to place the appropriate furniture within each of these areas. Industrial engineering techniques were utilized in order to create a standard procedure that will help Steelcase achieve this goal.

Team Members:
Christy Lyon
Jennifer McKeiver
Kyle Joslin
Larry Fisher

Sponsors:
Edward Vanderbilt and Jorge Lozano, Steelcase

Faculty Advisors:
Dr. Azim Houshyar and Dr. Bob White
ANALYSIS AND IMPROVEMENT OF PURCHASED COMPONENT MATERIAL REPLENISHMENT

A global tier-one automotive filtration supplier located in Portage, Michigan requested assistance in their effort to reduce material storage at their manufacturing cells from 4 hours to 1 hour. Improving the existing replenishment strategy using tugger routes required a systems-level approach. The tugger driver and decanter were analyzed using time and motion studies, root cause analysis, lean manufacturing principles, and ergonomics. A model was developed to consider safety, time standards, and manufacturing requirements to determine efficient batch sizes, material delivery routes, and standard packaging procedures. The dynamic model, strategy, and recommendations for continued improvement were delivered to the company.

Team Members:
Alex Berardelli
Charles Motley
Shane Leggett

Sponsor:
Don Wolz, Continuous Improvement Manager, Mann + Hummel

Faculty Advisor:
Dana Hammond

PREDICTING AS-CAST SURFACE QUALITY USING GRAIN DISTRIBUTION

Over 60% of all metal castings are created using a sand-casting process, with the type of sand used having a significant impact on the as-cast quality of the metal component. A lab experiment was designed and executed to determine what impact various characteristics of sand, such as grain size and distribution, have on surface area, which is one indicator of as-cast surface quality. State of the art statistical modeling techniques were used to predict surface area, based on the known characteristics. This novel technique provides a more efficient method for the foundry industry to predict as-cast surface quality of future metal castings, based on the sand used in the casting process.

Team Members:
Ali Clines
Leda Flory
Mariana Voigt
Katelyn McComb

Sponsors:
Western Michigan University and Dr. Sam Ramrattan

Faculty Advisors:
Dr. Lee Wells and Dr. Sam Ramrattan
CARBON FOOTPRINT REDUCTION FOR ALLEGAN COUNTY
The current carbon dioxide level is at a maximum for the last 650,000 years leading to a rise of more than 1 °C for global temperature, and over 3 mm increase in sea level per year. This rise in the global temperature will have negative long-term effects on the environment. A comprehensive strategic action plan for Allegan County was developed with various methods that can be undertaken to reduce the overall carbon footprint in the sectors of Transportation, Electricity Generation and Consumption, and Residential and Industrial Heating.

Team Members:
Dan Devereaux
Andrew Hopson
Yash Jange

Industry Advisor:
Scott Corbin, Allegan County Emergency Management Office

Faculty Advisor:
Dr. Bade Shrestha

SCRAMJET COMBUSTION LAB DEVELOPMENT
Scramjet engines are an area in need of further research, particularly their combustion chambers. A three-dimensional CAD model of a scramjet combustor lab was created in Solidworks. This model was used to conduct heat transfer and stress analysis and simulations. Numerical analyses were done in MATLAB to establish fluid flow conditions and requirements. The developed design provided a concept and supporting analytics to build the scramjet combustion lab at the College of Engineering and Applied Science, WMU.

Team Members:
Thomas Batucan
Aazan Bukhari
Caleb Grezeszak
Vegard Selnes

Faculty Advisors:
Dr. Bade Shrestha and Dr. Tianshu Liu
DECREASING THE AERO-ACOUSTIC NOISE GENERATED BY WIND TURBINE BLADES
One of the most prevalent restrictions on wind energy development is the noise pollution caused by turbine blades. To address this issue, three-dimensional airfoil models were developed, incorporating several design methods for reducing the aero-acoustic noise generated at the trailing edge. These models were 3D printed at a scale level and evaluated in a WMU acoustic wind tunnel. Simulations were performed in ANSYS to visualize the pressure fluctuations of the air flow over the airfoils. The experimental data affirm the effects of the noise-reducing features that were implemented. Reducing the low-frequency noise produced by wind turbine blades will enable larger expansion of wind energy applications.

