



12-2-2014

# 55th Conference on Senior Engineering Design

College of Engineering and Applied Sciences

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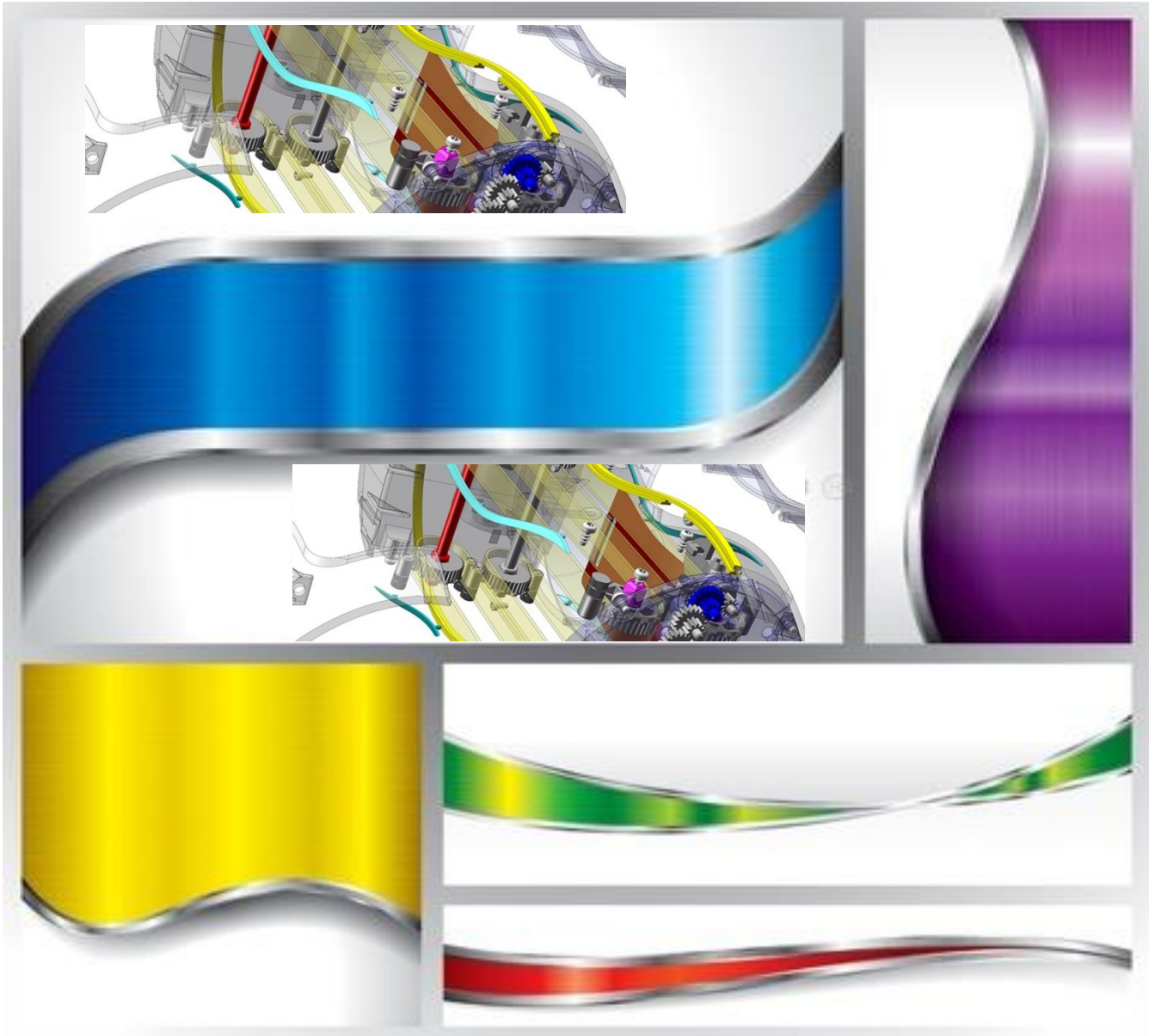
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# 55<sup>th</sup> Conference on Senior Engineering Design



Tuesday, December 2, 2014 9:00 a.m. – 4:00 p.m.



WESTERN MICHIGAN UNIVERSITY  
College of Engineering and Applied Sciences

# Conference on Senior Engineering Design Project



You are invited to attend the fifty- third Conference on Senior Engineering Design Projects. The conference will be held from 9:00 a.m. to 4:00 p.m., **Tuesday, December 2<sup>nd</sup>** 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. to 10:30 a.m.	p.5
Computer Science	D-202	9:00 a.m. to 2:30 p.m.	p.7
Electrical and Computer Engineering	D-204	9:00 a.m. to 12:00 a.m.	p.10
Engineering Design, Manufacturing, and Management Systems	D-201	8:30 a.m. to 12:00 p.m.	p.13
Industrial and Entrepreneurial Engineering & Engineering Management	D-210	9:00 a.m. to 10:00 a.m.	p.16
Mechanical and Aerospace Engineering	D-109	9:00 a.m. to 2:00 p.m.	p.17
Chemical and Paper Engineering	D-208	9:00 a.m. to 10:00 a.m.	p.20

