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12-6-2016

59th Conference on Senior Engineering Design

College of Engineering and Applied Sciences

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WESTERN MICHIGAN UNIVERSITY
**College of Engineering
and Applied Sciences**



**SENIOR ENGINEERING
DESIGN CONFERENCE
TUESDAY, DECEMBER 6, 2016**

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 8:30 a.m. to 3:30 p.m., **Tuesday, December 6, 2016** 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. – 12:00 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	8:30 a.m. – 12:00 p.m.	pg. 13
Industrial and Entrepreneurial Engineering & Engineering Management	D-208	11:00 a.m. – 12:00 p.m.	pg. 16
Mechanical and Aerospace Engineering A	D-109	9:00 a.m. – 3:30 p.m.	pg. 17
Mechanical and Aerospace Engineering B	D-210	9:00 a.m. – 12:00 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/senior>

TIME	ROOM/DEPARTMENT		TOPIC
8:30	D-201	EDMM	Aeration Device to Produce Resin-Coated Specimens
9:00	D-115	CCE	Total Bridge Replacement of M-13 over Cheboyganing Creek
	D-202	CS	Role Based Access Control File System
	D-204/205	ECE	6U CubeSat Power Systems and Cathode Design
	D-201	EDMM	Contemporary Usonian House Design
	D-109	MAE	Development of Autonomous Flight Control System for a Small-scale UAV
	D-210	MAE	CubeSat ADCS Validation and Testing Apparatus
9:30	D-115	CCE	Mattawan Consolidated School Building Demolition and Rehabilitation
	D-202	CS	Family Map
	D-204/205	ECE	Hardware Acceleration of a Machine Learning Algorithm
	D-201	EDMM	Multi-terrain Compactible Bicycle
	D-109	MAE	Adjustable Shoe Manifold for Bottling Industry
	D-210	MAE	Motor Controlled Direct-Drive Valve
10:00	D-115	CCE	WMU Campus Traffic Study & Improvements
	D-202	CS	West Advising Website
	D-204/205	ECE	2-U CubeSat Electrical Power System
	D-201	EDMM	Study of Weld Lines with Underflow and Molecular Orientation
	D-109	MAE	Design of Computerized Surgical Screwdriver
	D-210	MAE	Vehicle Mounted Deployable Spike Strip
10:30	D-115	CCE	I-94 Detroit Advance Bridge Replacement
	D-202	CS	OrderBrain, an Ecommerce Platform for Restaurants
	D-204/205	ECE	Automated Photometric Testing System for Lighting
	D-201	EDMM	Automated Packaging System for Low-Density Organic Fiber
	D-109	MAE	Implementation of Magnetorheological Fluid for VVA
	D-210	MAE	NOTE: CLOSED PRESENTATION TO PUBLIC Energy Harvesting for Powering a White Cane
11:00	D-115	CCE	Dentist Office in Schoolcraft, MI
	D-202	CS	DotStar Composer
	D-204/205	ECE	RoboBronco II: Drive System and Autonomous Navigation
	D-201	EDMM	Tooling Management Systems Integration
	D-208	IEE	Manual Assembly Evaluation and Design
	D-109	MAE	Cloud Controlled Aluminum Extrusion Machine
	D-210	MAE	Electrical Connection to a Moving Rocker Arm
			NOTE: CLOSED PRESENTATION TO PUBLIC

11:30	D-202	CS	Introduction to Spark Cluster Computing
	D-204/205	ECE	Automated Process Control for Custom EARSs
	D-201	EDMM	Work Center Process Improvement
	D-208	IEE	Product Changeover and Component Part Conveyance
	D-109	MAE	Improvements on Final Assembly Lines
	D-210	MAE	Deployable Spike Strips
			Modular Oven Accessories for Whirlpool
			NOTE: CLOSED PRESENTATION TO PUBLIC
1:00	D-204/205	ECE	Portable Ambient Light Sensor
	D-109	MAE	Maestro Oil-less Pneumatic Surgical Drill
1:30	D-109	MAE	Vertical Take-off and Landing Unmanned Aerial Vehicle for Payload Delivery Applications
2:00	D-109	MAE	Ultrasonic Testing Fixture Redesign
2:30	D-109	MAE	Rolling Chassis Design of a Formula SAE Vehicle
3:00	D-109	MAE	Design of a Variable Oil Pressure Regulator

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 2016. If you have a project for our students or if you would like more information, please call Tamara Bergman at (269) 276-3248.