Team Members:
Jacob Perry  
Ray Vigo  
Craig Ziehmer

Faculty Advisor:  
Dr. Bade Shrestha

AUTOMATED FORM-FILL-SEAL LOADER
Automated loading systems for form-fill-seal machines are large, costly, and fully integrated with the form-fill-seal machine itself. A portable, non-robotic automated loading system prototype was developed within Solidworks and built to operate with a form-fill-seal loading area model. Simple material loading and controls help to limit the required amount of human interaction during operation. All service life and initial dynamic motion calculations were completed using analytical methods. Various subsystem prototypes were created throughout the design process to validate the conceptual and 3D model designs. The designed automated loading system reduces operation cost, and saves material and time.

Team Members:
James Cook  
Amara Crosby  
William Medsker

Sponsor:  
Industry Mentor, Vaughn Gerber, Keystone Solutions Group

Faculty Advisor:  
Dr. Judah Ari-Gur
ROTARY JOINT SEALING SURFACE MANUFACTURING IMPROVEMENTS
SX rotary joints are designed to link rotating machinery to stationary piping, but if the sealing surfaces of the joint are not spherical enough to provide a perfect seal, leaks will occur. The manufacturing process of the 3300SXB rotary joint body was analyzed to isolate variables that introduced inconsistencies in the spherical sealing surface. Through testing, these variables were evaluated, and manufacturing solutions were proposed to minimize manufacturing inconsistencies. These solutions decreased variability of the sealing surface and improved sealing performance.

Team Members:
Jonathan Scare
Julia Sicoli
Amanda Vella

Sponsor:
John Peter, Kadant Johnson LLC

Faculty Advisors:
Dr. Judah Ari-Gur and Dr. Richard Meyer

PNEUMATIC CYLINDER AUTOMATED TESTING FIXTURE
Pneumatic cylinders must currently undergo a series of manual, time consuming tests before being shipped to a customer. To reduce testing time and effort, a test fixture is presented that will quickly measure the characteristics of each cylinder with little manual work. The fixture supplies regulated air flow and verifies the orientation of cylinder components, tests rod extension and retraction, and checks changes in air pressure. A Programmable Logic Controller that relies on a variety of position and pressure sensors is used to automate the testing process. Automating the test process decreases the cycle time and lowers labor costs associated with the production of a pneumatic cylinder.

Team Members:
Nicholas Garrison
Jake Henkel

Sponsor:
Parker Hannifin

Faculty Advisor:
Dr. Richard Meyer
FSAE ELECTRIC FORCED INDUCTION SYSTEM

This project outlines the design and development process of an electric-based, forced-induction system for the Western Michigan University Formula SAE vehicle. It is a rethink of forced-induction that eliminates the limitations imposed by mechanical coupling. A DC motor is fitted to the centrifugal compressor in place of an exhaust turbine or pulley-belt setup to supply boost independently of engine speed. Activation of turbo boost is programmable per application and driver. GT-POWER and MATLAB are utilized to test and validate an engine performance model and lap time simulation. By increasing the torque and power outputs through selected moderation, this system will decrease the FSAE vehicle’s lap times, increasing WMU’s competitive edge.

Team Members:
Logan Kucharek
Joshua Rios

Faculty Advisor:
Dr. Claudia Fajardo

OPTIMIZATION OF CYLINDER DEACTIVATION LATCH DESIGN IN A DIESEL ENGINE

Cylinder Deactivation (CDA) is utilized often within Passenger Vehicles for fuel economy benefits. Studies show that CDA reduces emissions (NOx) and improves fuel economy in Commercial Vehicle (CV) applications. CV engines operate with lower oil pressure than passenger vehicles. The goal of this project was to enable a Latch Pin System on a diesel CV application to reliably operate at pressures as low as 1.0 bar. The feasibility of optimizing the existing design or redesigning the system were explored. The tools used in this project include: GT-SUITE to design key features, Minitab for Design of Experiments (DOE), and CAD software to create the model for Testing and Packaging.

CLOSED TO PUBLIC

Team Members:
Isabel Campbell
Mitchell Carpenter
Britton Williams

Sponsor:
Eaton
Industry Mentor, Andrei Radulescu

Faculty Advisor:
Dr. Claudia Fajardo
AIRCRAFT ENGINE MOUNT REDESIGN

The aviation sector is a demanding and ever improving market to design and build the optimum products to surpass customers’ expectations. Our team created a three-dimensional engine mount that was designed in SolidWorks, a solid modeling computer-aided design and engineering program. The model can be used to study the stresses and deformations that come from inflight conditions using Finite Element Analysis. The completed model assists in the future modifications which can then be utilized and implemented in the design of aircrafts.

Team Members:
Cole D’Haese
Righa M. Righa

Sponsor:
WACO Aircraft Corporation

Faculty Advisor:
Dr. Matthew Cavalli, P.E.