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/senior-design-conference.html>

**CCE** Civil and Construction Engineering

**CS** Computer Science

**ECE** Electrical and Computer Engineering

**EDMMS** Engineering Design, Manufacturing, and Management Systems

**IEE & EM** Industrial and Entrepreneurial Engineering & Engineering Management

**MAE** Mechanical and Aerospace Engineering

**ChP** Chemical and Paper Engineering

<b>TIME</b>	<b>ROOM/DEPARTMENT</b>	<b>TOPIC</b>
<b>8:30</b>	<b>D-201 EDMMS</b>	<b>IMPROVING OPERATIONS EFFICIENCY OF A DISTRIBUTION CENTER</b>
<b>9:00</b>	<b>D-115 CCE</b>	<b>I-94 BL AND I-94 BL/M-96 INTERCHANGE ALTERNATIVES</b>
	<b>D-202 CS</b>	<b>CONSTRUCTING AN ENGAGING CURRICULUM FOR C/ASSEMBLY LANGUAGE</b>
	<b>D-204/205 ECE</b>	<b>WIND TURBINE SUPERVISORY CONTROL AND DATA MONITORING</b>
	<b>D-201 EDMMS</b>	<b>3D BONE MODELING AND SURGICAL SIMULATION</b>
	<b>D-210 IEE &amp; EM</b>	<b>EMERGENCY EVACUATION ASSESSMENT METHODOLOGY</b>
	<b>D-109 MAE</b>	<b>GT-15V TURBOJET ENGINE</b>
	<b>D-208 ChP</b>	<b>ELECTRONIC PROPERTIES OF INKS USED IN PRINTED ELECTRONICS</b>
<b>9:30</b>	<b>D-115 CCE</b>	<b>DIAMOND AND DONNELL LAKES WATER SYSTEM IMPROVEMENTS PROJECT</b>
	<b>D-202 CS</b>	<b>PARWEB: INTERFACE FOR HIGH PERFORMANCE COMPUTING</b>
	<b>D-204/205 ECE</b>	<b>TRUE RANDOM NUMBER GENERATOR</b>
	<b>D-201 EDMMS</b>	<b>HANDI-BIKE: WHEELCHAIR-BIKE FUSION FOR ENHANCED MOBILITY</b>
	<b>D-210 IEE &amp; EM</b>	<b>PLANT LAYOUT OPTIMIZATION</b>
	<b>D-109 MAE</b>	<b>DEVELOPMENT OF A LONG ENDURANCE SMALL UNMANNED AERIAL SYSTEM</b>
	<b>D-208 ChP</b>	<b>WATER BASED NICKEL INKS FOR SCREEN PRINTING OF PRINTED ELECTRONICS ON PAPER SUBSTRATES</b>
<b>10:00</b>	<b>D-115 CCE</b>	<b>OSHTEMO WELL FIELD DESIGN</b>
	<b>D-202 CS</b>	<b>PEOPLE MOVER</b>
	<b>D-204/205 ECE</b>	<b>DYNAMICALLY RECONFIGURABLE MINIATURE GOLF COURSE</b>
	<b>D-201 EDMMS</b>	<b>KINDER-COASTER: AN INTERACTIVE LEARNING EXPERIENCE</b>
	<b>D-109 MAE</b>	<b>THERMOELECTRIC GENERATOR FOR OFF-ROAD VEHICLE APPLICATION</b>

<b>10:30</b>	<b>D-202 CS</b> <b>D-204/205 ECE</b> <b>D-201 EDMMS</b> <b>D-109 MAE</b>	<b>TEMPERATURE/HUMIDITY SENSING USING MICROCONTROLLERS</b> <b>LENGTH DETECTION OF A MOVING OBJECT ON A CONVEYOR BELT</b> <b>VELO-ELECTRIC RECUMBENT BIKE WITH SIDECAR</b> <b>DESIGN OF AN ARMATURE SUSPENSION SPRING FOR A PROPORTIONAL SOLENOID</b>
<b>11:00</b>	<b>D-202 CS</b> <b>D-204/205 ECE</b> <b>D-201 EDMMS</b> <b>D-109 MAE</b>	<b>INDOOR POSITIONING SYSTEM</b> <b>PERFORMANCE FEEDBACK PUNCHING BAG</b> <b>3D HYBRID METAL PRINTING AND MILLING MACHINE</b> <b>CLOTHES DRYER MOTOR NOISE INVESTIGATION</b>
<b>11:30</b>	<b>D-202 CS</b> <b>D-204/205 ECE</b> <b>D-201 EDMMS</b> <b>D-109 MAE</b>	<b>LITERARY WORLDS</b> <b>SYSTEM TO MEASURE WMU RACE CAR PERFORMANCE AND ACTIVELY CONTROL REAR WING</b> <b>ANALYSIS OF PRESS SYSTEM DESIGN OF EXPERIMENTS</b> <b>OPTIMIZATION OF AN ANKLE LOADING MECHANISM FOR CT SCANNING</b>
<b>1:00</b>	<b>D-202 CS</b> <b>D-109 MAE</b>	<b>LAB REPORT SEARCH TOOL</b> <b>REUTILIZATION OF AUTOMOBILE DRIVELINE ASSEMBLY EQUIPMENT</b>
<b>1:30</b>	<b>D-202 CS</b> <b>D-109 MAE</b>	<b>PARALLEL WEB SERVER LOG PROCESSING USING CUDA</b> <b>DESIGN OF FATIGUE-LEARNING TOOL FOR COMPONENTS WITH NOTCHES</b>
<b>2:00</b>	<b>D-202 CS</b>	<b>SEED CORN SIMULATION GAME</b>