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TecNiq Inc.
United States Air Force
Western Aerospace Launch Initiative (WALI)
Whirlpool



CIVIL AND CONSTRUCTION ENGINEERING

Session Chair – Decker Hains, Ph.D.

Room D-115

TOTAL BRIDGE REPLACEMENT OF M-13 OVER CHEBOYGANING CREEK

by: Daniel Burns, Paul Herbert, and Blake Nichols

Sponsor: *Michigan Department of Transportation Bridge Design*, James Ranger and Dina Tarazi

Faculty Advisor: Yufeng Hu

9:00 a.m. – 9:25 a.m.

The Michigan Department of Transportation sought a proposal for a complete replacement of the M-13 Bridge over Cheboyganing Creek in Bay County, MI. The replacement will consist of demolition of the existing bridge and construction of the substructure and superstructure including piers, abutments, support beams, concrete deck, and railings. MDOT has determined that bridge rehabilitation is not design recommendation, design calculations, engineer's estimate of cost, and construction drawings. The proposed design engineering services will consider the cost of demolition but will not include the full scope of demolition planning services required.

MATTAWAN CONSOLIDATED SCHOOL BUILDING DEMOLITION AND REHABILITATION

by: Alexander Fields, Seth Bergman, and Alexander DeHaan

Sponsor: *Mattawan Consolidated Schools*, Dr. Robin Buchler

Faculty Advisor: Decker Hains

9:30 a.m. – 9:55 a.m.

Due to the recent construction of the new Early and Late Elementary Schools, the Mattawan School District requested an alternative use for their soon-to-be vacated school buildings. Four alternatives were initially proposed to the school board. Input from the school board and Mattawan residents was considered in determining the most feasible alternative for the community's needs. This alternative includes partial deconstruction of the Early Elementary school building and total deconstruction of the other two school buildings. The remaining section of the Early Elementary school building will be used for administration and early childhood development.

WMU CAMPUS TRAFFIC STUDY AND IMPROVEMENTS

by: Matthew Grabowski, Collin Lorenz, Cameron Minney, and Boyd Smart

Sponsor: *Fishbeck, Thompson, Carr & Huber, Inc.*, Ryan Musch

Faculty Advisor: Valerian Kwigizile

10:00 a.m. – 10:25 a.m.

Western Michigan University's Campus has been established since the early 1900's and over the course of 100+ years has been developed and redeveloped to meet the needs of a growing University. Navigating the campus by vehicle is more of a challenge as students, faculty, and staff must safely access buildings across campus during all times of the year. As vehicle and pedestrian routes change over the years, it is important to access traffic patterns at intersections. Vehicle and pedestrian patterns have been studied at select intersections on campus and traffic improvements have been recommended based on traffic analysis.

I-94 DETROIT ADVANCE BRIDGE REPLACEMENT; BRUSH STREET BRIDGE

by: Saleem Alsharari, Mert Can Kose, and Craig McNees

Sponsor: *HNTB Corporation*, Thomas Weston

Faculty Advisor: Haluk Aktan

10:30 a.m. – 10:55 a.m.

I-94 Detroit Advanced Bridge Replacement is meant to improve and increase the capacity of a 6-mile segment along a corridor of I-94 from French Avenue to Trumbull Avenue, located in a suburban neighborhood of Detroit. There is a total of nine bridges, built in the 1950's that need to be re-constructed for a capacity increase. Partial accelerated bridge construction technology will be implemented during the re-construction of the Brush Street Bridge, the one we chose to design. The suggested sustainable design will account for non-motorized traffic and a 100-year service life. The anticipated service completion date is August 2018.

