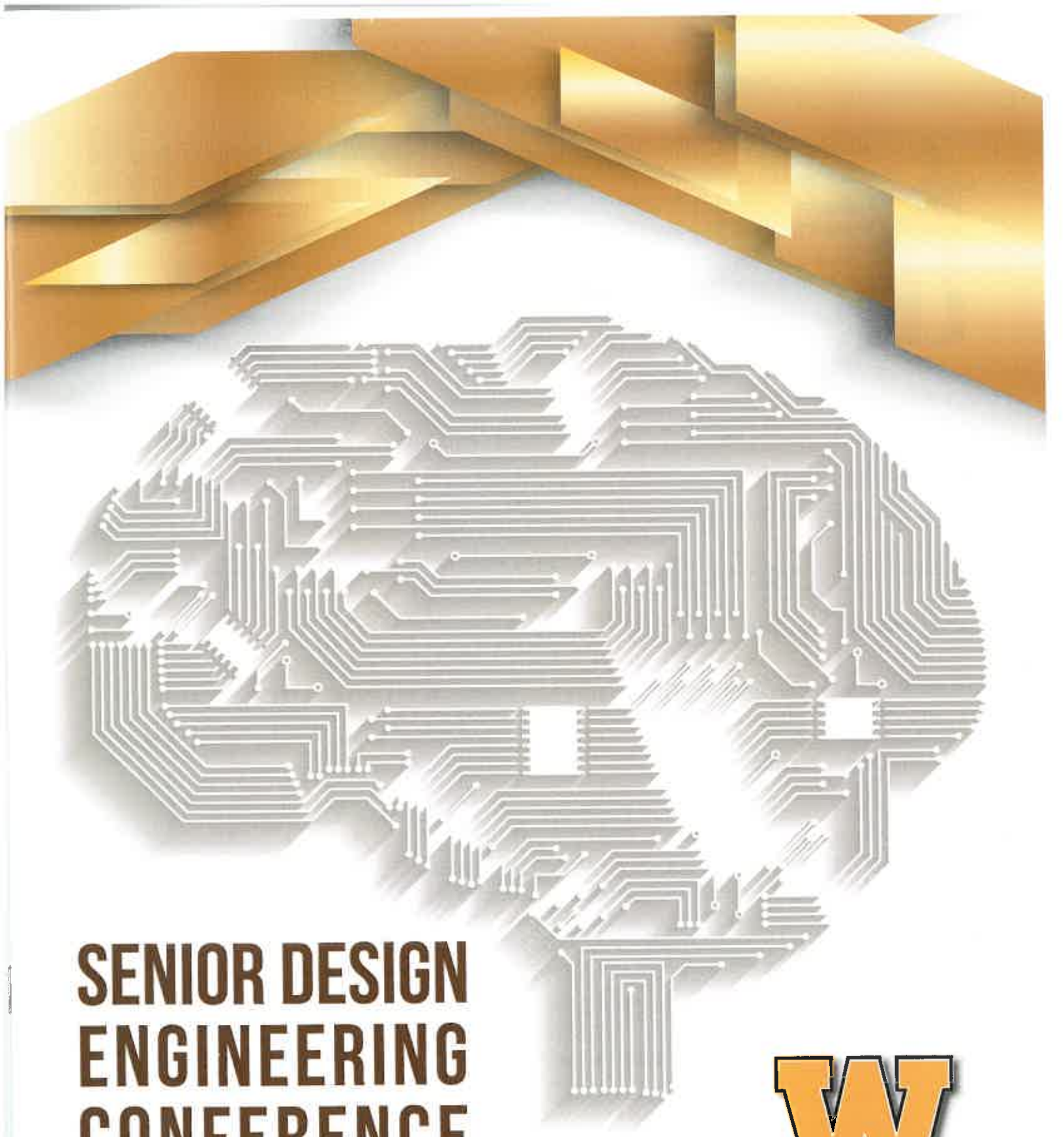
12-5-2017

61st Conference on Senior Engineering Design

College of Engineering and Applied Sciences



SENIOR DESIGN ENGINEERING CONFERENCE

DECEMBER 5, 2017 • 9 AM - 2 PM

WESTERN MICHIGAN UNIVERSITY

College of Engineering and Applied Sciences

Conference on Senior Engineering Design Project

You are invited to attend the fifty-ninth Conference on Senior Engineering Design Projects. The conference will be held from 9:00 a.m. to 2:00 p.m., **Tuesday, December 5, 2017** 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:

Civil and Construction Engineering	D-115	9:00 a.m. – 11:30 a.m.	pg. 5
Computer Science	D-202	9:00 a.m. – 1:30 p.m.	pg. 7
Electrical and Computer Engineering	D-204	9:00 a.m. – 1:30 p.m.	pg. 10
Engineering Design, Manufacturing, and Management Systems	D-201	9:00 a.m. – 12:00 p.m.	pg. 13
Industrial and Entrepreneurial Engineering & Engineering Management	D-208	10:00 a.m. – 11:30 p.m.	pg. 16
Mechanical and Aerospace Engineering A	D-109	9:00 a.m. – 2:00 p.m.	pg. 17
Mechanical and Aerospace Engineering B	D-210	9:00 a.m. – 2:00 p.m.	pg. 21