## 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 April 2014. 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 and Manufacturing*

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*WMU Chapter of the Society of Automotive Engineers*

*WMU Department of Psychology*



## **CIVIL AND CONSTRUCTION ENGINEERING**

Session Chair – Decker Hains, Ph.D.

Room D-115

### **I-94 BL (WHEATFIELD ROAD) AND I-94 BL/M-96 (MICHIGAN AVE) INTERCHANGE ALTERNATIVES**

by: Samuel Leatch, Mason Mellema, Tyler Mohre

Sponsor: Michigan Department of Transportation, Sarah Fedders

Faculty Advisor: Valerian Kwigizile, Ph.D.

9:00 a.m. – 9:25 a.m.

For years, the intersection of Wheatfield Road and Michigan Ave off of I-94 Exit 104 has been an issue of discussion. After historical research, field inspections, and data analysis a superior roadway design was developed. These alternatives were developed using traffic simulation, drainage design, geographical constraints, and constructability considerations. These alternatives were then evaluated based upon their sustainability, environmental, safety, level of service, constructability, serviceability, drainage, and cost characteristics. A superior alternative was designed based on these factors to greatly improve the efficiency of the entire interchange.

### **DIAMOND AND DONNELL LAKES WATER SYSTEM IMPROVEMENTS PROJECT**

by: Carlos Amarante, Mohammed Kaine, Ryan Myers, and Daniel Seely

Sponsor: Wightman & Associates, Inc., Alan Smaka

Faculty Advisor: Decker Hains, Ph.D.

9:30 a.m. – 9:55 a.m.

The current water system near the villages of Cassopolis and Vandalia is limited and many residents rely on well and ground water. Two design alternatives were developed and evaluated for servicing residents surrounding these areas. A water distribution system was designed based on our evaluations of these alternatives. Alternative evaluations were based on economics, needs of residents, population projections, and other factors. A detailed construction drawing was also created showing pipe sizing and system appurtenances for a portion of the system. The extended water system will provide safe and portable water, promoting health and welfare in the region.

## **OSHTEMO WELL FIELD DESIGN**

by: Cody Hostetler, Wes Jonik, and Nate Vankammen

Sponsor: City of Kalamazoo, Matt Johnson

Faculty Advisor: Yufeng Hu, Ph.D.

10:00 a.m. – 10:25 a.m.

To accommodate increased drinking water demand throughout the Kalamazoo area, a new well field is being constructed in Oshtemo Township at the intersection of G and 6<sup>th</sup>. Soil sampling and survey work was completed to prepare the site for design. The engineering process included pump selection along with structural design of a treatment facility while striving to reduce the site's environmental footprint. The scope also included the layout of equipment within the structure, filtration and sanitation equipment selection, and finally a tie-in connection to the existing water main system supplying the ever growing demand of the city.



**COMPUTER SCIENCE**  
Session Chair – John Kapenga  
Room – D-202

**CONSTRUCTING AN ENGAGING CURRICULUM FOR C/ASSEMBLY LANGUAGE**

by: Colin MacCreery

Sponsor: Department of Computer Science, Robert Trenary, Ph.D.

Faculty Advisor: John Kapenga, Ph.D.

9:00 a.m. – 9:25 a.m.

After all campus SPARC machines were decommissioned, it was necessary to find an alternate platform on which to teach students in Computer Science about CPU architecture and C/Assembly Language. Texas Instruments' MSP430 microcontroller and Launchpad development platform was chosen as a basis for the new CS 2230 curriculum. This new class structure involves utilizing video tutorials, in-class projects or flip teaching and leverages modern technologies to keep the material in this class relevant. By streamlining the instructional model, we have updated the material to keep students engaged and challenged to learn more.

**PARWEB: INTERFACE FOR HIGH PERFORMANCE COMPUTING**

by: Kyle Chipps, Benjamin Johnson, and Jacob Potter

Sponsor: High Performance Computational Science Lab, WMU

Faculty Advisor: John Kapenga, Ph.D.

9:30 a.m. – 9:55 a.m.

Scheduling jobs on CS departments cluster computer used to require users to SSH in, move their torque script into the proper directory then run that said script. ParWeb will allow users to log in via a web interface, upload their data, and with the click of a button schedule a job. Something that used to take knowledge of SSH, Bash commands, and torque scripts is now available to anyone with simple knowledge of a web browser. Using the very popular web framework Ruby on Rails allows for others to tailor this application specifically to their programs need.