DENTIST OFFICE IN SCHOOLCRAFT, MI

by: Juan Carlos Amarante Garcia, Daniel Brown, Thomas Palumbo, and Jonathan Welsing

Sponsor: *Prein & Newhof*, Mike Schwartz

Faculty Advisor: Decker Hains

11:00 a.m. – 11:25 a.m.

Alternate site design for a small medical office in Schoolcraft, MI. Includes site grading, design of a stormwater management system, parking lot, septic, well, and a detailed preliminary site plan. Sustainability and economic feasibility are incorporated as key project deliverables.



COMPUTER SCIENCE

Session Chair – John Kapenga

Room – D-202

ROLE BASED ACCESS CONTROL FILE SYSTEM

by: Ryan DePrekel, Scott Linder, and Justin Lanyon

Sponsor: *Department of Computer Science*, Steve Carr

Faculty Advisor: John Kapenga

9:00 a.m. – 9:25 a.m.

Access control is a prerequisite for security in computing systems. Linux permission bits are insufficient for many applications. Advanced access control models, including Multi Level Security (MLS), Role Based Access Control (RBAC), and Domain Type Enforcement (DTE) offer added security. A Linux file system implementing Role Based Access Control was implemented as a teaching aid for courses on secure software design. The file system is implemented in C using the Filesystem in Userspace (FUSE) kernel module. This will help students to better understand RBAC and the need for mandatory access control.

FAMILY MAP

by: Hogan Charters and Alex Hill

Sponsor: *Western Michigan University*, Dr. Michael Liepman

Faculty Advisor: John Kapenga

9:30 a.m. – 9:55 a.m.

The Family Map is an essential tool in diagnosing and helping to solve addictive and destructive behavior within a family. Using a directive graph of actions, thoughts, and emotions, a Family Map visually represents the family's actions in moving between abstinent behavior and using-intoxicant behavior. This method has been successfully used since the 1980's to help families in need. By digitizing this work, we allow more clinicians to easily learn and adopt this practice. This software uses the Ruby on Rails framework alongside JointJS and CryptoJS to create a secure, iterative, and interactive Family Map.

WEST ADVISING WEBSITE

by: Caleb Francisco and Dan Peekstok

Sponsor: *Western Michigan University CEAS Advising Office*

Faculty Advisor: John Kapenga

10:00 a.m. – 10:25 a.m.

Western Engineering Scheduling Tool (WEST) is a website used by advisors, support staff, and students for scheduling advising appointments. WEST is a redesign, from the ground up, of the original advising website. By utilizing the Laravel web framework, the maintainability, extensibility and security of the website can be easily managed by future developers. MySQL was used for storing appointment data and Laravel Excel was used for exporting data to a spreadsheet format. A new user interface was implemented using Bootstrap, allowing for a better desktop and mobile experience.

ORDERBRAIN, AN ECOMMERCE PLATFORM FOR RESTAURANTS

by: Matthew Knapper and Luke Margules

Sponsor: OrderBrain

Faculty Advisor: John Kapenga

10:30 a.m. – 10:55 a.m.

Many consumers order food online every day. However, there is no easy solution for restaurants to provide this without; taking away the identity of the restaurant, charging expensive transaction fees for providing effective customer support. OrderBrain is an online ordering platform for restaurants that enables them to have an easily customizable website that doesn't simply add their menu to an app. Customer's place orders within the client's web app and orders print in the store. OrderBrain is based on the secure test-driven framework, Django, the developer driven payment processor, Stripe, and the rock-solid scalable web host, AWS.

DOTSTAR COMPOSER

by: Aaron Branch, Zachary Jarman, and Peter Martinez

Sponsor: Juliana Payson

Faculty Advisor: John Kapenga

11:00 a.m. – 11:25 a.m.

There are limited systems for creating lighting effects choreographed with music for wearable LED costumes. The DotStar Composer was developed as an open source project to allow users to create lighting effects, synchronized with music to address this problem. A Pro Trinket microcontroller was programmed to hold these lighting effects and display them on DotStar RGB LED strips, synchronizing wirelessly with music on a laptop. Currently up to 5 strips of 100 DotStars on a costume were supported. Lithium Ion batteries were used and equipped with protection hardware to power the system on the user's costume.

