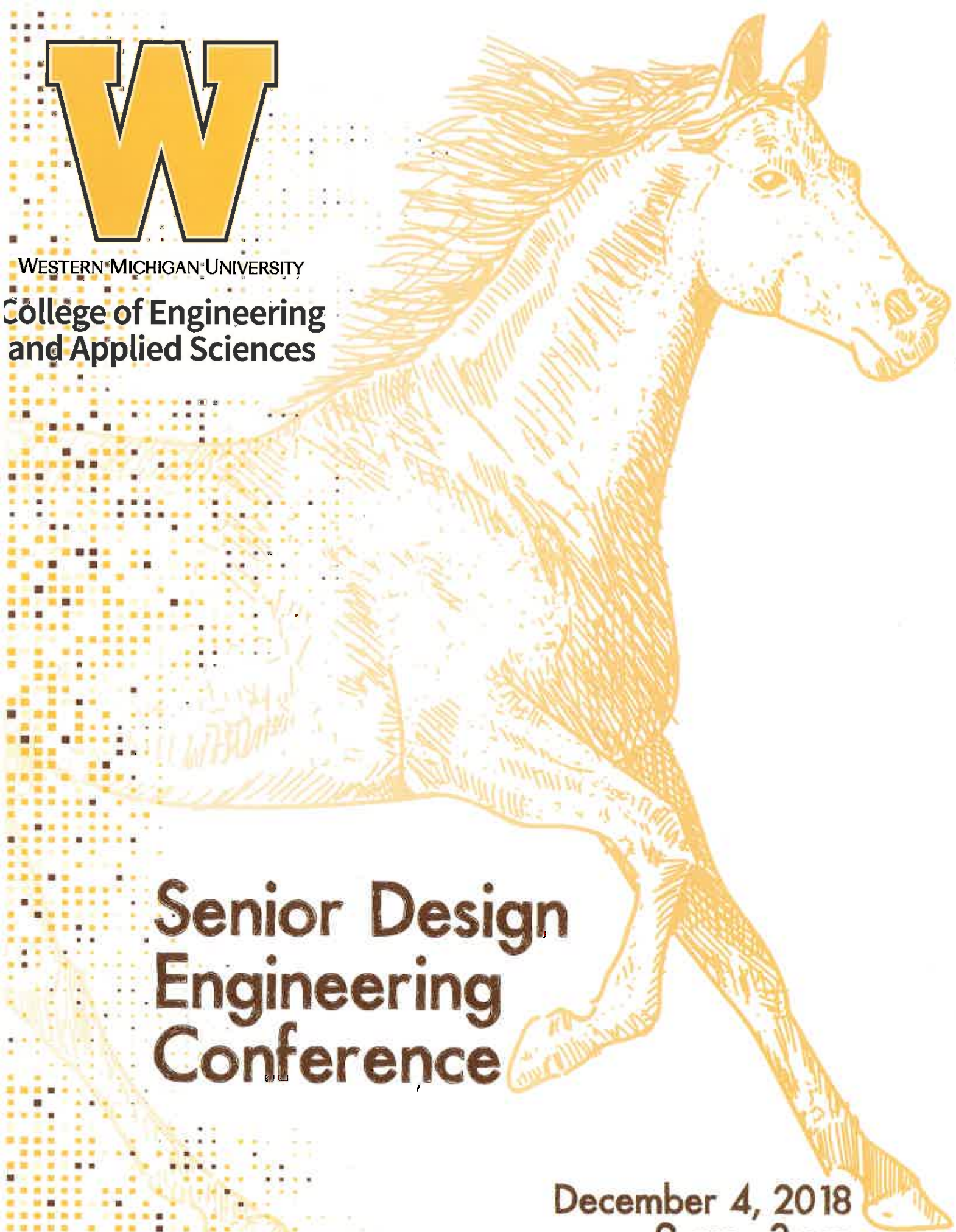
12-4-2018

63rd Conference on Senior Engineering Design

College of Engineering and Applied Sciences

WESTERN MICHIGAN UNIVERSITY

College of Engineering and Applied Sciences



Senior Design Engineering Conference

December 4, 2018
9 am - 3 pm

Conference on Senior Engineering Design Project

You are invited to attend the sixty-third Conference on Senior Engineering Design Projects. The conference will be held from 9:00 a.m. to 3:00 p.m., **Tuesday, December 4, 2018** at the College of Engineering and Applied Sciences on the Parkview Campus of Western Michigan University. The College of Engineering and Applied Sciences sponsors the conference to showcase the work of its graduating seniors, who are required to complete a capstone project that puts into practice what they have learned. Many of the projects are sponsored by business and industry. The conference is free and open to the public. You are welcome to attend all or part of the day's events. Reservations are not necessary.

High school and community college teachers are encouraged to bring students to the conference. Buses can drop off passengers in the College Circle in front of the building and then park in lot P-2 (See map).

Parking is available in the ramps behind the College of Engineering and Applied Sciences (See: Lots P3 and P4). There is no charge for parking for those attending the Conference.

Presentations begin on the hour and half hour. Please do not enter a room after a presentation has begun.

Session locations, times, and page number for project descriptions:

Chemical and Paper Engineering	D-212	9:00 a.m. to 9:25 a.m.	pg. 5
Civil and Construction Engineering	D-115	9:00 a.m. to 10:30 a.m.	pg. 6
Computer Science	D-202	9:30 a.m. to 2:00 p.m.	pg. 8
Electrical and Computer Engineering	D-204	9:00 a.m. to 1:30 p.m.	pg. 11
Engineering Design, Manufacturing, and Management Systems	D-201	9:00 a.m. to 2:30 p.m.	pg. 14
Industrial and Entrepreneurial Engineering & Engineering Management	D-210	11:00 a.m. to 11:25 a.m.	pg. 18
Mechanical and Aerospace Engineering A	D-109	9:00 a.m. to 3:00 p.m.	pg. 19
Mechanical and Aerospace Engineering B	D-208	9:00 a.m. to 2:30 p.m.	pg. 23

A lunch break is scheduled from 12 p.m. to 1 p.m. There is a café available on site.
For more information about the conference, call Tamara Bergman at (269) 276-3248.