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-115	CCE	Multi-Use Bridge and Trail Connections
	D-202	CS	Traffic Flow Monitoring System
	D-204	ECE	Solar Energy Generation and Conversion Education and Demonstration Systems
	D-201	EDMM	Mold Design and Construction to Demonstrate Anchoring
	D-109	MAE	BCM Espresso
	D-210	MAE	Humidifier Heat Exchanger Redesign
9:30	D-115	CCE	400 Bryant Street Brownfield Redevelopment Project
	D-202	CS	Peptide Database
	D-204	ECE	Solar Garden Continuous Data Comparative Analysis Code Design
	D-201	EDMM	Heated Sand Permeability Testing
	D-109	MAE	Boat-Lift Design and Analysis
	D-210	MAE	Low-Cost Control Engineering Experiments
10:00	D-115	CCE	Mountain Home Cemetery Retaining Wall Design
	D-202	CS	Food Pantry Tracking System
	D-204	ECE	Bronco Air-Hockey Table
	D-201	EDMM	Optimizing the Transportation of Work-in-Progress Parts
	D-208	IEE	Cost Benefit Analysis of a Cellular Manufacturing Design
	D-109	MAE	V-Band Clamp Failure
	D-210	MAE	Smart Shot – Advanced Firearms Training
10:30	D-115	CCE	Doster Farm Site Development Project
	D-202	CS	Gitolite User Interface (GITUI)
	D-204	ECE	Autonomous Navigation System for Robo Bronco
	D-201	EDMM	Residential Outdoor Lighting Design
	D-208	IEE	Bosch Service Center Analysis
	D-109	MAE	Air-hearing Test Fixture for Satellite Attitude Control System Development
	D-210	MAE	Design of Spring Loaded Camming Devices for Rock Climbing
11:00	D-115	CCE	RAM Trail II
	D-202	CS	Kiosk
	D-204	ECE	Educational Control System Packages
	D-201	EDMM	Re-engineered Solutions for Event Refuse
	D-208	IEE	Understanding Costs to Encourage Profitability
	D-109	MAE	Next Generation Modular Oven Accessory Development

	D-210	**MAE**	**Conversion of the Fuel Delivery System in a Single-Cylinder IC Engine**
11:30	**D-202**	**CS**	**SMBJ-A Software Solution to the WannaCry Hack for Java-based Systems**
	D-204	**ECE**	**Short Read Genomic Sequencing Using FPGAs**
	D-201	**EDMM**	**Redesign of Recreational Vehicle (RV) for Multiple Sclerosis (MS) Patient**
	D-109	**MAE**	**Automated CNC Chip Filter Cleaner**
	D-210	**MAE**	**Re-Usable Mechanical Flare**
1:00	**D-202**	**CS**	**A Simulation Model for Training and Decision Support for Influenza Management**
	D-204	**ECE**	**3-Axis Gimbal Auto-Calibrating System**
	D-109	**MAE**	**Optimization of Thermal Distortion Tester Heating Unit**
	D-210	**MAE**	**Universal Motorized Circuit Breaker Lift**
1:30	**D-109**	**MAE**	**Vented Gas Loss Reduction**
	D-210	**MAE**	**Direct, Clean, Quiescent Counter-Gravity Low Pressure Semi-Permanent Mold Casting of Aluminum**

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 2017. If you have a project for our students or if you would like more information, please call Tamara Bergman at (269) 276-3248.

Armstrong International Inc.
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Summit Polymers, Inc.
The City of Portage: Transportation & Utilities Department
Valley Family Church
Western Aerospace Launch Initiative (WALI)
Whirlpool Corporation
WMU Metal Casting
WMU-Development Office

CIVIL AND CONSTRUCTION ENGINEERING

Session Chair – Decker Hains, Ph.D.

Room D-115

MULTI-USE BRIDGE AND TRAIL CONNECTIONS

by: Kaitlyn Dziepak, Jacob Rickner, and Cole Villalobos

Sponsors: Kendra Gwin, and Muhammad Arif

The City of Portage: Transportation & Utilities Department

Faculty Advisors: Xiaoyun Shao, Ph.D. and Valerian Kwigizile, Ph.D.

9:00 a.m. – 9:25 a.m.

The City of Portage has an extensive bikeway system and strives to increase the length of this network to connect other neighboring township bikeway systems. A multi-use bridge and several trail connections were designed to link the two existing bikeway trails: The Texas Drive Non-Motorized Trail and City of Portage Multi-Use Trail. The completed bridge and trail connections required considerations for the foundation, structural components, grading, storm water management, traffic, and sustainability. AutoCAD software was used to create plans for the bridge and trail, which provided a visual for the possible designs. The recommended design allowed for the existing trails to be connected based on efficiency and safety for the trail users.

400 BRYANT STREET BROWNFIELD REDEVELOPMENT PROJECT

by: Omar Alharbi and Maxut Bariyev

Sponsor: Paul Pagano, Building Restoration Inc.

Faculty Advisor: Decker Hains, Ph.D., P.E., PMP

9:30 a.m. – 9:55 a.m.

400 Bryant St. is part of the old Allied Paper site. The building is 3 story brick structure. The brick building will be subdivided into residential living units as well as common areas for building tenants to utilize. The existing roof will be replaced by a new EPDM roof with a green roof system covering. The site will also be cleaned up and reworked for better traffic flow, parking, and green space for the tenants. The Owner would also like to partner with the City of Kalamazoo for Brownfield redevelopment of this site.

MOUNTAIN HOME CEMETERY RETAINING WALL DESIGN
by: Krystle Ingram, Justin LaLonde, and Yaritza Rodriquez
Sponsor: James Baker, City of Kalamazoo Department of Public Services
Faculty Advisor: Decker Hains, Ph.D., P.E., PMP
10:00 a.m. – 10:25 a.m.