INTRODUCTION TO SPARD CLUSTER COMPUTING

by: Blake Wrege and Daniel Billingslea

Sponsor: John Kapenga

Faculty Advisor: John Kapenga

11:30 a.m. – 11:55 a.m.

A computer cluster was created with the Apache Spark Cluster Computing Framework, on top of Hadoop's Distributed File System to solve problems in Big Data. Instructions and documentation have been provided for data science students and researchers on how to build, configure, and run the Spark Cluster. This environment can support Java, Scala, Python and Mahout. Ansible provides configuration for the system and Galinga gives monitoring support. Parallel Graphing algorithm examples were provided with the cluster.



ELECTRICAL AND COMPUTER ENGINEERING

Session Chair – Damon Miller, Ph.D.

Room D-204/205

6U CUBESAT POWER SYSTEM AND CATHODE DESIGN

by: Jeremy Schweiger, Shane Soper, Kaleb Vargo, and Matthew Wyman

Sponsor: *United States Air Force*

Faculty Advisor: Dean Johnson

9:00 a.m. – 9:25 a.m.

An Electrical Power System (EPS) for a Cube Satellite has been designed. The EPS is suitable to supply power to operate the satellite systems and payload, which may include a cathode design. The goal was to design a proof of concept prototype that will supply sufficient power to operate the satellite systems and payload. This was done by using small prototype boards, solar cells, battery management systems, and model subsystems to create a working model of the EPS.

HARDWARE ACCELERATION OF A MACHINE LEARNING ALGORITHM

by: Martin Cowley, and Alan Irwin

Sponsor: *Department of Electrical and Computer Engineering, Lina Sawalha*

Faculty Advisor: Lina Sawalha

9:30 a.m. – 9:55 a.m.

With machine learning being used in such diverse applications throughout modern technology, from spam filtering to voice recognition, there is a need to optimize associated operations in hardware to reduce cost and energy use and to increase performance speed of these operations. A hardware accelerator is a specialized architecture designed to perform either a single, complex operation or a set of operations. A Verilog floating point library was designed. The library was then used to implement the K-Nearest Neighbors algorithm on a Field Programmable Gate Array.

2-U CUBESAT ELECTRICAL POWER SYSTEM

by: Diomedes Mbekenga, Maria Yulanova, and Sean Huber

Sponsor: *Western Aerospace Launch Initiative (WALI)*

Faculty Advisor: Pablo Gomez

10:00 a.m. – 10:25 a.m.

The Cube Satellite, or CubeSat, that has been proposed by the Western Aerospace Launch Initiative, is made up of one Emitter Satellite and one 2-Unit CubeSat, or the Detector Satellite, which will detect and measure a plume of plasma from the Emitter Satellite. The Detector Satellite required an electrical power system to regulate, distribute, collect, and store power throughout the additional subsystems onboard. The design was modeled using MATLAB®, Simulink®, LTSpice, and AutoCAD®, and prototype was built to fulfill as many of the specifications as possible.

AUTOMATED PHOTOMETRIC TESTING SYSTEM FOR LIGHTING

by: Mathew Boyle, Phillip Peterson, and Steven Suter

Sponsor: *TecNiq Inc.*

Faculty Advisor: Damon Miller

10:30 a.m. – 10:55 a.m.

To ensure compliance with federal safety standards, lens assemblies are required to be tested for illuminance at specific angles. A system was designed and built to automate the process of adjusting and recording values of illuminance at predetermined points in space as set by the test engineer. The system consists of a controller for two axes of movement, a light sensor measuring illuminance, and a user interface. By designing a fully automated system, overall cycle time was reduced, allowing users to focus on other tasks, thereby facilitating improved quality control and reduced corrective action time.

ROBOBRONCO II: DRIVE SYSTEM AND AUTONOMOUS NAVIGATION

by: Samuel Hoff, Joshua Holovka, and Jacob Hunter

Sponsor: *Tarun Gupta*

Faculty Advisor: Bradley Bazuin

11:00 a.m. – 11:25 a.m.