**PEOPLE MOVER**

by: Ian McPherson, Ben Reed, and Mike Reisterer

Faculty Advisor: John Kapenga, Ph.D.

10:00 a.m. - 10:25 a.m.

Keeping track of patients in a modern hospital is a task not meant for pen and paper. Systems are currently in place to manage this task, but are rapidly becoming outdated. People Mover aims to replace a currently outdated patient queue system with a more streamlined and updated system crafted specifically for the end user and for the benefit of the patients. This system will greatly decrease each patient's overall time spent waiting within the hospital.

## **TEMPERATURE/HUMIDITY SENSING USING MICROCONTROLLERS**

by: Marcel Englmaier, Justin Koehler, and Jason Pearson

Sponsor: Department of Computer Science, WMU

Faculty Advisor: John Kapenga, Ph.D.

10:30 a.m. – 10:55 a.m.

The current system for reporting temperature and humidity in certain areas is very expensive. Using a microcontroller and an all-in-one sensor package, this project strives to create a smaller, cheaper alternative.

## **INDOOR POSITIONING SYSTEM**

by: Rodney Dulin, Davion Teh, and Kelvin Yap

Faculty Advisor: John Kapenga, Ph.D.

11:00 a.m. – 11:25 a.m.

There is no dynamic method of finding one's location in a Mall. A GPS is widely used to locate one's position precisely if the device is outdoors. However, GPS does not work indoors very well. An Android app was created to be able to locate one's location reliably inside a building.

## **LITERARY WORLDS**

by: Owen Watson, John Lewis, and Tim Cunningham

Faculty Advisor: Allen Webb

11:30 a.m. – 11:55 a.m.

Literary Worlds is a WMU project that provides a Java Applet based Multi User Domain (MUD) based on LambdaMOO and encore Mootcan. Since modern browsers do not typically support Java Applet technology, a new frontend was designed using client side JavaScript as well as a Node.JS server side component to interchange between the client and the legacy LambdaMOO software. The literary Worlds update project will allow all modern browsers as well as mobile devices to use the Literary Worlds MUD.

## **LAB REPORT SEARCH TOOL**

by: Anton Aleynikov, Barry De Young, and Alan Douglas

Faculty Advisor: John Kapenga, Ph.D.

1:00 p.m. – 1:25 p.m.

Businesses constantly need files and data. The Lab Report Search tool was designed to give end users the ability to query the data and retrieve the files they need without any programming knowledge. Through searching, filtering and sorting, this tool increases efficiency in business workflows on a day-to-day basis. By giving the power to the users to retrieve the data and files electronically, this tool will decrease the manual labor needed for the business processes to be completed.

## **PARALLEL WEB SERVER LOG PROCESSING USING CUDA**

by: Matthew Sarver, Michael Shields, and John Stanley

Faculty Advisor: John Kapenga, Ph.D.

1:30 p.m. – 1:55 p.m.

With the staggering growth of the internet in the last decade, web servers must be fast, adaptable, and secure to a variety of attacks. An open source web server log processor, currently PIWIK, is modified to use Nvidia's CUDA computing architecture and API, yielding faster response and detection of suspicious activity on a web server by parsing through security logs and analyzing activity in parallel. This modification has been tested and appropriately scaled and demonstrates another use for accelerating applications with a Graphics Processing Unit (GPU).

## **SEED CORN SIMULATION GAME**

by: Nick Karasch, Jon Sneathen, and William Taylor

Faculty Advisor: Donna Kaminski, Ph.D.

2:00 p.m. – 2:25 p.m.

Students at a younger age are less aware of the ins and outs of the process of growing corn. This website was designed to give teachers a method to teach their students about how corn is grown and what variables are involved. It takes the student through a full season and is built upon fully realistic simulation software. This includes weather and corn growth based off of real data from the past seasons. This site will be fully immersive and will raise awareness of what goes into seed corn farming.

## **ELECTRICAL AND COMPUTER ENGINEERING**

Session Chair – Damon Miller, Ph.D.

Room D-204/205

### **WIND TURBINE SUPERVISORY CONTROL AND DATA MONITORING**

by: Emily Kaleta, Brian Rouse, and Kyle Schaberg

Sponsor: Kalamazoo Valley Community College, Thomas Sutton

Faculty Advisor: Johnson Asumadu, Ph.D.

9:00 a.m. – 9:25 a.m.

Wind turbines are often in isolated places making remote monitoring systems vital for continuous operation. The designed system consists of a communications converter, data logger, and LabVIEW® application. The communications converter interfaces directly with the main turbine controller and transmits data over the internet. The data logger acts as a backup, logging all data in the event of communication failures. The heart of the remote monitoring system is a LabVIEW® application which receives the transmitted data and presents it to monitoring personnel, giving a real-time view of turbine status.

### **TRUE RANDOM NUMBER GENERATOR**

by: Ahmed Alshammari, Claudy Mejia, and Masaru Sone

Sponsor: Department of Computer Science, John Kapenga, Ph.D.