Brochure available electronically at:
http://www.wmich.edu/engineer/news/seniors

TIME	ROOM/DEPARTMENT		TOPIC
9:00	D-212	ChP	DESIGNING AND OPTIMIZING A SYSTEM OF HEAT EXCHANGERS FOR CRUDE OIL REFINERY
	D-115	CCE	I-75 RECONSTRUCTION FROM N. ERIE RD. TO NORTH OF S. OTTER RD.
	D-204	ECE	INTELLIGENT TIC-TAC-TOE PLAYING ROBOTIC ARM
	D-201	EDMMS	REDUCING MANUFACTURING COSTS OF CLEANABLE HEAT EXCHANGERS
	D-109	MAE A	DESIGN OF AN ADVANCED COMPOSITE FORMULA SAE CHASSIS UTILIZING CARBON FIBER LAMINATES
	D-208	MAE B	SMART CANE
9:30	D-115	CCE	BRIDGE REPLACEMENT OF M-25 OVER QUANICASSEE RIVER
	D-202	CS	INTRODUCTION TO MATHEMATICAL STATISTICS: R PACKAGE
	D-204	ECE	LOW COST SOLUTION TO OBTAIN SOLAR CELL I-V CURVES
	D-201	EDMMS	WHEELCHAIRS FOR DEVELOPING COUNTRIES
	D-109	MAE A	ERGONOMIC SCREED BOARD
	D-208	MAE B	ENGINEERING FLIGHT SIMULATOR STRUCTURE DESIGN & CONSTRUCTION
10:00	D-115	CCE	WMU BTR PARK PHASE 2: MASTER PLAN AND SITE DEVELOPMENT ENGINEERING
	D-202	CS	HDTOOLS
	D-204	ECE	ROBO BRONCO AUTONOMOUS NAVIGATION SYSTEM
	D-201	EDMMS	DESIGN OF A MODULAR UTILITY VEHICLE
	D-109	MAE A	ROTATING MOUNT FOR COMPLEX FLUID FLOW RESEARCH
	D-208	MAE B	TESTER FOR QUANTIFYING TORQUE LOSSES FROM BEARINGS AND SEALS
10:30	D-202	CS	TOUCHSCREEN VENDING MACHINE INTERFACE
	D-204	ECE	TRANSMISSION CONTROL MODULE 2.0
	D-201	EDMMS	AN OVERPAYMENT PREVENTION AND IMPROVED RECONCILIATION PROCESS
	D-109	MAE A	MICRO-SURGICAL POWER TOOLS - DESIGN, MANUFACTURING, AND IMPLEMENTATION OF TEST SETUP CLOSED SESSION TO PUBLIC
	D-208	MAE B	INVESTMENT CASTING “In a Box”
11:00	D-202	CS	PERFORMANCE SYSTEM
	D-204	ECE	MOBILE SOLAR SINGLE-AXIS TRACKING SYSTEM
	D-201	EDMMS	SHIPPING AND PACKAGING OPTIMIZATION MODEL
	D-210	IEE	SMALL BATCH DISTILLERY PRODUCTION OPTIMIZATION
	D-109	MAE A	FRICTION MODELING IN VALVE TRAINS
	D-208	MAE B	CARBON NANOTUBE STRAIN GAUGE

11:30	**D-202** **D-204** **D-201** **D-109** **D-208**	**CS** **ECE** **EDMMS** **MAE A** **MAE B**	**CANCER FAMILIES UNITED WEBSITE** **INTERACTIVE 3D DISPLAY** **FLOYD HALL RECYCLING CENTER** **ELECTROMECHANICAL SWITCHING MECHANISM FOR CYLINDER DEACTIVATION** **CLOSED SESSION TO PUBLIC** **TESTING THERMAL COMFORT OF ORTHOPEDIC SURGERY GOWNS**
1:00	**D-202** **D-204** **D-201** **D-109** **D-208**	**CS** **ECE** **EDMMS** **MAE A** **MAE B**	**INDOOR NAVIGATION UTILIZING NETWORKED BLUETOOTH BEACONS** **DESIGN OF A SYNTHETIC PHOTOVOLTAIC GENERATION SYSTEM** **EXTERIOR WALKWAY LIGHTING** **COMBINATION TOOL FOR CNC MILL** **DESIGN, DEVELOPMENT, AND VALIDATION OF A VARIABLE-SPEED TEST BED WITH POWER LOSS MEASUREMENT CAPABILITY FOR GEARBOXES**
1:30	**D-202** **D-204** **D-201** **D-109** **D-208**	**CS** **ECE** **EDMMS** **MAE A** **MAE B**	**EMPLOYEE TICKETING PORTAL (RELEASE 2)** **AUTONOMOUS CONTROL OF A THERMAL DISTORTION TESTER** **VORTEX GENERATORS FOR SEDANS** **DESIGN OF AUTOMATED IMPACT TEST MACHINE** **SIT-TO-STAND ASSIST DEVICE**
2:00	**D-201** **D-109** **D-208**	**EDMMS** **MAE A** **MAE B**	**QUALIFICATION OF CHEMICALLY BONDED SANDS FOR LOW-PRESSURE COUNTER-GRAVITY PROCESS** **DRY ERASE AUTOMATED WHITEBOARD** **NEW CONCEPT IN FOOTBALL HELMET DESIGN**
2:30	**D-109**	**MAE A**	**7-AXIS 3-D PRINTED ROBOTIC ARM**

THANK YOU

The College of Engineering and Applied Sciences is grateful to these sponsors that have provided or cooperated in Senior Engineering Design Projects being presented in December 2018. If you have a project for our students or if you would like more information, please call Tamara Bergman at (269) 276-3248.

American Axle & Manufacturing
Cedaridge Condominium Association
Cancer Families United
Denso
Dimplex Thermal Solutions
Eaton Corporation
Edward's Garments
Fishbeck, Thompson, Carr, & Huber Inc.
Green Door Distilling Co.
Michigan Department of Transportation
Midwest Reality Group
St. Joseph County Fair Association
Stryker Instruments
Whirlpool Corporation
WMU Foundry
WMU Metal Casting Laboratory
WMU OIT Help Desk
WMU Solar Garden
WSP USA

CHEMICAL AND PAPER ENGINEERING

Session Chair – Said AbuBakr

Room – D-212

DESIGNING AND OPTIMIZING A SYSTEM OF HEAT EXCHANGERS FOR CRUDE OIL REFINERY

by: Kaleab Mamo, Rachel Lahiff, Hadi Doudar, Abdulaziz Algarni, Khalil Wines-Masi

Sponsor: NONE

Faculty Advisor: Said AbuBakr, Ph.D.

9:00 a.m. – 9:25 a.m.

A new petroleum refinery in Michigan has been developed and needs the most efficient and cost effective process in place. Our group has been tasked with addressing the portion of the process after the distillation of crude gas oil into four by-products which include gasoline, kerosene, light gas oil (LGO) and heavy gas oil (HGO). Each of these streams will require to either heat or cool the stream as needed.

It is important to note that gasoline is the lightest of the four in terms of average molar mass, likewise, HGO is the heaviest. Due to the fact that composition for each of these streams is constantly varying, even within the same original crude oil stream, the average hydrocarbon chain for each is used to carry out this project. The physical properties of these known hydrocarbons will be used to calculate expected flow rates for the steam and cooling water in addition to other necessary calculations such as the overall heat transfer coefficients for each heat exchanger. Furthermore, detailed design that includes total heat transfer area, tube and shell diameters, length of the tube, the total number of tubes required, the number of shell and tube passes to carry the heat transfer duties, and other necessary details to ensure optimal design of this process.