A new generation RoboBronco is being constructed from the wheels up in collaboration between electrical, computer, industrial and manufacturing engineering students and faculty. Intended as a mobile, autonomous guide and information robot, a four wheeled base capable of moving throughout Floyd Hall has been constructed. The RoboBronco base and driving systems consist of multiple drive motors with embedded computer controls, a lithium-ion battery based power supply system, an inertial measurement unit and additional sensors that support fully autonomous motion and navigation, and Wi-Fi connectivity for remote video monitoring and manual control if and when desired.

AUTOMATED PROCESS CONTROL FOR CUSTOM EARs

by: Brian ThunderEagle, Caleb Kennett, Michael Tison, and Nathan Boswell

Sponsor: *Dallas Chase*

Faculty Advisor: Ralph Tanner

11:30 a.m. – 11:55 a.m.

A control system was designed for a mechanical process that works on extruded aluminum rails (EARs). These extruded aluminum rails have operations performed on them by a machine controlled by the designed electrical system. The operations performed on the rails are cutting to specified length, drilling both horizontally and vertically through the rails at specified locations. The cutting and drilling profiles are uploaded to the control system through a web based human machine interface.

PORTABLE AMBIENT LIGHT SENSOR

by: Abdullah Al Zaher

Sponsor: None

Faculty Advisor: Steven Durbin

1:00 p.m. – 1:25 p.m.

The purpose of the portable ambient light sensor is to measure ambient lighting conditions with respect to how they may affect the health of people. The designed low cost sensor is portable and battery-powered.



ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS

Session Chair – Betsy Aller, Ph.D.

Room D-201

AERATION DEVICE TO PRODUCE RESIN-COATED SPECIMENS

by: Lekesh Chelladorai, Jason Collins, and Jack Seuss

Sponsor: *Sinto Japan*

Faculty Advisor: Sam Ramrattan

8:30 a.m. – 8:55 a.m.

Resin-coated sand technology is an important part of the metal casting industry. The ability to make complex thin wall cores is an essential part of automotive manufacturing. Sand aeration technology allows us to do this. An improved aeration device was designed using Creo Parametric modelling software. Materials were sourced, and the design was then built to allow the production of test specimens. Following final testing, the new device may be scaled up for mass production.

CONTEMPORARY USONIAN HOUSE DESIGN

by: Binyam Minassie Tadesse, Nick Romanowski, and Steve Wagner

Sponsor: *David Middleton*

Faculty Advisor: David Middleton

9:00 a.m. – 9:25 a.m.

Increasing costs of home construction and renovation have pushed consumers to explore non-traditional housing options. The movement toward alternative solutions prompted the design of a modern, customizable, and cost-effective residential home building system that appeals to the average family, yet can be easily modified to suit individual needs. Through extensive research in various aspects of commercial, industrial, and residential construction methods, a material list and sample floor plan were created using Autodesk Inventor. Designs were presented to a licensed architect for review and approval. The final housing plan satisfied the sponsor and architect, and can serve as a new model for residential construction.

MULTI-TERRAIN COMPACTIBLE BICYCLE

by: Chris Diacono, Brenna George, Dakota Legge, Muhamad Shammass, and Johnny Shepherd

Sponsor: No sponsor

Faculty Advisor: David Middleton

9:30 a.m. – 9:55 a.m.

As city commuters' demands have changed, the need for a compact, multi-terrain form of travel has increased. This new multi-terrain bicycle can provide both recreational trail and transport usage. The design intent was to keep the bike lightweight and compact enough to fit into a small car or a closet but still moderately priced for general public use. Designs were modeled parametrically using SOLIDWORKS and Siemens NX, and models were tested using finite element analysis. Cost analysis and project management techniques helped make the design as cost effective as possible. The final prototype represents a durable, unique, cost-effective, and mass-producible bike.

STUDY OF WELD LINES WITH UNDERFLOW AND MOLECULAR ORIENTATION

by: Zachary Alcini, Patrick Coliton, and James Meirndorf

Sponsor: *Autodesk Incorporated*, Jay Shoemaker

Faculty Advisor: Jay Shoemaker

10:00 a.m. – 10:25 a.m.