Faculty Advisor: Ralph Tanner, Ph.D.

9:30 a.m. – 9:55 a.m.

Random numbers have numerous uses from security to gambling and game applications. These are usually generated by a Pseudo Random Number Generator (PRNG) using mathematical formulas that produce a sequence of numbers that appear to be random. In contrast with PRNGs, a True Random Number Generator (TRNG) is a device that uses random physical phenomena to generate random binary strings. This TRNG generates true random numbers (TRNs) by measuring electrical noise created by the noise generator circuit, converting it into digital signals and creating strings of TRNs. These strings are then transferred to a computer to be used in computer programs.

## **DYNAMICALLY RECONFIGURABLE MINIATURE GOLF COURSE**

by: Mohammed Abukabbos, Ryan Feist, and James Lind

Sponsor: Department of Electrical and Computer Engineering, Steve Durbin, Ph.D.

Faculty Advisor: Steve Durbin, Ph.D.

10:00 a.m. – 10:25 a.m.

The Electrical and Computer Engineering Department is in need of a project that uses a variety of electronic components to demonstrate to prospective students what they will learn by enrolling in the WMU electrical engineering program. A dynamically reconfigurable miniature golf course was created to achieve this initiative. The putt-putt course incorporates an Arduino microcontroller, various sensors, servos, and other electronic equipment to bring the real-life attributes of a multi-hole putting experience to one single playing field. The miniature golf course will be used to provide a fun, interactive demonstration, showing what the WMU electrical engineering program has to offer.

## **LENGTH DETECTION OF A MOVING OBJECT ON A CONVEYOR BELT**

by: Phat Le, Aaron MacDougall, and Andrew Maletta

Faculty Advisor: Janos Grantner, Ph.D.

10:30 a.m. – 10:55 a.m.

In manufacturing processes, accuracy is important; as a result, performing quick and reliable measurements is often necessary. A system has been built to measure the length of objects on a fixed speed conveyor belt by incorporating a series of Keyence fiber optic and infrared sensors interfaced with a MicroLogix 1000 Programmable Logic Controller, providing a digital readout of the results on an LCD display.

## **PERFORMANCE FEEDBACK PUNCHING BAG**

by: Ryan Bowman, Alex McLean, and Derek Visch

Sponsor: WMU Department of Psychology, Dr. Wayne Fuqua, Neil Deochand, and Dale Gregory

Faculty Advisor: Bradley Bazuin, Ph.D.

11:00 a.m. – 11:25 a.m.

The Performance Feedback Punching Bag System has been designed to measure and record the force and frequency of user punches on a punching bag and to provide immediate user performance feedback. The system provides users a combination of auditory and visual feedback queues based on a predetermined performance threshold and expected improvement. The primary sensors used are three-dimensional accelerometers which are connected to an embedded microcontroller to record user input and wireless communication with a terminal PC. The PC includes a database and extensive graphical user interface to allow psychology researchers to customize training plans, provide appropriate user feedback and track user progress. In the future, psychology researchers expect to use the system to better understand the effects of immediate feedback on performance improvement.

## **SYSTEM TO MEASURE WMU RACE CAR PERFORMANCE AND ACTIVELY CONTROL REAR WING**

by: Matthew Andres, David Hopwood (Aeronautical Engineering), Matthew Tuley, and Rodney Wang'alia

Sponsor: WMU Chapter of the Society of Automotive Engineers, Claudia Fajardo, Ph.D.

Faculty Advisor: Massood Atashbar, Ph.D.

11:30 a.m. – 11:55 a.m.

To maximize performance of the WMU Chapter of the Society of Automotive Engineers formula race car, a system was developed to measure vehicle speed, acceleration, and suspension strain, as well as to dynamically adjust the angle of its rear wing based on immediate car performance. Custom implementations of Arduino master/slave controllers, controller area network bus interfaces, and a data storage unit were developed. The data collection and wing adjustment subsystems were designed around off-the-shelf sensors and actuators. The system was also designed for easy maintenance and expansion by future race teams.

## **ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS**

Session Chair – Betsy Aller, Ph.D.

Room D-201

### **IMPROVING OPERATIONS EFFICIENCY OF A DISTRIBUTION CENTER**

by: Tyler Mendrek, Justin Robinson, and Patrick Telford

Sponsor: Kazoo, Inc./Edwards Garment

Faculty Advisor: Kailash Bafna, Ph.D.

8:30 a.m. – 8:55 a.m.

The successful operation of a distribution center relies heavily on how the material is stored in the warehouse and also on proper picking techniques. Time studies were conducted to determine the time needed to fill an order from the active pick area. Shelf design and storage techniques such as the first-in-first-out (FIFO) inventory method were modified to improve the overstock area. An analysis was performed to determine if these techniques would impact overall savings. The recommendations provided to the company will allow them to fill orders faster and provide the capability of filling more orders each day.

### **3D BONE MODELING AND SURGICAL SIMULATION**

by: Megan Derwich and Andrea Micou

Faculty Advisor: Pavel Ikononov, Ph.D.