As retaining walls age, regardless of construction, application, or designed strength, potential wall failure and durability are concerns that engineers must address. These concerns are magnified when public safety is essential and a wall is retaining soil from areas of high pedestrian and vehicular traffic. When analyzing a retaining wall, the use of Retain Pro can be very helpful in designing repairs or a replacement wall. Retain Pro aids in the design and analysis of nearly any cantilevered or restrained retaining wall and is not confined by configuration or conditions of the applied loading pressure.

DOSTER FARM SITE DEVELOPMENT PROJECT
by: Ahmad Amani, Eric Barkovich, Skylar Cudney, and Mike VanRyckeghem
Sponsor: John Doster
Faculty Advisor: Decker Hains, Ph.D., P.E., PMP
10:30 a.m. – 10:55 a.m.

Water and drainage problems are common issues that properties and landowners face. Several design alternatives were proposed and designed to solve the water problem that a property had. The contours of the property were surveyed and mapped in order to evaluate how the problem should be solved. Several drainage basins were designed along with a potential layout for future residential development. These designs will help turn the property into a more economically beneficial asset for the landowner then it was previously.

RAM TRAIL II
by: Anthony Conigliaro, Paul Harvey, Braden Kaup, and Nathan Lloyd
Sponsor: Todd Sneathen, Hubbell, Roth & Clark, Inc.
Faculty Advisor: Decker Haines, Ph.D., P.E., PMP
11:00 a.m. – 11:25 a.m.

The RAM Trail II Project is a pedestrian trail in Ingham County that connects three neighborhoods and extends the biking network in the area. The trail is over 1.5 miles long and stretches through wetlands. Geotechnical analysis and watershed modeling was used in designing the trails and culverts. Site plans, cost estimation, and a complete work schedule for the project was completed. In turn, this trail will inspire the community to use bicycles more frequently and reduce the carbon footprint.

COMPUTER SCIENCE

Session Chair – John Kapenga
Room – D-202

TRAFFIC FLOW MONITORING SYSTEM

by: Jimena Cuadros and Gerald Glasgow
Sponsor: Mathew Hill, Traffic Engineer
Faculty Advisor: John Kapenga, Ph.D.
9:00 a.m. – 9:25 a.m.

Current technologies used to measure vehicle traffic are very expensive. Traffic Flow Monitoring System (TFMS) uses a Raspberry Pi with a Wi-Fi antenna, a custom probe logging program and a Java application for analysis. Traffic flow is estimated using cell phone probes that contain the MAC address of the phone, allowing vehicles to be identified. Substantial on road testing was done comparing actual traffic to the reported traffic, both for off-peak times and rush hours. TFMS delivers similar data to the client, while significantly reducing the cost, compared to current commercial products.

PEPTIDE DATABASE

by: Jack McClure, Jonah Groendal, Jake Schuurmans, Josh Looney, and Angelo Danducci
Faculty Advisors: John Kapenga, Ph.D. and Robert Trenary, Ph.D.
9:30 a.m. – 9:55 a.m.

There is enormous potential in the use of peptides for medical advancement due to their useful properties such as being antibacterial, antiviral, anticancer or antifungal. The sheer number of possible peptides makes them practically impossible to categorize through experimentation alone. Delivered is a consolidated database of peptides and their experimentally verified properties from external projects. Tools used to clean and canonicalize data from many sources is also included. A machine learning algorithm example is applied to this database to predict properties of given peptides.

FOOD PANTRY TRACKING SYSTEM
by: Michael Bell, Marila Kravtsova, and Anna Stephens
Sponsor: Jon Martin, Valley Family Church
Faculty Advisor: John Kapenga, Ph.D.
10:00 a.m. – 10:25 a.m.

Non-profit food pantries often work with little technical support and limited funds. Food Pantry Tracking System (FPTS) was designed to help foot pantries track, manage, and distribute food and other items. It was built using Django, MUI, and PostgreSQL to work on both mobile devices and desktops. It can easily be used in shipment, warehouse, and office settings. It was deployed with AWS and thoroughly documented so that it can be managed easily. FTPS will greatly increase food productivity and empower them to distribute food more effectively in our local area.

GITOLITE USER INTERFACE (GITUI)
by: Jeremiah Boswell, Alexander Snow, and Katherine Vittini-Rodriguez
Sponsor: Robert Trenary, Department of Computer Science
Faculty Advisor: John Kapenga, Ph.D.
10:30 a.m. – 10:55 a.m.

Computer science courses typically require online submission of student work for review by course instructors. GITUI is a system which facilitates this by using Gitolite, Ruby on Rails, Python, HTML/CSS, Apache and SQL technologies. The system provides a simple to use Python script for automating the process of authenticating students. GITUI functions as a version control system for students to use as they develop their work, while also serving as a work submission system which graders can access. The solution is secure, portable, simple to install, easy to use, maintainable, and reliable.

KIOSK
by: Andrew Burcroff, Maximilian Ellsberry, Mohammad Rasak, and Stephen Wimsatt
Sponsor: Johnson Asumadu, Ph.D.
Faculty Advisor: John Kapenga, Ph.D.
11:00 a.m. – 11:25 a.m.

Internet access and vending services are limited in remote areas of Africa. A large touch screen kiosk (TSK) will allow for many people to easily and affordably access the internet and purchase items. This large touch screen display is controlled by a Windows 10 system using the Angular2 framework. Each kiosk runs a local database that keeps track of sales and advertisements. The kiosk communicates with a AWS server for management of multiple TSKs. Security was a major part of the design for the servers. TSKs will provide necessary services and products across Africa.