Understanding properties of plastics is crucial to good product design. Two molds were built to help students understand the concepts of weld lines, underflow and molecular orientation, and how they affect strength in molded products. Autodesk Inventor was used to design the molds, while Autodesk Moldflow simulated optimal gate locations for moving weld lines. Two different gate locations demonstrated the effect of weld line formation. Tensile and impact tests show how weld line strength is influenced by gate location. The second mold was used to show the influence of process conditions, material selection, and the shape of the flow front on molecular orientation. Project results will add to future students' better understanding of these critical but under-studied aspects of product design.

AUTOMATED PACKAGING SYSTEM FOR LOW-DENSITY ORGANIC FIBER

by: Jordan Ahrens, Matthew Charles, Gary Hiatt, and Cody Smith

Sponsor: *J. Rettenmaier USA LP*, Jeff Hampton and Scot Miller

Faculty Advisor: Tarun Gupta

10:30 a.m. – 10:55 a.m.

Businesses need to renovate, repurpose, and replace production equipment to maintain a competitive edge in the 21st century. The current manual method of fiber compression and packaging at a local company is both costly and risk prone. When upgrading aging equipment, many variables need to be assessed to determine a cost competitive solution. This process requires extensive research and consideration on viable models, cost analysis, and working through the design process before improvements could be implemented. The modernized fiber compression packaging system will greatly improve worker safety, while also increasing productivity, lowering cost, and improving the process as a whole.

TOOLING MANAGEMENT SYSTEMS INTEGRATION

by: Erik Fritz, Bryan Kuntz, and Nick Manchik

Sponsor: *StructureTec*, Brian McClure

Faculty Advisor: David Lyth

11:00 a.m. – 11:25 a.m.

A local consulting and construction services firm was in need of a tooling management system. A vast variety of equipment and material is required to successfully complete roofing projects around the Midwest. In choosing a system to catalog, track, and maintain equipment, multiple software packages were analyzed to fit the predetermined needs for the company. An implementation trial of the chosen system allowed adjustments for efficiency, and the finalized system was installed into the company and used. Equipment needed and vehicle fleet specification are now readily available for project personnel. The new system reduces labor costs, provides tracking ability for tooling throughout the company, and, ultimately, provides increased efficiency and satisfaction for the company and their clients.

WORK CENTER PROCESS IMPROVEMENT

by: Adam Barnier, William Conway, and Jacob Patterson

Sponsor: *Ranir*, David Berkemeier, Brad Walbridge, and Ann Mason

Faculty Advisor: Larry Mallak

11:30 a.m. – 11:55 a.m.

Improving a process can lead to higher efficiency and lower production costs. A regional multi-national company produces a wide variety of dental hygiene products. A packaging work center was analyzed for improvement. Video analysis, process charts, and time studies were used to identify areas of inefficiencies, and lean manufacturing techniques were applied. Recommended actions should lead to higher output rates, increased effectiveness, and lower costs.



INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING & ENGINEERING MANAGEMENT

Session Chair – Azim Houshyar, Ph.D.

Room D-208

MANUAL ASSEMBLY EVALUATION AND DESIGN

by: Zach Crawford, Ben Lawson, and Shaunise Williams

Sponsors: *Amway Corporation*, Bill Reymond and Patric Adams

Herman Miller, Diana Terpstra

Faculty Advisors: Azim Houshyar and Bob White

11:00 a.m. – 11:25 a.m.

An evaluation of a company's externally contracted hand assembly processes revealed that there was potentially a significant financial incentive to internalize these operations which warranted further investigation. A cost analysis for bringing back all contracted hand assembly products to be made within the company justified this decision. In-depth product and capacity analyses were completed, identifying the optimal hand assembly location within the company. At this location, multiple hand assembly lines were designed and built to create a lean, efficient, high quality production environment for all products requiring hand assembly now and in the future.

PRODUCT CHANGEOVER AND COMPONENT PART CONVEYANCE IMPROVEMENTS ON FINAL ASSEMBLY LINES

by: Michael Cunic, Luis Duarte-Perpuly, Wren Jacob, and Mike Riley

Sponsor: *DENSO Manufacturing Michigan, Inc.*, Lee Washburn

Faculty Advisors: Azim Houshyar and Bob White

11:30 a.m. – 11:55 a.m.