CHARGE TRACING FOR DETERMINING ELECTRICAL FACILITY EFFECTS ON ELECTRIC SPACECRAFT PROPULSION SYSTEMS

Electric Propulsion Systems are the future of deep space travel; however, analysis of how testing facilities affect system performance, especially with respect to the flow of charged particles, at universities lacks proper equipment. Using COMSOL, a physics simulation and modeling software, and SolidWorks, a 3D CAD software, a small-scale instrument for tracking charge in electric propulsion testing facilities was designed based on a larger version in use by the Air Force Research Laboratory. This design will allow universities to analyze the flow of charged particles in the propellant stream of electric propulsion systems, providing universities with a vital instrument to continue research into electric propulsion systems.

Team Members:
Joseph Backe
Tyler Bye

Sponsor:
Lee Honors College, Western Michigan University

Faculty Advisor:
Dr. Kristina Lemmer
LONG-DURATION VENUS EXPLORER

Due to the high temperatures and pressures on Venus, no scientific landers have been able to survive on the surface for more than two hours, which significantly limits the amount of science that can be collected. To address this, a lander was designed to withstand the extreme conditions of the Venustian surface for an extended period. Passive pressure management and thermal control systems were designed as an improvement upon prior landers, and a thermoelectric generator was selected to provide power to the lander by utilizing the difference between the lander’s interior and exterior temperature. The design was rendered and validated using software packages such as Inventor, MATLAB, and Simscape. A long duration Venus lander can help determine whether Earth could evolve to be as inhospitable as Venus in the future and answer questions about the evolution of the solar system.

Team Members:
Scott Miller
Ethan Reid
Aidan Wales

Faculty Advisor:
Dr. Kristina Lemmer

PASSIVE THERMAL CONTROL SYSTEM DESIGN AND ANALYSIS FOR OPS-CUBE 6X1 CUBESAT

The team will be designing and analyzing a passive thermal control system for the Optical Plasma Spectroscopy Cube-Satellite. The full success criteria for this project will be proving the thermal control system has effectively reduced the heat flux within the satellite via thermal modeling in a specialized software, as well as product selection for the thermal control components. This is fully realized by ensuring that component temperature is maintained within given standards for consumer off-the-shelf materials. This is determined and adhered to for application-built hardware.

Team Members:
Kyle Chilla
Ryan Fox
Brendan Schulz

Faculty Advisor:
Dr. Kristina Lemmer
CHAINLESS CHALLENGE HYDRAULIC BIKE
A vehicle that utilizes hydraulics with human power serving as the prime mover needed to be designed and built to compete in a competition against 16 other universities. First, a conceptual design needed to be created to place necessary components needed for the vehicle to function using hydraulics as the propulsion system. Calculations were then made to drive the choice of components needed for the vehicle. Next, ordering and receiving of components took place until a working prototype was assembled. Finally, evaluation of the prototype commenced with testing and final adjustments until the vehicle met desired performance and efficiency parameters.

Team Members:
Jared Beno
Hong Yi Lee
Hiew Hang Wan

Sponsor:
Dean Pollee, Parker Hannifin Hydraulics System Division

Faculty Advisors:
Dr. Jorge Rodriguez, Dr. Alamgir Choudhury, Dr. Javier Montefort

SOLAR CAR HINGING, PROPPING, AND LATCHING MECHANISMS
The WMU Solar Car Project designs, builds, and races solar-powered vehicles. Hinging, propping, and latching mechanisms were designed for the 2021 iteration of the Sunseeker Solar Car. SolidWorks was used to create CAD drawings of the parts used in the mechanisms. An FEA analysis was also carried out in SolidWorks to evaluate the strength of the hinging mechanism. A combination of machinable and commercially-available parts were used in the designs of these mechanisms.

Team Members:
Zach Ruppenthal
Landen Wallace
Ryan Zaharia

Sponsor:
WMU Sunseeker Solar Car Project

Faculty Advisor:
Dr. Javier Montefort
CATAMARAN SOLAR RACE VEHICLE SUSPENSION AND STEERING SYSTEM
Suspension and steering are critical systems in any race vehicle and have special constraints when designed for solar racing. WMU SunSeeker’s new solar-powered catamaran design requires low profile, reliable, serviceable, and lightweight suspension and steering systems. Using SolidWorks, models were created considering CNC machining and additive manufacturing techniques. To validate a final design, these models were evaluated with a battery of stress and dynamic multibody simulations using Ansys and Adams software. The most competitive, financially viable iteration was selected for use in the American Solar Challenge and Formula Sun Grand Prix 2021 races.