9:00 a.m. – 9:25 a.m.

The current surgical tools for training and teaching are very limited and extremely expensive. Using segmentation program 3D Slicer and Meshlab modeling software, CT scans were converted from two-dimensional images to three-dimensional models. The models were used to simulate physical responses to user interactions through surgical simulation. These personalized models will provide an inexpensive medical training and treatment option for students and surgeons, and may provide an enhanced level of individualized patient care.

### **HANDI-BIKE: WHEELCHAIR-BIKE FUSION FOR ENHANCED MOBILITY**

by: Adam Jeffrey, Samuel McDaniel, Jacob Meyers, and Gregory Peterson

Sponsor: Parker Hannefin

Faculty Advisor: David Middleton

9:30 a.m. – 9:55 a.m.

Wheelchairs are a great tool in aiding disabled individuals, but their design has evolved little over time, especially regarding mobility. The Handi-Bike is a wheelchair that provides the operator various means of mobility, without depending on other methods of transportation. When indoors, the wheelchair functions typically, achieving Americans with Disabilities Act (ADA) standards. When outdoors, the Handi-Bike extends a stability wheel and unique pedaling system to accomplish higher speeds, while retaining comfort and safety. Conceptual designs were implemented, starting from sketch models, progressing through computer-aided design, Finite Element Analysis (FEA), and final models.

### **KINDER-COASTER: AN INTERACTIVE LEARNING EXPERIENCE**

by: Carleigh Blanchard, Andre Martinez, Tim Murray, and Evan West

Sponsor: The Comstock STEM Academy: Greg Rabick and Linda Foster

Faculty Advisors: Betsy Aller, Ph.D. and Mitchel Keil, Ph.D.

10:00 a.m. – 10:25 a.m.

Numerous studies show that hands-on learning is beneficial at an early age, especially in the areas of Science, Technology, Engineering, and Mathematics (STEM). The Kinder-Coaster was created to serve as a fun, interactive learning device to demonstrate science and engineering concepts to kindergarten through 2<sup>nd</sup> grade students. Design ideas and criteria for the coaster were identified by surveying and observing students and faculty. Sketches and computer-aided design software (CAD) were used to design the coaster's elements, which were then fabricated. Exposure to the Kinder-Coaster has the potential to inspire students to pursue engineering-related fields later on in life.

### **VELO-ELECTRIC RECUMBENT BIKE WITH SIDECAR**

by: Koal Bristow, Adam VanderZouwen, and Mark Zielinski

Faculty Advisor: David Middleton

10:30 a.m. – 10:55 a.m.

Environmental concerns and rising fuel costs promote interest in alternative modes of transportation. The Velo-Electric design is based off a recumbent bicycle and is electric assisted. The incorporated sidecar improves stability and increases storage. The sidecar was designed using sketch models, user feedback, and CAD software, such as Catia and Creo. The prototype was analyzed for speed and durability. This design is targeted for commuters with short trips back and forth to any location.

### **3D HYBRID METAL PRINTING AND MILLING MACHINE**

by: Jake Ives, Jim McQueen, Dan Ziemer, and Matt Ziemer

Faculty Advisor: Pavel Ikononov, Ph.D.

11:00 a.m. – 11:25 a.m.

Most complex metal parts require multiple secondary operations after their initial production. These operations add time and cost to the manufacturer. A 3D metal printer was developed that can create complex machined parts with high accuracy in a single operation. Using computer numeric controlled (CNC) technology along with knowledge of metal deposition techniques, the first rapid prototype machine for metal parts was created for under \$5,000. With this technology, users can create extremely intricate parts while maintaining quality in a single operation.



## **ANALYSIS OF PRESS SYSTEM DESIGN OF EXPERIMENTS**

by: Coral Huffmaster, Eric Miller, and Andrew Tran

Sponsor: Stryker Instruments: Ryan Hoag

Faculty Advisor: Larry Mallak, Ph.D.

11:30 a.m. – 11:55 a.m.

Without a standard procedure, Designs of Experiments (DOE) can end up costing more than they are worth. Root cause analysis determined that the lack of procedures is the biggest concern with designing experiments. Pareto analysis helped evaluate the experiments that are needed for servo-mechanical press system applications. Microsoft Excel, pilot experiments, and statistical process controls were used to develop a financial calculator that compares cost to benefit of Design of Experiments in various testing parameters for a medical device manufacturer. The completed tool will reduce the defect rate of presses and time spent on the designing of experiments.

**INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING & ENGINEERING  
MANAGEMENT**

Session Chair – Bob White, Ph.D.

Room D-210

**EMERGENCY EVACUATION ASSESSMENT METHODOLOGY**

by: Duy Duong-Tran, Noah Marciniak, Josue Soto-Ramirez, and R. Joey Stempky II

Faculty Advisors: Steven Butt, Ph.D. and Tycho Fredericks, Ph.D.

9:00 a.m. – 9:25 a.m.