CIVIL AND CONSTRUCTION ENGINEERING

Session Chair – Decker Haines, Ph.D.

Room D-115

I-75 RECONSTRUCTION FROM N. ERIE RD. TO NORTH OF S. OTTER RD (MDOT JN 125868)

by: Jonathan Abreu, Roberto Nunez, and Ogden Wright

Sponsors: Stephen Wang, and Andrew Schimberg
WSP USA

Faculty Advisor: Decker Hains, Ph.D.

9:00 a.m. – 9:25 a.m.

I-75 is a divided, rural interstate freeway which supports a significant volume of traffic daily; linking Ohio and Michigan to Canada, and accounts for 28% of commercial vehicle traffic. Our section of freeway at the Luna Pier Road interchange in Monroe County, approximately 8000 feet, needed reconstruction to accommodate the public's current needs and maintain critical infrastructure. Using Microstation, GEOPAK, and IHSDM software, new alignment profiles matching current design standards were created, based on data analysis provided by the project sponsor. Improved culvert designs were also provided as part of the project's scope for full depth reconstruction.

BRIDGE REPLACEMENT OF M-25 OVER QUANICASSEE RIVER

by: Maghan Homan, Andrew Kliczko, Curtis Robb, and Morgan Zapata

Sponsor: John Nadjarian, Michigan Department of Transportation

Faculty Advisors: Xiaoyun Shao, Ph.D. and Upul Attanayake, Ph.D.

9:30 a.m. – 9:55 a.m.

The M-25 bridge over the Quanicassee River in Tuscola County, Michigan is in need of replacement. This required a complete redesign and reconstruction to maintain functionality. Two alternatives that were considered were the use of a steel-concrete composite structure, and an entirely concrete structure. The span of the bridge, piers, foundation, and any other aspects included with the design process were designed using bridge design specifications from AASHTO and MDOT. In addition to the design, a cost estimate and construction plans were developed. The newly designed bridge will ensure a more serviceable structure better suited to modern traffic loads.

WMU BTR PARK PHASE 2: MASTER PLAN AND SITE DEVELOPMENT ENGINEERING

by: Andrea MacDonald, Bradley Gagnon, Matthew Mueller, and Richard Gavin Wilke
Sponsor: Nate Barton, and Ryan Musch
Fishbeck, Thompson, Carr, & Huber Inc.
Faculty Advisor: Decker Hains, Ph.D.
10:00 a.m. – 10:25 a.m.

This project proposes to design and develop the WMU BTR Park in the second phase of its master plan and site development. This project has developed the existing site conditions, clearing the desired site, site layout plans, storm water management plan, grading plan, and utility plan. This report has also developed the quantity takeoff and cost estimate of the site, an analysis of alternatives, and the sustainability of the site once developed or during development. This project has prepared the way to develop this underutilized site into a productive aspect of the WMU BTR Park.

COMPUTER SCIENCE ENGINEERING

Session Chair - John Kapenga, Ph.D.

Room: D-202

INTRODUCTION TO MATHEMATICAL STATISTICS: R PACKAGE

by: Bryan Greener, Paul R. Phillips, and Austin Ragotzy

Sponsor: Joseph McKean, Ph.D., WMU

Faculty Advisor: John Kapenga, Ph.D.

9:30 a.m. – 9:55 a.m.

Teaching statistical programming languages is becoming increasingly more important in statistics as the world transitions to computer-based systems. An R package has been created from the code in the 8th Edition of Introduction to Mathematical Statistics, written by Dr. McKean, Robert Hogg, and Allen Craig. The package was developed in RStudio, which is an IDE for the statistical programming language R. The software package is a tool for the application of the statistical and mathematical concepts covered in the book. Methodology used for creating this package follows the standard practices described in the book, R Packages, by Handley Wickham.

HD TOOLS

by: Charles Larson, Alexander Dekau, and Joshua Moats

Sponsors: Tyler Payne and Dylan Ledbetter, WMU OIT Help Desk

Faculty Advisor: John Kapenga, Ph.D.

10:00 a.m. – 10:25 a.m.

The OIT Help Desk helps and average of 4,600 walk-in students, faculty, and staff every year with computer and technology related problems. On top of making sure every customer leaves satisfied, the Help Desk makes sure to closely watch why the customers visited to create better solutions in the future. HDTools is a website that helps employees do their jobs more effectively by supporting the services the Help Desk offers as well as providing shift management and data tracking functionalities.

TOUCHSCREEN VENDING MACHINE INTERFACE
by: Jonah Kubath, Matt Peter, and Michael Riess
Sponsor: Johnson Asumadu, Ph.D.,WMU Electrical & Computer Engineering Dept.
Faculty Advisor: John Kapenga, Ph.D.
10:30 a.m. – 10:55 a.m.

In certain parts of the world, personal devices like smartphones and computers aren't always available to many people, limiting their ability to access the internet. By taking a typical vending machine and giving it a touchscreen interface, it can be used for much more than just selling drinks or snacks. Using Linux as the operating system and a combination of Angular and Electron for app development, the vending machine can provide web browsing for the user, as well as advertising for other businesses. Current product availability in the vending machine can easily be checked, and ads can be adjusted when needed. With these additional features, a typical vending machine can help bring valuable resources to parts of the world that need them.

OPERATIONS PERFORMANCE SYSTEM
by: Luke Hovarter
Sponsor: Denso Manufacturing
Faculty Advisor: John Kapenga, Ph.D.
11:00 a.m. – 11:25 a.m.

Real time data is becoming more and more prevalent throughout various systems in our society. The auto industry is no different. Giving real time feedback to engineers during the manufacturing process can help prevent inefficiencies. The Operations Performance System allows engineers and associates on the floor to see the status of the machine and associates using displays on the floor and in the office in order to streamline existing processes and help identify inefficiencies. Using the production and office programs of the Operations Performance System, will give engineers the ability to process data for both newer and legacy manufacturing machines.

CANCER FAMILIES UNITED WEBSITE
by: Xavier Gray, Nathan Hileman, and Ali Itani
Sponsor: Mary Kay Pederson, Cancer Families United
Faculty Advisor: John Kapenga, Ph.D.
11:30 a.m. – 11:55 a.m.

There is an overwhelming emotional toll for families whose child has been diagnosed with cancer. Major social media platforms do not offer the private, direct communication and support that these families require. A website was created as a tool for these parents and guardians to interact, as well as providing them with a local organization that cares. The website was developed in a custom WordPress environment using PHP, JavaScript, and CSS; and designed with the intention of being secure, simple to use and maintain for content creators, and easily accessible for all types of people and devices.