Team Members:
William Gregg
Keaton Warn

Sponsor:
WMU Sunseeker Solar Car Project

Faculty Advisor:
Dr. Zachary D. Asher

AUTONOMOUS VEHICLE CAMERA MOUNT APPLICATION
The rise in autonomous vehicle research has created the need for improved data collection of different sensors including object detection and depth-sensing cameras. A universal camera mount was designed in SOLIDWORKS to increase the quality of data collection of a stereo camera by reducing windshield and camera lens glare. Object detection software was created using Python on Ubuntu and utilized by a ZED stereo camera to test the effectiveness of data collection using the created mount. The products created will assist with further research with autonomous vehicle applications using depth-sensing stereo cameras and other related instrumentation.

Team Members:
Noah Franklin
Parth Kadav
Yuan Sheng Sit

Sponsor:
Nicholas Goberville, Revision Autonomy

Faculty Advisor:
Dr. Zachary Asher
AUTOMATED HYDROPONICS SYSTEM
An automated hydroponic system offers better control over the growing process and allow for easier maintenance. An NFT hydroponic system, capable of growing romaine lettuce, was constructed. A control system was designed to control the lights, water pump, and nutrient dispensers, using information collected from various sensors. If the system detects a variable is outside of optimal parameters, it can automatically make adjustments. This control system would allow people a better way to grow their own produce at home and reduce reliance on commercially grown produce. Alternatively, commercial growers could incorporate the control systems to improve their own operation.

Team Members:
Colin Ceisel
Joshua Desmon

Sponsor:
WMU Student Sustainability Grant
Director Jeff Spoelstra, Office for Sustainability, Western Michigan University

Faculty Advisor:
Dr. William Liou

DESIGN OF A FULL-SCALE PLANT FOR PLASTIC PYROLYSIS
An estimated 27 million US tons of plastic is wasted in landfill per year while only about 8 million US tons of plastic waste is recycled or combusted for energy recovery, according to data from the US Environmental Protection Agency for 2018. This team, partnered with Gulf Coast Environmental Systems, is investigating the feasibility of a full-scale pilot plant design to recycle high and low density polyethylene as well as polypropylene into oil. The team was responsible for creating and optimizing the technical concept of the plant and design of the reactor. The plant is designed to process 10 US tons per day. The environmental and economic impact of recycling these plastics was also analyzed. The pilot design is expected to begin manufacturing in the summer of 2021 in Conroe, Texas. Each plant will help recycle 3,650 US tons a year, bringing us closer to eradicating the plastic waste problem.

Team Members:
Kaden Allen
David Lont
Hannah Sargent
Christopher Weaver

Sponsors:
Cary Allen
Chad Clark

Faculty Advisor:
Dr. Parviz Merati
OPTIMUM DOUBLE RHOMBIC FLAP DESIGN FOR Z-PLASTY

In medicine especially in plastic surgery, rhombic transposition flaps are widely used for complex wound closure, where transposing a skin flap leads to a stress field throughout the tissue around affected area. The adverse effects of these high tensile stresses are deemed to be a major cause of flap failure. In this project, a double rhombic flap design for z-plasty that can be a replacement for conventional single rhombic flap for z-plasty was developed. This design was analyzed using the finite element method. Ansys, a finite element analysis software, was utilized to carry out a parametric study to determine an optimum rhombic angle that can minimize these stresses on the skin. By reducing these magnitudes of tensile stresses can result in a reduction in healing time and prevent harmful consequences such as the formation of necrosis, dehiscence, granulation, and ischemia.

Team Members:
Abdullah
Guo Wei Choy

Faculty Advisor:
Dr. Jinsoek Kim

HALO+ REDESIGN

Diamond turning plays an important role in ultra-precision machining. Recent breakthroughs in diamond turning includes laser-assisted machining by Micro-LAM INC. The laser is emitted through a transparent diamond cutting tool precisely at the cutting edge, applying heat to soften the workpiece. The ideal wattage being emitted from the laser differs based on the material being machined. Micro-LAM currently uses the system HALO+ to measure the power being emitted from the laser through the diamond which consists of a power meter and camera on a swivel bracket. Current issues with the HALO+ includes the inability to vertically adjust the power meter and camera independently as well as high production costs from machining and assembly time. The end goal of the HALO+ design is improved adjustment about the power meter and camera as well as to cut production costs.