The absence or presence of common factors within a given space influences the action taken by individuals during an emergency. Data regarding these factors were gathered for spaces across the university. Data patterns allowed the spaces to be clustered and identified the important factors to address to improve safety and potential outcomes. Additional studies identified appropriate ways of alleviating the negative effects of factors within a given space. A resulting methodology was developed to help support emergency management success in environments beyond the university.

**PLANT LAYOUT OPTIMIZATION**

by: Denis Mursoi, Karanja Mathai, and Sujeet Shrestha

Sponsor: American Axle and Manufacturing

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

9:30 a.m. – 9:55 a.m.

Studies to improve cost of material handling, reduce production delays and lead time were done at American Axle and Manufacturing. Tools used to evaluate layout effectiveness included value stream maps, process flow and from to charts. A revised layout was developed. The resulting layout was evaluated for cost effectiveness and feasibility of implementation.

## **MECHANICAL AND AEROSPACE ENGINEERING**

Session Chair – Christopher Cho, Ph.D. and Bade Shrestha, Ph.D.

Room D-109

### **GT-15V TURBOJET ENGINE**

by: Alan DeWitt, Joseph Johnson, and Thomas Shock

Sponsor: Honeywell Turbo Technologies, Nathan Theiss

Faculty Advisor: William Liou, Ph.D.

9:00 a.m. – 9:25 a.m.

A turbojet engine was designed and fabricated around a modern automotive turbocharger. This engine acts as a demonstrational tool, while also doubling as an aid in the future research of combustion chambers, afterburners, and nozzle designs. Pressure, temperature, angular velocity, and fuel consumption measuring instrumentation was installed within the system to assess the performance of each specific engine component. This monitoring system allowed the Open Brayton Cycle to be properly displayed. System performance was recorded to be compared with future design variations.

### **DEVELOPMENT OF A LONG ENDURANCE SMALL UNMANNED AERIAL SYSTEM**

by: Andreas Quainoo, Shane Russell, and Cameron Segard

Sponsors: MAE Department and Lee Honors College

Faculty Advisor: Kapseong Ro, Ph.D.

9:30 a.m. – 9:55 a.m.

Unmanned aerial systems (UAS) are becoming increasingly prevalent in modern times. An autonomous aircraft is developed and flight tested to serve as a Long-Endurance UAS (LEUAS) test platform, which has a maximum payload of up to 5 pounds for 12 hours with an on-board charging system capable of supporting onboard avionic systems. This project will aid in the development and understanding of unmanned aerial systems for future generations.

### **THERMOELECTRIC GENERATOR FOR OFF-ROAD VEHICLE APPLICATION**

by: Joshua Douglas, Tyler Foune, and Dennis Mott

Faculty Advisor: Christopher Cho, Ph.D. and Alaa Attar, Ph.D.

10:00 a.m. – 10:25 a.m.

The off road vehicle industry is growing at a rapid rate and the demand to convert vehicles to be street legal is growing equally. It can be costly to turn a standard off-road motorcycle into a street legal vehicle due to lighting requirements. The addition of lights to the motorcycle can decrease efficiency and performance of the engine because of the addition of a higher capacity stator and coil assembly that results in higher parasitic losses on the engine. Heat recovery systems can be utilized to harvest wasted heat energy and convert it to usable electrical energy. Numerical computations and ANSYS simulations were completed to optimize the system in order to produce the most power. The device was designed and tested for an off-road motorcycle being converted for street legal use without sacrificing performance.

## **DESIGN OF AN ARMATURE SUSPENSION SPRING FOR A PROPORTIONAL SOLENOID**

by: Tom Eldred and Kevin Irwin

Sponsor: FEMA Corporation, Jerry Boza

Faculty Advisor: James Kamman, Ph.D.

10:30 a.m. – 10:55 a.m.

Solenoid actuated valves are commonly used to control hydraulic systems. Some existing solenoid designs incorporate suspension springs which support the armature in the solenoid. Suspending the armature eliminates sliding friction in the solenoid and improves valve performance. However, the maximum displacement of the solenoid is limited by the geometry of the suspension spring. A new suspension spring with increased maximum displacement was designed, prototyped, and tested. The new design can achieve five times the displacement and still keep the armature centered in the solenoid. Successful design of a new suspension spring will allow for the development of a new family of solenoid actuated valves.

## **CLOTHES DRYER MOTOR NOISE INVESTIGATION**

by: Tyler Burnett, Oscar Munoz, and Sarah Vicary

Sponsor: Whirlpool Corporation, Mark Christensen and Steve Lentz

Faculty Advisor: Koorosh Naghshineh, Ph.D.

11:00 a.m. – 11:25 a.m.

Whirlpool Corporation is known for having world-class appliances. To continue this tradition, they strive for quieter products such as clothes dryers designed at their St. Joseph (Michigan) Technology Center. Two different dryer motors, with varying shaft lengths, were considered in this investigation. By analyzing the differences between the two motor configurations through virtual simulation and physical noise/vibration testing, it was shown that the shaft length was a large contributor to motor noise. The dryer motor with a longer shaft was found to be quieter; with the shorter shaft length operating louder in the 120 Hz frequency range by 4 dB.