SMBJ – A SOFTWARE SOLUTION TO THE WANNACRY HACK FOR JAVA-BASED SYSTEMS
by: Christopher Smerek and Cody Swanson
Sponsor: Tim Webster – Level Data, WMU Development Office
Faculty Advisor: John Kapenga, Ph.D.
11:30 a.m. – 11:55 a.m.

The WannaCry Attack of May 2017 left the majority of Windows 7 users vulnerable to ransomware encryption. The original open source SMBJ library was created to combat this vulnerability for Java-driven systems and allow users to safely share files through the SMBv3 protocol. The library was initially lacking in documentation and contained serious flaws that prevented it from being used effectively. The library was improved upon, tested, documented, and committed back to the original open source repository. With these improvements, the SMBJ library can aid all users with Java-driven applications by providing safe and secure file sharing communications.

A SIMULATION MODEL FOR TRAINING AND DECISION SUPPORT FOR INFLUENZA MANAGEMENT
by: Greg Ostroy
Sponsor: Diana Prieto, Ph.D.
Faculty Advisor: John Kapenga, Ph.D.
1:00 p.m. – 1:25 p.m.

There are many models for simulating infectious disease outbreaks that assist health policy officials in making better decisions about mitigation strategies in the event of an epidemic. However, none of the existing models address the needs to train students and policy makers in the concepts and use of such models. The project, Flu MODELO 1.0, is an implementation of a model that simulates an outbreak of influenza that can be mitigated with a variety of strategies. Flu MODELO 1.0 is coupled with a GUI for running, replicating, and analyzing simulations. A novel addition in the GUI is the module for educating users about the concepts used in flu outbreak simulation.

ELECTRICAL AND COMPUTER ENGINEERING

Session Chair – Brad Bazuin, Ph.D.
Room D-204/205

SOLAR ENERGY GENERATION AND CONVERSION EDUCATION AND DEMONSTRATION SYSTEMS

by: Dustin Thomas Bremer, Andrew James Cabush, and Kyle Michael Christianson
Faculty Advisor: Brad Bazuin, Ph.D.
9:00 a.m. – 9:25 a.m.

Solar energy systems have experienced tremendous growth in the United States and the world. Educational material and multiple classroom and laboratory demonstration system components have been developed to provide hands-on learning opportunities for college and pre-college students and the community at large. Each demonstration system includes small custom solar panels, a light source, if needed, meters for measuring current and voltage, energy conversion and regulation modules, and electronic devices that can use either unregulated power directly from the solar panel or converted and regulated power from modules. The material has been developed to train and inspire students and the community to embrace solar energy and consider related career choices and opportunities

SOLAR GARDEN CONTINUOUS DATA COMPARATIVE ANALYSIS CODE DESIGN

by: Benjamin Weisberg, Mike Tapper, and Ben Norton
Sponsor: Brad Bazuin, ECE, WMU
Faculty Advisor: Brad Bazuin, Ph.D.
9:30 a.m. – 10:00 a.m.

Two distinct solar arrays from the WMU Education Solar Garden at Floyd Hall were installed in Fall 2016. The arrays provide a small portion of power needed by Floyd Hall. The arrays, along with weather station, provide continuous streams of data on performance for analysis and for research that are now being collected by a server. This project has automated data collection and analysis to perform actual versus expected power output based on weather, provide return-on-investment and cost savings estimates, and provide daily, monthly, and yearly solar array output information for display on the WMU Educational Solar Garden web site that has also been significantly enhanced and improved by the team. The critical hardware, computer, network and software elements required will be briefly described.

BRONCO AIR-HOCKEY TABLE
by: Reiley McDonnell, Jason Vietti, and Di Wu
Faculty Advisor: Steven Durbin, Ph.D.
10:00 a.m. – 10:25 a.m.

The air hockey table is a timeless classic. It has entertained the masses since the late sixties. A state of the art air hockey table was constructed utilizing methods and techniques learned through the WMU ECE program. The Bronco Air Hockey Table includes features such as automatic scoring, multiple game modes, and different air flow distributions. The air hockey table demonstrates hardware such as photo optic sensors, LED displays, and microcontrollers. The air hockey table was created in order to provide an entertaining display of the ECE program and to attract newcomers to the program.

AUTONOMOUS NAVIGATION SYSTEM FOR ROBO BRONCO
by: Abdulelah Alnoaim, Larry Armstrong, and Miguel Quintero
Sponsor: Tarun Gupta, Ph.D. WMU
Faculty Advisor: Brad Bazuin, Ph.D.
10:30 a.m. – 10:55 a.m.

With automation on the rise in the US Economy every field is looking towards automating their processes. Robo bronco will serve as an automated tour guide of the College of Engineering and Applied Sciences building. This is a continuation project and the main goal of this project is to develop the autonomous navigation system for the robot to use to travel throughout the building.

EDUCATIONAL CONTROL SYSTEM PACKAGES
by: Fahad Dughaither, Fouad Kawass, and William Sprinkle
Sponsor: Ralph Tanner, Ph.D. WMU
Faculty Advisor: Ralph Tanner, Ph.D.
11:00 a.m. – 11:25 a.m.