INDOOR NAVIGATION UTILIZING NETWORKED BLUETOOTH BEACONS
by: Ryan Hamilton, Adam Kessler, and Dylan Martin
Sponsor: Johnson Asumadu, Ph.D., WMU Electrical & Computer Engineering Department
Faculty Advisor: John Kapenga, Ph.D.
1:00 p.m. – 1:25 p.m.

In today's world, when people travel to any new place they use GPS on their smart phone for wayfinding. However, GPS is not designed for navigating inside buildings. As buildings become larger finding your destination becomes increasingly complex. This mobile application is designed to provide indoor navigation for individuals visiting WMU's Floyd Hall. The application employs Bluetooth beacon technology to determine the position of the user in the building to give directions to rooms, offices, and events. The application will make navigating Floyd Hall simple for any visitor.

EMPLOYEE TICKETING PORTAL (RELEASE 2)
by: John Gray, Dan Kiel, and Jinxin Zhang
Sponsor: Barb Uildriks, Midwest Realty Group
Faculty Advisor: John Kapenga, Ph.D.
1:30 p.m. – 1:55 p.m.

Organizing and allocating the time of employees is an integral part of any business. An online application designed for keeping track of employee tasks has been created using the MEAN stack, a bundle of software built on JavaScript. The ticketing portal application was then passed along and improved for a second release, which included much needed usability, security, testing, and documentation updates. The application is now in a much more usable state and will continue helping the company plan and track the work of its employees.

ELECTRICAL AND COMPUTER ENGINEERING

Session Chair - Daniel Litynski, Ph.D.
Room: D-204

INTELLIGENT TIC-TAC-TOE PLAYING ROBOTIC ARM

by: Thomas Doerschler, Manuel Garcia Abonza, and Brian Schoonover
Sponsor: Robert Makin, Department of Electrical and Computer Engineering
Faculty Advisor: Ralph Tanner, Ph.D.
9:00 a.m. – 9:25 a.m.

This interactive machine is designed to drive interest and showcase skills in Electrical and Computer Engineering for prospective STEM students. It employs pre-programmed strategies to execute easy and intermediate play modes. Additionally, it employs TensorFlow for machine learning strategies for a 'fiendish' level of difficulty that increases as more games are played. The arm and board are constructed largely of 3D printed materials and commercial off the shelf parts. The arm manipulates the game pieces using several semi-soft robotic fingers while the board detects and sends information for each move.

LOW COST SOLUTION TO OBTAIN SOLAR CELL I-V CURVES

by: Michael Bell, William Hopkins, and Henry Wagerson
Sponsor: Steve Durbin, Ph.D., Department of Electrical and Computer Engineering
Faculty Advisor: Steve Durbin, Ph.D.
9:30 a.m. – 9:55 a.m.

Solar renewable energy is a continuously evolving field. A countertop solar cell tester was built to capture I-V characteristics of silicon and gallium-arsenide solar cells. The tester allows the user to insert a 1 inch to 4-inch diameter solar cell into the enclosure and capture its I-V characteristic curve. The completed tester will aid in evaluation of solar cells in the molecular beam epitaxy lab.

ROBO BRONCO AUTONOMOUS NAVIGATION SYSTEM

by: Nicholas J. Beam, Samuel N. Cronk, and Mickey R. McGuire
Sponsor: Tarun Gupta, Ph.D.
Faculty Advisor: Janos Grantner, Ph.D.
10:00 a.m. – 10:25 a.m.

A challenge in engineering is to implement autonomous machines in everyday life. When fully completed, the Robo Bronco project will be a multi-team effort to design a robot that will give automated tours of the College of Engineering and Applied Sciences. A navigation system was designed and implemented to allow the Robo Bronco to travel autonomously on a specified path. This was accomplished using proximity sensors and an Inertial Measurement Unit (IMU) controlled by a computer.

TRANSMISSION CONTROL MODULE 2.0
by: Alex Wadsten, and Payton Wood
Sponsor: Brent Hoerman, Ph.D., Eaton Corporation
Faculty Advisor: Dean Johnson, Ph.D.
10:30 a.m. – 10:55 a.m.

A control device has been created to aid in investigating transmission failures during post-production testing. This standalone, battery-powered tool performs shifting movements and displays position results when connected to a transmission's pneumatic shift actuation system. The design features an Arduino microcontroller which reads feedback signals provided by a transmission unit to determine each rail location. The tool promotes operator safety by automating the internal movement process and provides valuable insight when troubleshooting a transmission such as the Endurant™ by Eaton Corporation.

MOBILE SOLAR SINGLE-AXIS TRACKING SYSTEM (MoSSATS)
by: Neal Benson, and Cameron Boot
Sponsor: WMU Solar Garden-funded by a gift from Consumers Energy
Faculty Advisor: Bradley Bazuin, Ph.D.
11:00 a.m. – 11:25 a.m.

Solar power generation is at the forefront of renewable energy technologies. Traditional fixed axis solar systems are heavily dependent on the angle of incoming sunlight. The adjustment of a solar panel on as little as one axis of rotation can have a significant increase on panel efficiency. A mobile solar single-axis tracking system was developed to provide a platform for the research of tracking systems. Additionally, the project is portable using a small trailer and stores collected energy in batteries to provide a mobile solar energy demonstrator for various public and community events and displays.

INTERACTIVE 3D DISPLAY
by: Afdal Almejadi, Travis Holmes, and Jeff Howe
Sponsor: WMU Electrical & Computer Engineering Department
Faculty Advisor: Daniel Litynski, Ph.D., and Robert Makin, Ph.D.
11:30 a.m. – 11:55 a.m.

Tour guides cannot enter a laboratory room, preventing them from showing prospective students the full capabilities of the labs. To solve this problem, an Interactive 3-Dimensitonal display for a lab uses the Pepper's Ghost technique to attract attention and present information. A Raspberry Pi makes the necessary computations for displaying appropriate images. A Bluetooth and Wi-Fi connection allows the tour guide user to change operational modes and interact with the machine. This creates an attractive presentation and allows demographic data collection for feedback.

DESIGN OF A SYNTHETIC PHOTOVOLTAIC GENERATION SYSTEM
by: Abdullah Assiri, Rueben Jagatheesan, and Kenneth Macleod
Sponsor: St. Joseph County Fair Association, Centreville, MI
Faculty Advisor: Pablo Gomez, Ph.D. and Johnson Asumadu, Ph.D.
1:00 p.m. – 1:25 p.m.

This design showcases a synthetic photovoltaic generation system based on real data collected from an existing electrical distribution grid, with the aim of reducing electricity cost. Data of the existing grid was initially collected and tabulated, followed by the use of simulation software tools to calculate the adequate parameters of a photovoltaic generation system, as well as the determination of an optimal location of solar modules, selection of suitable power converters and wiring of the renewable system to meet the requirements of the existing grid. This analysis also included the estimation of return-of-investment of the proposed system.