## **OPTIMIZATION OF AN ANKLE LOADING MECHANISM FOR CT SCANNING**

by: Frank Calabro and Krista Fox

Sponsor: James Jastifer, Ph.D.

Faculty Advisor: Peter Gustafson, Ph.D.

11:30 a.m. – 11:55 a.m.

There is currently no cost effective method to diagnose ankle and foot deformities under the normal load of a patient's weight. Medical practitioners may rely on a specialized computed tomography (CT) scanning machine to view the distal region of the leg while the patient is standing. However, specialized CT equipment carries substantial costs. An ankle loading device was developed to simulate a patient applying pressure to their foot under various loads and angles. This device functions with a standard CT scanner or x-ray machine to assist in the diagnosis of ankle deformities. This project is an optimization of a previous device developed by students at Western Michigan University.

## **REUTILIZATION OF AUTOMOBILE DRIVELINE ASSEMBLY EQUIPMENT**

by: Ross Bemben

Sponsor: American Axle and Manufacturing, Tony Brooks and Scott Herford

Faculty Advisor: Javier Montefort, Ph.D.

1:00 p.m. – 1:25 p.m.

During a changeover of manufacturing equipment, no product is produced, and therefore no revenue is generated. A three machine process for the production of heavy duty automotive rear axles was re-tooled, tested, and validated so that four processes on a main assembly line could be bypassed, which resulted in the elimination of changeovers for axles with lower customer demand. Using CAD software packages, new tools were developed and existing tools were modified to allow the production of these axles on the equipment. High precision force and distance measuring devices were employed to validate part specifications and dimensions. The completed machines provide the final assembly line with partially built axles that can be introduced four stations ahead of the line. With these stations bypassed, fewer changeovers are required to build low demand axles and consequently more time is available to produce axles in higher demand.

## **DESIGN OF FATIGUE-LEARNING TOOL FOR COMPONENTS WITH NOTCHES**

by: Joshua Teo Lee Kuok

Faculty Advisor: Daniel Kujawski, Ph.D.

1:30 p.m. – 1:55 p.m.

In order to assist and enhance the user experience with web-based [www.fatiguenet.com](http://www.fatiguenet.com) software a fatigue-learning tool was designed. This web-based learning tool model was created using PHP, Java and DB management. The purpose of this learning tool was to guide users through a step-by-step process by providing specific details and explanations without the need of a tutorial handbook. This creates a self-explanatory and frustration free website software, allowing users to have a productive and effective experience, while expanding their knowledge on the fundamentals of modern fatigue analysis methods.

## **CHEMICAL AND PAPER ENGINEERING**

Session Chair – Andrew Kline, Ph.D.

Room D-208

### **ELECTRONIC PROPERTIES OF INKS USED IN PRINTED ELECTRONICS**

by: Katherine Stickels

Faculty Advisor: Margaret Joyce, Ph.D.

9:00 a.m. – 9:25 a.m.

The high cost of silver and the increase in printed electronic sales has piqued the interest of finding alternatives to silver inks. Printed circuits were screen printed using varying layers of nickel inks with a top layer of silver inks. The circuits were tested for resistivity, smoothness, and thickness. The results provided an effective way to use nickel inks to reduce conductive ink costs in some printed electronics applications.

### **WATER BASED NICKEL INKS FOR SCREEN PRINTING OF PRINTED ELECTRONICS ON PAPER SUBSTRATES**

by: Joseph Henderson

Faculty Advisor: Margaret Joyce, Ph.D.

9:30 a.m. – 9:55 a.m.

Printed electronics is a fast growing market hindered by the high costs of silver required to make the conductive inks. If nickel can replace silver as the conductive material of the ink, then market growth and profit margin increases may occur. Investigation was made into determining the key substrate properties for screen printing of a water based nickel flake ink. By adjusting base sheet properties the best base sheet was determined for this ink based on print performance and functionality of the printed electronic.



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

### CEAS Mission

To educate our learning community for life-long excellence in responsible professional leadership. To increase knowledge through collaborative discovery, integration, application, and teaching. To serve as a resource and partner to our constituents. To prepare job-ready graduates for the global market.

### CEAS Vision

A scholarly community dedicated to excellence through student-centered education and research emphasizing professional practices in engineering and applied sciences.

### 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

- Interim Dean: Dr. Edmund Tsang
- Chair of Civil and Construction Engineering: Dr. Osama Abudayyeh
- Chair of Computer Science: Dr. Steven Carr
- Chair of Electrical and Computer Engineering: Dr. Steve Durbin
- Chair of Industrial and Manufacturing Engineering: Dr. Steve Butt
- Chair of Mechanical and Aerospace Engineering: Dr. Parviz Merati
- Chair of Chemical and Paper Engineering: Dr. Said AbuBakr

### CEAS Data (Fall 2013)

- Bachelor's Enrollment: 2220
- Master's Enrollment: 362
- Number of Faculty: 100
- Number of Staff: 24

### 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](http://www.wmich.edu/engineer)