Students in Control Systems introductory course, ECE 3710, struggled in finding a feasible project within the time constraints imposed by the length of a semester. A package of four designs was created where each design dips into a certain type of motion control. Each design will have a unique output. The outputs are; vertical, horizontal, and two angular motions. A position control elevator is built to demonstrate a vertical output, where an angular output is demonstrated by an antenna azimuth position. The package includes a suggested parts-list for each design with detailed information to guide students in their chosen project. The package will assist students obtain valuable information such as the mathematical models and computer simulations, and potentially build the design. If students were to assemble their project, the package would provide them with sources to purchase the parts needed within a reasonable price.

SHORT READ GENOMIC SEQUENCING USING FPGAs
by: Justin Leek, James Novorita, and Kevin Scorza
Sponsor: Fahad Saeed, Ph.D.
Faculty Advisor: Fahad Saeed, Ph.D.
11:30 a.m. – 11:55 a.m.

Whole genome sequencing has been an important tool used for diagnosis of diseases and learning more about Deoxyribonucleic Acid (DNA). Identifying genome mutations is vital in medical decision making. Short read sequencing is a standard among data formats in the field of bioinformatics; however, this data set is large and time intensive. To solve this, the OpenCL development environment for Field Programmable Gate Arrays (FPGA) was used to construct a sequencing method in the C programming language. This allows for a more human readable programming language instead of a traditional Hardware Description Language (HDL) to improve time and space complexity. This design utilizes a Boyer–Moore string searching algorithm and can be used as a future benchmark for OpenCL FPGA related research regarding computational genomics.

3-AXIS GIMBAL AUTO-CALIBRATING SYSTEM
by: Caleb Slater and Nico Welch
Sponsor: Steve Kuznicki, MathWorks
Faculty Advisor: Janos Grantner, Ph.D.
1:00 p.m. – 1:25 p.m.

Complex embedded systems are in everything from washing machines to airplanes. These can have teams working on FPGA development and programming a microcontroller. MathWorks developed a suite of products, including: C Coder, HDL Coder, MATLAB and Simulink, which ties this process together to allow for rapid development of projects. We demonstrated how these tools could be used with a Zedboard Zynq 7020 and a 3 axis gimbal to perform image stabilization and image tracking, which could be implemented on a drone to perform video recording.

ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS

Session Chair – Betsy Aller, Ph.D.

Room D-201

MOLD DESIGN AND CONSTRUCTION TO DEMONSTRATE ANCHORING

by: Joe McCarty, Cole McGinn, and Nate Reinke

Sponsors: Jay Shoemaker, Autodesk, Inc.
Frank Hessel and Randy Kerkstra, PCS Company
Brodie Delemeester and Chad Gierak, INCOE Corporation

Faculty Advisor: Jay Shoemaker

9:00 a.m. – 9:25 a.m.

Injection molded parts warp, generally in either a bow or a twist shape. There are multiple ways to measure and view warpage in a part. Six parts were designed to demonstrate typical bow and twist shapes and how the placement of anchoring points affect the way warpage is visualized. The parts and injection mold base were designed using Autodesk Inventor and Autodesk Moldflow Insight. The mold was machined at WMU using tool paths created with Autodesk Inventor HSM. The mold produces two 3-part assemblies that industries can use to visually demonstrate how anchoring planes affect warpage results.

HEATED SAND PERMEABILITY TESTING

by: Craig Bays, Patrick Devine, and John Nelson

Sponsors: Sinto Steel
Brian Lewis, Foundry Educational Foundation

Faculty Advisor: Sam Ramrattan, Ph.D.

9:30 a.m. – 9:55 a.m.

Chemically bonded precision sand used in the production of automotive powertrain components is the fastest growing segment of sand casting systems. In order to limit casting defects, foundries test sand permeability once per batch at room temperature. However, this permeability is dissimilar to that of the same sand at molten metal temperatures, which can lead to unwanted casting defects. Utilizing 3D modeling, CNC machining, and computer programming, a testing system was developed to perform both room temperature and elevated temperature permeability tests at casting line production speeds. Using this system, foundries will be able to test how their sand reacts at molten metal temperature prior to pouring, and adjust their sand mixture as necessary in order to prevent defects in cast metal parts.

OPTIMIZING THE TRANSPORATION OF WORK-IN-PROGRESS PARTS
by: Austin Currier, Drew Nowak, Taylor Perry, and Christopher Stepek
Sponsor: Kenneth Martin, Mann + Hummel, Inc.
Faculty Advisors: David Lyth, Ph.D.
10:00 a.m. – 10:25 a.m.

The handling of materials is necessary in production, from raw materials to finished products and shipping. Efficient work-in-progress processes are crucial when transporting material between multiple buildings, which must be done in a safe, timely, and cost effective manner. Focusing on transport of plastic injection molded parts from one plant to another, the current method in place was compared to alternative modes and processes of transportation. Through time studies and statistical and cost analyses, new systems were explored to identify the most cost effective way to deliver parts. An implementation plan and final recommendation will provide cost savings and an efficient process of moving work-in-progress parts.

RESIDENTIAL OUTDOOR LIGHTING DESIGN
by: Connor Hall, Ethan Larsen, Dwight Merrill, and Nolan Raab
Sponsor: Cedaridge Condominium Association
Faculty Advisor: David Middleton
10:30 a.m. – 10:55 a.m.