AUTONOMOUS CONTROL OF A THERMAL DISTORTION TESTER
by: Kevin Morrow, Zachary Pick, and Michael Sallmen
Sponsor: Sam Ramrattan, Ph.D., WMU Metal Casting Laboratory
Faculty Advisor: Damon Miller, Ph.D.
1:30 p.m. – 1:55 p.m.

The Thermal Distortion Tester measures the thermo-mechanical deformation of a sand mold used in metal casting. A closed-loop feedback system implemented in the graphical programing language LabVIEW™ reduces human interaction and thus improves measurement accuracy. A high capacity power supply enables use of higher temperatures, matching conditions found in the metal casting industry.

ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS

Session Chair - Betsy Aller, Ph.D.

Room D-201

REDUCING MANUFACTURING COSTS OF CLEANABLE HEAT EXCHANGERS

by: Theron Badgero, Mike Green, Kyle Pepper, and Ben Root

Sponsor: Dimplex Thermal Solutions

Advisor: Timothy Greene, Ph.D.

9:00 a.m. – 9:25 a.m.

A local Kalamazoo business has requested in-depth knowledge of their manufacturing processes for their cleanable heat exchanger. A thorough mapped analysis of the manufacturing process for the heat exchanger was developed. Then, using Excel, a cost analysis of the entire process determined the overall cost to manufacture cleanable heat exchangers. Using the mapped process in parallel with the cost analysis, a make vs. buy analysis was created which helped recommend improvements and cost reduction options. The resulting current process map and total current production cost will allow for process improvement and cost reduction opportunities for the cleanable heat exchanger.

WHEELCHAIRS FOR DEVELOPING COUNTRIES

by: Sara Al Hunaidi, and Arlexis Branson

Sponsor: None

Faculty Advisor: Jorge Rodriguez, Ph.D.

9:30 a.m. – 9:55 a.m.

The current wheelchair market does not meet demands of users in underdeveloped regions, which means that 90% of people with physical disabilities in those places live without a wheelchair. Keeping location, functionality, and cost in mind, the design process guided the development of a functioning prototype of a wheelchair. Research, CAD models and documentation, and product testing allowed for creative wheelchair design that will satisfy the identified need. Adaptability to various environmental conditions and the use of bike parts common to the targeted regions are key to a wheelchair design able to adjust easily and be repaired as needed. The resulting product will be made accessible to potential users in these regions, helping to improve their lives with an adaptable, collapsible, and inexpensive wheelchair.

DESIGN OF A MODULAR UTILITY VEHICLE (MUV)
by: Matthew Bernard, Matthew Greco, Zack Meisner, and Andrew Tuinenga
Sponsor: None
Faculty Advisor: Jorge Rodriguez, Ph.D.
10:00 a.m. – 10:25 a.m.

Western Michigan University uses different types of gas-powered utility vehicles (UTVs) that are inefficient, noisy, and have varying power outputs. The Modular Utility Vehicle (MUV) was designed to overcome some of these issues. It is built around an optimal frame that increased its range of applications through the support of modular configurations (transporting passengers, equipment, etc.). Finite Element Analysis (FEA) and Computer Aided Design (SolidWorks) helped identify key features of UTV frame designs by simulating forces that occur during operation. The integration of an electric powertrain provided a significant increase in efficiency and power output while also reducing operational costs and noise. This project delivers electronic documentation in CAD for an MUV. The MUV's combined features make it the optimal UTV for WMU.

AN OVERPAYMENT PREVENTION AND IMPROVED RECONCILIATION PROCESS
by: Erica Gatmaitan, Sandrine Ingabire, Bial Patel, and Logan Wright
Sponsor: Whirlpool Corporation
Faculty Advisor: Larry Mallak, Ph.D.
10:30 a.m. – 10:55 a.m.

A large corporation with approximately 92,000 employees identified a recurring concern with overpaying inactive, retired, or terminated employees. The most frequent cause of the problem – late managerial entries – was found from scanning and interpreting data and surveys. The engineering design process was followed throughout the project; tools used in designing solutions included economic analysis, Pareto charts, process mapping, and Pugh matrices. The project outcome is a revised process incorporating small technological changes and reminders while maintaining a sustainable user-friendly system. These solutions have been implemented and have shown to decrease the reoccurrence of overpayments.

SHIPPING AND PACKAGING OPTIMIZATION MODEL
by: Stephen Bloomenstein, Kurt Dutrizac, and Otto Jung
Sponsor: Edward's Garments
Faculty Advisor: David Lyth, Ph.D.
11:00 a.m. – 11:25 a.m.

Saving money and improving packaging efficiency is needed to stay competitive in the high demand clothing and apparel e-commerce market. A statistical prediction model that predetermines packaging dimensions based on order contents, order trends, and seasonality was created using RStudio, a statistical analysis program. The model allows for more certainty when selecting packaging type and size, since the packaging dimensions of each order are predetermined. The model also allows for customers to be charged up front, rather than being back charged for shipping costs. The developed model allows for an improved packaging process and reduction in shipping costs.

FLOYD HALL RECYCLING CENTER
by: Kevin Couk, Joseph Ranieri, Jonathan Wax, and Samuel Wilson
Sponsor: None
Faculty Advisor: Mike Konkel
11:30 a.m. -11:55 a.m.

In addition to recyclable items, the Recycling Center (RC) at Floyd Hall handles surplus items, dead electronics, light bulbs, batteries, and printer cartridges. The Floyd Hall Recycling Center lacked a methodology for its use and had no user interface, resulting in extreme disorganization. Through research and input sought from stakeholders, the RC was refocused on user and recycling needs. A new layout, increased space efficiency, and instructional signage will better guide those dropping off items as well as those picking up recyclable materials. User testing proved the new system to be more accessible and user friendly. This aesthetic and efficient process can serve as an example for WMU's other recycling centers.

EXTERIOR WALKWAY LIGHTING
by: Zach Baltrus, Maurice Broadway, Richard Burke III, Charles Johnson, and Samuel Troyke
Sponsor: None
Faculty Advisor: David Middleton
1:00 p.m. – 1:25 p.m.

Cedaridge Condominium Association currently has outdated exterior light fixtures. This project focused on walkway lights. A previous project used NX 12, developed a prototype, and tested it. This new design improved the light distribution and overall aesthetic, and produced multiple walkway lights. To streamline the process of short-run production, a Design for Manufacturing (DFM) guide was created. The DFM guide will serve as a tool for professors and students to use on future projects.

VORTEX GENERATORS FOR SEDANS
by: Michael Englmaier, and Gina Noble
Sponsor: None
Faculty Advisor: David Middleton
1:30 p.m. – 1:55 p.m.