Team Members:
Nathan Farrington
Jacob Goodrich
Curtis Brandl

Faculty Advisor:
Dr. Jinseok Kim
SUSPENSION ANALYSIS FOR FORMULA SAE VEHICLE
Each year Western Michigan University's Formula SAE team designs and manufactures a formula one style vehicle to compete in an international racing competition. The suspension system plays a critical role in both the handling and performance of the vehicle. The previous suspension load analysis failed to consider both aerodynamic loads and accurate tire characteristics. An updated load case was created through the use of simulation and test data. Suspension components were then simulated using ANSYS and redesigned with weight reduction in mind.

Team Members:
Nicholas Durham
Jonathan Gallee
Austyn Loehr

Faculty Advisor:
Dr. Jinseok Kim

PORTABLE SOLAR WATER PUMP
Water is essential to all living beings and having an easy access to clean water is substantial. Inability to access safe water is likely to occur in areas without proper means of transporting water duly. A portable water pumping mechanism helped solving this problem using renewable solar energy, water filters, 12V battery, charge controller, an inverter, and a DC motor to run the pump. The electrical part was simulated using LabVIEW software, and the design was done on SolidWorks. This project diminished the lack of water in remote areas and can be done on a larger scale to support irrigation.

Team Members:
Mohammed Adel H Alabdulmuhsin
Abdulaziz A B F N Alotaibi
Aqeal Taher H Alowa

Faculty Advisor:
Dr. Christopher S. Cho
DESIGN OF AN AUTONOMOUS QUADCOPTER
Autonomous drones have many practical applications. A quadcopter prototype was designed and built featuring autonomous flight controller software that was coded using Arduino. The manually controlled vehicle is capable of acrobatic motion and automatic functions such as holding attitude and altitude. The prototype was primarily created to study engineering concepts such as hardware and software integration, flight dynamics, structural mechanics, performance, and design. The project successfully demonstrates the process of design and analysis of an aerial vehicle.

Team Members:
Amir Emilio Lora Figuereo
Matt Montrief
Sandeep Sainju

Faculty Advisor:
Dr. Kapseong Ro

TWO - SHOT TRANSDUCER
A transducer has been installed in a Two-shot CX 1.000 KN Krauss Maffei Plastic Injection Molding Machine which used a shoot and ship method. The transducer collects live data to track the quantity and quality of mass injected by the machine. A user-friendly interface display’s this data for the monitoring of goods. This interface also stores data for future analytics. Being able to create an alternative to the shoot and ship method has reduced poor quality of goods from reaching the supplier and creation of scrap.

Team Members:
Sam Berry
Josh Holcomb

Sponsor:
Summit Polymers Inc.

Faculty Advisor:
Dr. Muralidhar Ghantasala
AUTOMATION OF THE DIE CASTING IN A BOX (DCIB) MACHINE
The “Die Casting in a Box” (DCIB) 4.0 project is a machine built to demonstrate the fundamentals of the die-casting process in an educational environment. DCIB 3.0 was a fully realized die-casting press which required manual regulation of metal poured into the cast and produced a singular product. The goal of DCIB 4.0 was to automate this process and electronically regulate the flow of metal into the cast. This was accomplished by mounting a servo motor which actuated a steel plunger allowing us to send programmable signals to the device to regulate the flow of metal in the casting basin.

Team Members:
Nathaniel Althouse
Shantanu Phalke

Sponsors:
NADCA Chapter, Mr. Rob McInerney, Manager
Visi-Trak, Mr. Tom Vann, President

Faculty Advisors:
Dr. Sam N Ramrattan, Dr. Kevin C Barnes, Dr. Muralidhar K Ghantasala

DESIGN OF VENTILATION SYSTEM FOR SOLAR CAR BATTERY BOX
When a solar car’s battery pack overheats, the battery cells constituting the pack are prone to combust and/or explode. Effective ventilation is paramount to avoid such disasters. A ventilation system was designed using a combination of modelling, and data collection. Thermal data was obtained through testing battery cells in a lab setting. This data was used to build thermal/CFD models in a Finite-Element Analysis (FEA) software, ANSYS Fluent solver. The insights gained from aforementioned trials and modelling guided the design of a ventilation system which will properly regulate battery pack temperature for the Sunseeker 2020 racecar.

Team Members:
Cory Burnette
Adam Clarkson
Alex Dunham
David Vidler

Sponsor:
WMU’s Sunseeker Solar Car Racing Team

Faculty Advisor:
Dr. Hosung Lee