An existing walkway lighting system was dilapidated, mismatched, and inefficient to power and repair. A replacement lighting system was designed to use the existing underground 110-volt power, with a goal of following the Dark Skies design guidelines. Furthermore, any landscape light must look good when turned both on or off. Working models helped determine characteristics such as the area lighted, size, and aesthetics. A prototype was modeled using 3D CAD software and created with equipment and materials from the CEAS laboratories. An efficient lighting system will provide an attractive, safe, and welcoming environment around the town homes, without polluting the sky with unwanted light or wasting electricity.

RE-ENGINEERED SOLUTIONS FOR EVENT REFUSE
by: Matthew Bracey, Troy Sutberry, Anthony Trubiano, and Mike Zobl
Sponsor: Ryan Bradley, Newell Brands, Rubbermaid
Faculty Advisor: Jorge Rodriguez, Ph.D.
11:00 a.m. – 11:25 a.m.

Public and private events create a large amount of waste that must be gathered and disposed of properly. Event staff are continually pressured by both time and physical demands to accommodate this waste cleanup. Existing refuse containers were examined and re-engineered to combat these problems. Following initial ideation, classification, and selection using a Pugh matrix, designs were prototyped and documented in CAD. The recommended solution will offer venue, custodial, and event staff a more efficient means of cleanup and waste management.

REDESIGN OF RECREATIONAL VEHICLE (RV) FOR MULTIPLE SCLEROSIS (MS) PATIENT

by: Derek Fox, Tyler Graybill, Grant Januska, and Tyler Kroes
Sponsor: Nadine Billin
Faculty Advisor: Jorge Rodriguez, Ph.D.
11:30 a.m. – 11:55 a.m.

The enjoyment of traveling was taken away from a patient who was diagnosed with Multiple Sclerosis (MS). A donated Recreational Vehicle (RV) was re-designed to accommodate this quadriplegic patient. Research on current devices used by MS patients was conducted to create multiple designs. Precise vehicle measurements and structural analysis of the RV were used when creating computer models in NX software. Using a Pugh matrix, a design was chosen that requires less structural modification to the RV while providing greater ease of mobility. Design documentation will allow the sponsor to take the re-design to a RV manufacturer for modification. These adaptations will allow the patient to travel extensively and comfortably once again.

INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING & ENGINEERING MANAGEMENT

Session Chair – Dana Hammond

Room D-208

COST BENEFIT ANALYSIS OF A CELLULAR MANUFACTURING DESIGN

by: Dylan Flegel and Dylan Gale

Sponsor: Jayne Brown and Robbie Wandell

Parker Hannifin, FSC

Faculty Advisor: Lee Wells, Ph.D., and Dana Hammond

10:00 a.m. – 10:25 a.m.

Cellular manufacturing has the potential to reduce part costs, decrease lead times, and improve quality. An optimized cellular manufacturing process was designed by analyzing lead times, inventory levels, holding costs, and quality defects of a traditional pneumatic cartridge manufacturing process. The new design was evaluated by using simulation, facility planning, and statistical analysis to determine the effectiveness of the proposed cellular manufacturing layout and associated costs.

BOSCH SERVICE CENTER ANALYSIS

by: Alexandra Benitez, Reem Ghareeb, and Joanna Wisniewski

Sponsor: Phillip Bowman, Jim Crowe, and Tiffany Teresa

Bosch Automotive Service Solutions

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

10:30 a.m. – 10:55 a.m.

Customer calls requesting warranty service at Bosch range from 200 to 800 per day with seasonal variation. The system required to process these customer service requests was studied to identify potential areas of improvement including transferred calls, service center training, number of calls on hold, and number of abandoned calls. Industrial engineering techniques including work sampling, work design, queuing theory, simulation and statistical analysis were used to analyze the process. Improvements were recommended that would result in a more efficient service process and potentially higher rates of customer satisfaction.

UNDERSTANDING COSTS TO ENCOURAGE PROFITABILITY

by: Zachary Baker, Devin Cole, and Jordyn Nichols
Sponsor: Bud Dunn, Atlas Sales Inc.
Faculty Advisors: Azim Houshyar, Ph.D. and Bob White, Ph.D.
11:00 a.m. – 11:25 a.m.

A local beer distribution company wants to improve its method for determining when it's economically feasible to deliver product to its various accounts. Industrial Engineering tools, such as cost analysis and statistics, have been used to determine how to minimize costs and maximize profits by the appropriate adjustments of delivery, quantity, and frequency.

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

BCM ESPRESSO
by: Mark Bliss, David Curle, and Dylan McNamara
Faculty Advisor: Richard Meyer, Ph.D.
9:00 a.m. – 9:25 a.m.

Espresso machines feature a brew group which brings hot water from the boiler to the coffee. The brew group design currently used in high end espresso machines is from 1961. Application of modern engineering methods could result in reduced cost and increased performance, such as greater temperature stability and better pre-infusion. Current espresso machines were studied and areas for improvement were identified. Based upon this research, a new brew group and espresso machine were designed and prototyped.

BOAT-LIFT DESIGN AND ANALYSIS
by: Nathan Schick and Jacob Tussey
Faculty Advisor: Javier Montefort, Ph.D.
9:30 a.m. – 9:55 a.m.

A boat-lift, currently in production, had never been theoretically analyzed. Using simulation software, the boat-lift was theoretically tested to find the points that have high stress/deflection. The boat-lift was redesigned to increase strength in high stress points and decrease material in low stress areas which made the boat-lift more structurally sound and light.

V-BAND CLAMP FAILURE
by: Sahil Dey, Brent Ellis, and Nathan Latuszek
Faculty Advisor: Peter Gustafson, Ph.D.
10:00 a.m. – 10:25 a.m.