The need to reduce dependence on nonrenewable resources and increased regulations on the fuel economy of vehicles support the need for more aerodynamic sedans with lower coefficients of drag. Vortex generators (VGs) were integrated onto the tops of two contemporary sedan-style cars to test the difference in fuel efficiency between factory and modified aerodynamic design. The models were designed using PTC Creo and tested using Computational Fluid Dynamics simulation (Autodesk Flow Design) and real-world trials. The different layouts and VG design results were compared to base-line trials to determine if improvements were significant. Final results indicate that there are improvements to be made to current aerodynamic designs of sedans.

QUALIFICATION OF CHEMICALLY BONDED SANDS FOR LOW-PRESSURE COUNTER-GRAVITY PROCESS

by: Juan Andrade, Daniel Bonek, and Austin Cline
Sponsor: None
Faculty Advisor: Sam Ramrattan, Ph.D.
2:00 p.m. – 2:25 p.m.

Foundries across the world continue to combat defects caused by chemically bonded sands used in the metal casting processes. Focusing on the low-pressure counter-gravity process, tooling was designed to accommodate chemically bonded sand test specimens. Process parameters were collected and implemented to assure validity of data. Computer aided engineering software (CAE), such as SolidWorks and Click2Cast, were used in the development of tooling and process. Casting trials were performed on various test specimens, and observations were documented on casting quality. Project tooling and results will continue to be used in ongoing research to reduce chemically bonded sand-related casting defects.

INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING & ENGINEERING MANAGEMENT

Session Chair - Dana Hammond

Room D-210

SMALL BATCH DISTILLERY PRODUCTION OPTIMIZATION

by: Federico A. Conde Valdez, Amber Delgado, Wesley Moon, and Joshua Yingling

Sponsor: Jon Good, Green Door Distilling Co.

Faculty Advisor: Bob White, Ph.D. and Azim Houshyar, Ph.D.

11:00 a.m. – 11:25 a.m.

A local distillery wanted to improve its production throughput to meet anticipated growth in demand. The existing facility was studied using cost analysis, forecasting, work measurement, ergonomics, simulation, and facilities planning. Using these tools, a strategic plan was developed to minimize costs and maximize profitability.

MECHANICAL AND AEROSPACE ENGINEERING A
Session Chair – Bade Shrestha, Ph.D. and Christopher Cho, Ph.D.
Room D-109

DESIGN OF AN ADVANCED COMPOSITE FORMULA SAE CHASSIS UTILIZING CARBON FIBER LAMINATES
by: Susanne Crum, and David Hart
Sponsor: None
Faculty Advisor: Daniel Kujawski, Ph.D.
9:00 a.m. – 9:25 a.m.

This project focuses on Western Michigan University's Formula SAE car and the team's goal of implementing carbon fiber for weight reduction and increased structural stiffness. Weight reduction will increase the vehicle's handling characteristics and acceleration times, while the increased stiffness will allow the suspension to handle more optimally. Design, simulation, and physical validation was completed and a carbon fiber hybrid monocoque chassis will be implemented on the 2019 Formula car. Throughout the process it was proven that the carbon fiber frame has achieved its goal of being a lighter weight and structurally sound design. Overall, this design improvement will greatly advance Western Michigan University's Formula SAE team in terms of drivability and advancement in design.

ERGONOMIC SCREED BOARD
by: Alex Clark, Patrick Miles, and Kevin Schuetz
Sponsor: None
Faculty Advisor: Yufeng Hu, Ph.D.
9:30 a.m. – 9:55 a.m.

Spine injuries are a common ailment that plagues concrete workers due to the constant need to be bent over while working. AutoCAD was used to model an ergonomic screed board, a straight edge used to initially level concrete, which is designed to be used from a standing position. The screed board provides workers an optimal way to move concrete with the minimal amount of user input. The current design fills a gap in the concrete industry and provides employers an affordable means to protect their employees from chronic back pain while additionally supplying them with an ergonomic tool to ease work load and provide a safer working environment.

ROTATING MOUNT FOR COMPLEX FLUID FLOW RESEARCH
by: Riley Balk, Kirsten Murphy, and Viraj Patil
Sponsor: None
Faculty Advisor: Tianshu Liu, Ph.D.
10:00 a.m. – 10:25 a.m.

Fluid flow around rotating objects is mathematically complex and there is currently limited experimental data on the subject. To make Western Michigan University capable of this research, a rotating wind tunnel mount was developed. The mount design was integrated into the existing setup at the Applied Aerodynamics Laboratory (AAL) to allow seamless transitions between different research projects. Non-rotating and rotating prototypes were created from 3D-printed materials to test and revise the mount's capabilities before finalizing the design. Experimental data gathered from utilizing this rotating mount will be used to better model the aerodynamic effects on rotating objects in fluid streams.

MICRO-SURGICAL POWER TOOLS-DESIGN, MANUFACTURING AND IMPLEMENTATION OF TEST SETUP
CLOSED SESSION TO PUBLIC
by: Magreth Haji, Darren Promer, and Brian Weber
Sponsor: Jeffrey Karl and Pedro Muniz, Stryker Instruments
Faculty Advisor: Muralidhar Ghantasala, Ph.D.
10:30 a.m. – 10:55 a.m.

In an orthopedic world, it is important to make the perfect cut during surgery. During an osteotomy drilling of a bone, down force and speed can affect the quality of the cut. Using SolidWorks, a test fixture was designed to monitor these properties, a feature that is not available in the current mechanical system. The newly designed fixture, will perform the necessary data acquisition using LabVIEW. The acquired data will be used to analyze and correlate properties of the cut material and help optimize the tool-cut parameters.

FRICTION MODELING IN VALVE TRAINS
by: John Gregory Kaiser, and Sean William Miller
Sponsor: Mark Van Wingerden, Eaton Corporation
Faculty Advisor: Bade Shrestha, Ph.D.
11:00 a.m. – 11:25 a.m.

Friction in valve trains is a large component of energy losses for internal combustion engines. Due to the lack of current data on friction in valve trains, a new study was needed to help understand where friction losses occur. Parameters for the study were determined and verified through the use of virtual testing. A test stand was then developed and used to acquire the physical data on where the friction losses occur in valve trains. The study provided data that will aid in designing more efficient valve trains.

ELECTROMECHANICAL SWITCHING MECHANISM FOR CYLINDER DEACTIVATION
CLOSED SESSION TO PUBLIC
by: Jeffrey Brown, Daniel Jeffers, and Matthew Stetter
Sponsor: Ryan Krieger, Eaton Corporation
Faculty Advisor: Bade Shrestha, Ph.D.
11:30 a.m. – 11:55 a.m.

The traditional actuation method for cylinder deactivation in passenger vehicles requires the use of engine oil pressure. A new concept uses an electromechanical mechanism instead of oil pressure, but the power draw must be minimized in order to improve efficiency. Several design concepts were modeled using PTC-Creo, INVENTOR, and simulated. A test stand was created to evaluate the design concepts and compare with simulations. Design concepts and testing procedure will aid in the development of future electromechanical switching mechanism designs.

COMBINATION TOOL FOR CNC MILL
by: Ryan Bootka, Andrew Fritsch, and Aaron Mitchell
Sponsor: Tony Reinartz and Jason Taylor, American Axle & Manufacturing
Faculty Advisor: Judah Ari-Gur, Ph.D.
1:00 p.m. – 1:25 p.m.

Optimization of the machining process is extremely important, especially within an automotive manufacturing facility. A combination CNC tool was designed to optimize the machining process while reducing excess metal chips from the axle tube. The tool was designed using AutoCAD software. The tool combined two different diameter boring heads, two different size drills, and two back-chamfering tools. The implementation of the combination tool results in a reduction in machining cycle time by removing the need for tool changes. The newly designed coolant journals effectively flush metal chips from the axle tube limiting chip wrap.

DESIGN OF AUTOMATED IMPACT TEST MACHINE
by: Logan Albrecht, and Lindsey Atherton
Sponsor: None
Faculty Advisor: Sam Ramrattan, Ph.D. and Peter Thannhauser, MFS
1:30 p.m. – 1:55 p.m.

Current models of impact testing for small specimens do not meet industry requirements due to lack of automation. The goal of this project is to design an impact test machine that is automated and requires minimal human interaction; the test specimen used is a small sand disk. A linear solenoid was used to execute the impact function and a position transducer was used to measure the change in position over time as the impactor comes in contact with the test specimen. The amount of energy and other mechanical properties was calculated through this collection of data.

DRY ERASE AUTOMATED WHITEBOARD
by: Jon Homrich, Michael Ginzinger, and Samuel Riojas
Sponsor: None
Faculty Advisor: Daniel Kujawski, Ph.D.
2:00 p.m. – 2:25 p.m.

Current whiteboard designs underutilize the space that they take up, especially those found in the larger lecture rooms of Floyd Hall. The objective of this project was to create a new whiteboard design that would better utilize the space that it occupies while offering additional features to aid with the learning process. The new design offers fully automated function to extend and retract itself into the walls as well as providing a vertical movement of the surface of the whiteboard so that new writing space is always available. The design provides an erasing feature which allows user to have the board clean itself.

7-AXIS 3-D PRINTED ROBOTIC ARM
by: Mahmoud Alshiyokh, Manju Freeman, and Scott Ziegler
Sponsor: None
Faculty Advisor: Jennifer Hudson, Ph.D.
2:30 p.m. – 2:55 p.m.

The cost of 3D printed parts increases when human operators are needed to remove parts. Industrial robots that are being used in 3D printing farms today are very expensive. A 3D printed Robot was designed in 3D using SolidWorks; parts were then 3D printed. The circuit design was completed using LT Spice, programming was done in C, and the controls system design was created in MATLAB. Testing then commenced using the 3D printed parts. The project made a versatile robot arm that can be constructed at a low price pint which can be used to remove parts from a 3D printer autonomously.

MECHANICAL AND AEROSPACE ENGINEERING B

Session Chair – Kristina Lemmer, Ph.D. and Javier Montefort, Ph.D.
Room D-208

SMART CANE
by: Faisal Almindil, Bilal Arshad, and Mitchell Ryan
Sponsor: None
Faculty Advisor: Pnina Ari-Gur, Ph.D.
9:00 a.m. – 9:25 a.m.

The visually impaired face risks of injury from hitting objects undetectable by the standard white cane. A Smart Cane with distance measuring alert system was created that will assist the visually impaired in traveling. The Smart Cane uses a vest that carries all the components of the design, such as sensors, speakers, batteries, solar cells, and an Arduino board. The model operates by providing an alert sound to the user if there is any object in the way to prevent them from colliding with objects and allows to take proper precautions.

ENGINEERING FLIGHT SIMULATOR STRUCTURE DESIGN & CONSTRUCTION
by: Heather Irish, and Scott Miller
Sponsor: Department of Mechanical & Aerospace Engineering and WMU Office for Sustainability
Faculty Advisor: Kapseong Ro, Ph.D.
9:30 a.m. – 9:55 a.m.

Flight simulators are extensively used for pilot training and as a R&D tool among pilot training industry, aerospace manufacturers, and government institutions. Previously, the MAE department at Western used a yoke and pedal with a consumer grade flight simulation software for basic aircraft familiarization at freshmen level. To enhance the undergraduate aerospace engineering curriculum and to create a high-fidelity simulation environment for advanced aircraft control system design and handling qualities research, a research focused engineering flight simulator was designed and built, that incorporates a programmable control loading system with an immersive wrap around display and virtual flight instruments. This senior design project laid out the internal structure for simulator cockpit and virtual flight instrument system with other team of collaboration members.

TESTER FOR QUANTIFYING TORQUE LOSSES FROM BEARINGS AND SEALS
by: Nathan Dumminger, Brent Mostowy, and Bret Van Bruggen
Sponsor: Nathan DeVille, Eaton Corporation
Faculty Advisor: Richard Meyer, Ph.D.
10:00 a.m. – 10:25 a.m.

As the automotive industry strives for higher fuel efficiency, there is a need to better understand and quantify powertrain parasitic losses as a precursor to any loss minimization efforts. An automotive supercharger bearing and seal test stand was designed to measure the torque losses from them. The tester was designed to accommodate multiple sizes of bearings and seals. A 3D printed model was produced to demonstrate the function of the tester. The completed assembly provides a method to optimize future supercharger designs by increasing both the understanding of losses and how to minimize them.

INVESTMENT CASTING "in a Box"
by: Elie Chahine, Kevin Greer, and Victoria Urquhart
Sponsor: Sam Ramrattan, Ph.D., WMU Foundry
Faculty Advisor: Sam Ramrattan, Ph.D.
10:30 a.m. – 10:55 a.m.

Manufacturing processes are perceived as archaic and unglamorous by younger people despite their incorporation of advanced technologies. A miniature, portable version of the investment casting process was produced with an induction furnace. Instrumentation has been used to validate for the furnace and a small casting pattern was designed. Appropriate materials for investment casting were selected to streamline the procedure. The investment casting "in a box" process will teach and expose future generations of WMU students to this manufacturing technology during a laboratory session.

CARBON NANOTUBE STRAIN GAUGE
by: Tyler Howard, Jesse Sum, and Weizhong Tang
Sponsor: None
Faculty Advisor: Muralidhar Ghantasala, Ph.D.
11:00 a.m. – 11:25 a.m.