Parker Hannifin is interested in looking for ways to reduce the stress and increase fatigue life of the V-Band clamp used to mount the engine driven hydraulic pumps on a customer's aircraft. The failure is a crack that propagates from a cut out radius where the bolt can be inserted to close the clamp. There is no correlation of failures with flight hours, or cycles. Lab testing suggests failure are due to resonance. The critical region was analyzed through a finite element analysis to determine the failure mode with the intent of forming a cost effective technical solution.

AIR-BEARING TEXT FIXTURE FOR SATELLITE ATTITUDE CONTROL SYSTEM DEVELOPMENT

by: Andrew Doering and Zachary Ruckel
Sponsor: Western Aerospace Launch Initiative (WALI)
Faculty Advisor: Jennifer Hudson, Ph.D.
10:30 a.m. – 10:55 a.m.

CubeSat's are used for many different space expeditions that require data collection. An air-bearing test fixture was created to simulate the gravitational effects of large bodies on a CubeSat without going through the costs of launching into space. Designing of a test plate, holding mechanism and using the air-bearing were required to run tests on the CubeSat to generate the weightlessness feeling felt in a space-like atmosphere. With extremely clean air, the device can sit on top of the air-bearing with the thought of minimal friction and free motion. This modelled design provides use in an aerospace industry because it can be used to run simulations and attitude adjustment without requiring a budget increase by launching into space.

NEXT GENERATION MODULAR OVEN ACCESSORY DEVELOPMENT

by: Samuel Dayton, Evan Reich, Travis Shivley, and Ryan Thompson
Sponsor: Zachary Bruin-Slot, Michele Harping Johnson
Whirlpool Corporation
Faculty Advisor: Bade Shrestha, Ph.D.
11:00 a.m. – 11:25 a.m.

Standard household convection ovens have a limited number of capabilities for preparing food. Using an existing built-in oven platform, a modular accessory was designed and validated in order to expand the food preparation possibilities of the standard convection oven. Multiple iterations were designed using 3D Solid Modeling Software and were rapid prototyped. Testing was developed under the Design of Experiments method and executed using various forms of data acquisition. The result is a detailed product concept for Whirlpool to refine and integrate into their next generation oven platform.

AUTOMATED CNC CHIP FILTER CLEANER

by: Nick Tackett, Tommie Turney, and Klaus Zielke
Sponsor: Jerry Bowers
Faculty Advisor: Pavel Ikonomov, Ph.D.
11:30 a.m. – 11:55 a.m.

The Automated CNC Chip Filter Cleaning system was needed to increase production with less maintenance and more profit. An array of nozzles with predetermined positions dislodged debris from the filtration through and allowed coolant flow to the CNC machine. A hose from the pump placed in the coolant tank was connected to 6 solenoid valves. These solenoid valves were controlled by the PLC to deliver coolant. The solenoid ball valves directed coolant into the different segments of pipe to spray the filter clean of all debris.

OPTIMIZATION OF THERMAL DISTORTION TESTER HEATING UNIT

by: Brandon Harrison, James Murata, and Caleb Ohland
Sponsor: WMU Metal casting
Faculty Advisor: Sam Ramrattan, Ph.D.
1:00 p.m. – 1:25 p.m.

As the need to produce complex castings increases, so does the complexity of cores and molds. To accomplish near-net shape casting with minimal defects it is necessary to understand the thermal-mechanical effect suffered by cores and molds when different binders, additives, and coating are used for precision sands. A thermal distortion tester (TDT) developed at WMU can accommodate 50 mm disc-shaped specimens of varying thicknesses. The machine performs semi-automated testing on the specimen at a temperature and pressure representative of the casting process. During the test, thermal gradients in the specimen are captured as well as both longitudinal and radial movement of the specimen in real-time. The current design is limited to testing temperatures of 1000 °C or less. The aim of this study was to increase the hot surface test temperature to 1200 °C or more so effects of ferrous alloys can be investigated.

VENTED GAS LOSS REDUCTION

by: Arif Azfar Ahmad Sofian, Nicholas Ball, and Mark Swift
Sponsor: Jeff Parker, Consumer Energy
Faculty Advisor: Bade Shrestha, Ph.D.
1:30 p.m. – 1:55 p.m.

Gas losses is inevitable during pipeline maintenance. A small scale compression system was designed to reduce gas losses. The compression system pumps out the natural gas from a specific pipeline during maintenance, then stores in a gas tank instead of venting the gas out. Efficiency and safety of the device was analyzed throughout the designing period using finite element analysis. Evaluation of the pressure changes between the pipeline and the compression system was analyzed mathematically and simulated. Reducing the amount of natural gas losses into the air during pipe construction helps minimize air pollution and save cost. Hence, maintaining the natural state of the environment.

MECHANICAL AND AEROSPACE ENGINEERING B
Session Chair – William Liou, Ph.D. and Tianshu Liu, Ph.D.
Room D-210

HUMIDIFIER HEAT EXCHANGER REDESIGN
by: Mitchell Bingaman, Michael Carr, and Kody Plummer
Sponsor: Mickey Gaines, Armstrong International Inc.
Faculty Advisor: Javier Montefort, Ph.D.
9:00 a.m. – 9:25 a.m.

A heat exchanger is a thermal device used to transfer heat between two fluids. This particular design is a steam to steam evaporator used in a humidifier. A SOLIDWORKS model and MathCAD program were developed to maximize the area of the system and provide an approximation of the steam output. Structural analysis was completed before outsourcing the prototype for manufacturing. The completed models and prototype provide a design that optimizes the workable area to provide maximum steam output.