Strain gauges are commonly used throughout many fields of Engineering to measure displacement, load, pressure, etc. Carbon nanotubes (CNTs) are found to have interesting conductivity and strain properties that can be very useful for strain gauge applications. Their sensitivity to these changes is critically dependent on the materials and configurations used. Two solutions of varying concentrations of CNTs were used to manufacture strain gauges based on nanocomposite materials with higher sensitivities than standard metal strain gauges. The CNT-based nanocomposite films were produced using different processing steps including Ultra Sonification, annealing, UV light and Ozone (UVO) exposure, and spinning. The patterning and testing of the CNT nanocomposite-based strain gauges is described.

TESTING THERMAL COMFORT OF ORTHOSPEDIC SURGERY GOWNS
by: Nathan Howell, Drew Kilgore, and Gage Lammers
Sponsor: Steve Isham, Stryker
Faculty Advisor: Kapseong Ro, Ph.D.
11:30 a.m. – 11:55 a.m.

A common complaint by orthopedic surgeons is that their surgical gowns do not keep them cool throughout a full procedure. Standard surgical gowns come in two-piece designs that restrict airflow below the neck, so a one-piece toga design was developed to make surgeons more comfortable during surgery. A test was developed to gather and compile thermal and subjective data to benchmark gown designs. The results of this testing was used to determine the design that is preferred by surgeons and will be used to improve on future gown designs.

DESIGN, DEVELOPMENT, AND VALIDATION OF A VARIABLE-SPEED TEST BED WITH POWER LOSS MEASUREMENT CAPABILITY FOR GEARBOXES
by: Caleb Gurd, and Tyler Smith
Sponsor: Carlos Wink, Eaton
Faculty Advisor: Claudia Fajardo-Hansford, Ph.D. and Mr. John Bair
1:00 p.m. – 1:25 p.m.

The objective of this project is to design, develop and validate a variable-speed test bed with gearbox efficiency measurement capability for the Center for Advanced Vehicle Design and Simulation (CAViDS) consortium. The test bed was experimentally validated for future use at Western Michigan University. The implementation of the test bed will provide a time-and cost- effective solution for efficiency measurements of gearboxes, and facilitate hands-on student learning of mechanical systems.

SIT-TO-STAND ASSIST DEVICE
by: Richmond Flint, and Kyle Kantola
Sponsor: None
Faculty Advisor: Pnina Ari-Gur, Ph.D.
1:30 p.m. – 1:55 p.m.

Being able to stand is an important function that is necessary for an independent and fulfilling lifestyle that persons with partial disability often struggle with. A device was designed to aid with the sit-to-stand motion of these people. The device is a specialized cushioned seat, placed on top of a chair and can slide forward, allowing the user to position their weight for easier standing motion. It is designed to be lightweight, simplistic, and easy for transportation. If needed, it can be attached to the side of walker. It has great potential for many applications, such as in occupational therapy, physical rehabilitation, and assisted living centers.

NEW CONCEPT IN FOOTBALL HELMET DESIGN

by: Scott Krawczyk, and Hussain Ghandaih
Sponsor: None
Faculty Advisor: Pnina Ari-Gur, Ph.D.
2:00 p.m. – 2:25 p.m.

American football players are repeatedly experiencing injuries during games and practices. The most critical ones include the head which could result in permanent brain damage. A new football helmet design was created with the goal of eliminating concussion injuries by absorbing energy that is transferred through the helmets plastic outer shell from impact. Strips of nitinol were placed in strategic locations between the foam and interior shell of the helmet to maximize the reduction of energy in the system.

The College of Engineering and Applied Sciences offers a wide variety of programs:

Civil and Construction Engineering (269) 276-3210

- Civil Engineering
- Construction Engineering

Computer Science (269) 276-3101

- Computer Science - Theory and Analysis
- Computer Science - General option

Electrical and Computer Engineering (269) 276-3150

- Computer Engineering
- Electrical Engineering

Industrial and Entrepreneurial Engineering & Engineering Management (269) 276-3350

- Industrial and Entrepreneurial Engineering

Engineering Design, Manufacturing, & Management Systems (269) 276-3554

- Engineering Design Technology
- Engineering Management Technology
- Manufacturing Engineering Technology

Mechanical and Aerospace Engineering (269) 276-3420

- Aerospace Engineering
- Mechanical Engineering

Chemical and Paper Engineering (269) 276-3500

- Chemical Engineering
- Paper Engineering
- Graphic and Printing Science

College of Engineering and Applied Sciences Advising Office (269) 276-3270

The **Master of Science in Engineering** is offered in chemical, computer, electrical, mechanical, and industrial engineering. The **Master of Science** is offered in aerospace engineering, chemical engineering, computer science, construction engineering, engineering management, manufacturing engineering, and paper and printing science. The **Ph.D.** is offered in chemical engineering, computer science, electrical and computer engineering, industrial engineering, mechanical engineering, and paper and printing science.

Information about the College of Engineering and Applied Sciences at Western Michigan University

CEAS Mission

- Educate: develop career-ready engineering and applied science graduates for success in the global market;
- Discover: advance knowledge and innovation through high-quality research, teaching, and student engagement;
- Inspire: prepare our learning community for lifelong excellence, ethical behavior, and professional leadership;
- Transform: cultivate an inclusive learning environment, contributing to diversity in the engineering workforce; and
- Respond: answer challenges in our local and global communities to improve the well-being of society.

CEAS Vision

To be the College of choice for tomorrow's engineers through excellence in education, discovery, and service.

CEAS Four Cornerstones

- Engagement: Produce job- ready graduates with the ability to grow in their profession and who are lifelong learners
- Innovation: Move the profession and society forward by providing engineers, scientists, and technologists with new capabilities
- Leadership: To graduate engineers, technologists, and applied scientists who are and will continue to be leaders in their profession and community
- Globalization: Our graduates must be prepared to work in a global engineering and applied sciences industry

CEAS Administration

- Dean of Engineering: Dr. Houssam Toutanji
- Chair of Civil and Construction Engineering: Dr. Osama Abudayyeh
- Chair of Computer Science: Dr. Steven Carr
- Chair of Electrical and Computer Engineering: Dr. Brad Bazuin
- Chair of Engineering Design, Manufacturing Engineering, and Management Systems: Dr. Steve Butt
- Chair of Industrial and Entrepreneurial Engineering and Engineering Management: Dr. Steve Butt
- Chair of Mechanical and Aerospace Engineering: Dr. Koorosh Naghshineh
- Chair of Chemical and Paper Engineering: Dr. Li Kecheng

CEAS Contact Information

- CEAS Advising Office: (269) 276-3270
- CEAS Dean's Office: (269) 276-3253
- CEAS Student Outreach and Recruitment Coordinator: Scot Conant – (269) 276-3272
- CEAS Website: www.wmich.edu/engineer/news/senior