LOW-COST CONTROL ENGINEERING EXPERIMENTS
by: Megan Arduin, Jason Eichorn, and Zachary Reinke
Faculty Advisor: Richard Meyer, Ph.D.
9:30 a.m. – 9:55 a.m.

There are few labs where there is one overall project that can be used to teach multiple class topics from start to finish. This project was designed to teach both classical and modern control systems methods at an affordable price. This project was designed to be modular and easily changed to better fit the class. The designs were created using a computer aided design software and then 3D printed, thus making it easy to modify and repair. The constructed models are then used to teach motion and control techniques in a thorough and engaging way.

SMART SHOT – ADVANCED FIREARMS TRAINING
by: Jorge Diaz-Sanin and Conner Knepley
Sponsor: Jim McQueen and Evan Bunner
Faculty Advisor: Daniel Kujawski, Ph.D.
10:00 a.m. – 10:25 a.m.

Current firearm training systems for law enforcement are inadequate at preparing officers for the stressful threats they will experience on the job. A three-dimensional training system was developed simulating the dynamic nature of a real deadly encounter. Officers are challenged to respond to a quick appearing threat where sensing technology will determine if they have made the appropriate shots to disable the threat. Through extensive research and development, utilizing computer modeling and electronic controls, the integrated target system will better prepare law enforcement officers for the deadly situations they will encounter as they protect and serve the public.

DESIGN OF SPRING LOADED CAMMING DEVICES FOR ROCK CLIMBING
by: Zachary Singer and Brooke Treece
Faculty Advisor: Daniel Kujawski, Ph.D.
10:30 a.m. – 10:55 a.m.

Spring loaded camming devices, or "cams" are used worldwide for traditional rock climbing. As a climber ascends a rock face, cams are placed intermediately within cracks for protection during a fall. After analyzing current cam designs and determining force requirements, the optimal features were determined for various crack sizes. Two separate cams were then designed for different crack sizes. Each cam's design aimed to maximize load capacity, usable range and durability, while minimizing weight and manufacturing cost. The designs were then tested and evaluated for maximum stress using finite element analysis simulations.

CONVERSION OF THE FUEL DELIVERY SYSTEM IN A SINGLE-CYLINDER IC ENGINE
by: Michael Allen, Rebecca Crouch, and Jay Martin
Sponsor: Charles Allen, Daytona Enterprises
Faculty Advisor: Claudia Fajardo-Hansford, Ph.D.
11:00 a.m. – 11:25 a.m.

The modern internal combustion (IC) engine has undergone significant technological advances in the last 40 years. Improvements in fuel injection strategies: from carburetion, to port fuel injection to direct fuel injection, have enabled gains in performance and efficiency, as well as and pollutant reduction. Integrating computer engine simulation with experimental testing, a Predator single-cylinder engine was benchmarked at the carbureted state and converted to port fuel injection in order to quantify power and efficiency differences. Understanding this conversion process is crucial to engine research and development and the lessons learned will be applied to future engine design projects.

RE-USABLE MECHANCIAL FLARE
by: Andreas Argoudelis
Faculty Advisor: Jennifer Hudson, Ph.D.
11:30 a.m. – 11:55 a.m.

Although outdoor activities like hiking and camping can be very entertaining, they also involve a degree of danger. Being separated from a group is an isolated area could be fatal if one does not have the tools to become reunited with their party. This device is a safe, easy to use tool that can get anyone's attention and assist in the reconnection of a group. Applicable in many situations, this device could be essential to include on any outdoor excursion.

UNIVERSAL MOTORIZED CIRCUIT BREAKER LIFT
by: Kyle Tracy and David Gerechka
Faculty Advisor: Daniel Kujawski, Ph.D.
1:00 p.m. – 1:25 p.m.

Transportation of industrial circuit breakers for maintenance can be a challenging and tiring task if necessary to perform by hand. The use of a hand crank is not sufficient when attempting to avoid worker fatigue which can become hazardous to the safety of its operator. The use of an electric lift is more suitable for this type of application. A universal housing resting on moving rails is able to efficiently and effortlessly lift loads over a wide area. Structural analysis was performed in order to ensure operational safety of this device while adding a level of portability between different rail systems.

DIRECT, CLEAN, QUIESCENT COUNTER-GRAVITY LOW PRESSURE SEMI-PERMANENT MOLD CASTING OF ALUMINUM
by: Andrew Haldeman and Eric Jonsson
Sponsor: WMU Metal Casting
Faculty Advisors: Sam Ramrattan, Ph.D. and Mike Konkel
1:30 p.m. – 1:55 p.m.

Traditional practices of pouring liquid metal in molding is responsible for defects that negatively affect the strength and integrity of casted products. Pouring a stream of metal downward into a mold cavity entrains air and promotes the incorporation of bi-films through turbulence. These bi-films are responsible for stress risers and weakness in casting. Counter-gravity low pressure or filling from the bottom of the mold with low turbulence upwards through a filter located directly at the gate of the part cavity will reduce the negative defects associated with conventional pouring. The smooth controlled flow of clean metal into the part cavity will reduce the propensity for bi-film related defects to occur. Through the design of a new semi-permanent mold the effects of this new filling process on core materials was studied using a variety of disc-shaped specimens casted in a 356-aluminum alloy.

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- Inspire: prepare our learning community for lifelong excellence, ethical behavior, and professional leadership;
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