The reduction of warehousing space in a facility has required final assembly lines to become more flexible and capable of frequent changeover between products, and just-in-time (JIT) production. Using time-studies, standard work procedures, and production quality statistics, improvements to the product changeover process were made to allow for even more frequent changeovers to enable JIT production. In order to further enable JIT production, the component parts delivery system had to be altered. Using time-studies and simulation, a new component parts delivery system was developed to enable JIT production.



MECHANICAL AND AEROSPACE ENGINEERING A

Session Chair – Bade Shrestha, Ph.D. and Muralidhar Ghantasala, Ph.D.

Room D-109

DEVELOPMENT OF AUTONOMOUS FLIGHT CONTROL SYSTEM FOR SMALL-SCALE UAV

by: Nathan Beckman and Jeremy Gravedoni

Faculty Advisor: Kapseong Ro

9:00 a.m. – 9:25 a.m.

Unmanned Aerial Vehicles (UAV's) are becoming very prominent within the aerospace industry in recent years. An autonomous flight control system is developed and implemented into a small scale aircraft. Flight dynamics and control was modeled using computational resources prior to experimental flight testing. The control system and software was tuned for the particular aircraft being flown. GPS waypoint navigation and autonomous level flight was performed. This project will benefit students' knowledge of flight dynamics and the development of unmanned systems.

ADJUSTABLE SHOE MANIFOLD FOR BOTTLING INDUSTRY

by: Joe Gidley, Henry Hulbert, and Zach Wegner

Sponsor: *FBN Sales Inc.*, Dennis LaVanWay

Faculty Advisor: Parviz Merati

9:30 a.m. – 9:55 a.m.

The scope of this project is to design an adjustable manifold for USB-style pressure gravity bottle filler. USB-style gravity filler uses a manifold to evenly distribute product through valves and into bottles. This filler is often used to fill different size bottles. Inside the current filler assembly there is a shutoff shoe that covers a designed percentage of the manifold port. The new design will allow for more adjustability for the shutoff shoe. This optimization will allow less product overflow, in turn saving the company time and money.

DESIGN OF COMPUTERIZED SURGICAL SCREWDRIVER

by: Jacob Nye and Timothy Ruesink

Sponsor: *Orthodrive LLC*

Faculty Advisor: Peter Gustafson

10:00 a.m. – 10:25 a.m.

During internal fixation surgery, it is often necessary for surgeons to insert screws into trabecular bone. When a surgeon exceeds the maximum torque that a patient's bone can withstand, trabecular bone may strip at the screw-bone interface. This effect may be the cause of a negative surgical outcome. A screwdriver was designed with instrumentation for measuring torque and rotation. A printed circuit board was designed and manufactured. A strain gauge based torque sensor was designed and integrated into the screw driver shaft. An algorithm was implemented to measure torque and rotation and provides surgical guidance.

IMPLEMENTATION OF MAGNETORHEOLOGICAL FLUID FOR VVA

by: Robert Drumm, Dominic Leonard, Taylor Roe, and Joshua Rohrer

Sponsor: *Eaton, Mark Van Wingerden*

Faculty Advisor: Claudia Fajardo-Hansford

10:30 a.m. – 10:55 a.m.

NOTE: CLOSED PRESENTATION TO PUBLIC

A variable valvetrain actuation system incorporating a magnetorheological fluid was designed for application in internal combustion (IC) engines. Solid modeling, computer simulations and experiments were used to validate the design concept and assess its performance relative to the baseline system. The project was motivated by the need to improve fuel economy and reduce pollutant emissions in IC engines.

CLOUD CONTROLLED ALUMINUM EXTRUSION MACHINE

by: Dallas Chase

Sponsor: *Artificially Intelligent Machinestop, Conquer*

Faculty Advisor: Ralph Tanner

11:00 a.m. – 11:25 a.m.

Artificially Intelligent Machinestop is the next generation, fully autonomous machine shop. Part data is uploaded to our online web application, the system machines parts out of aluminum extrusion without operator assistance.

DEPLOYABLE SPIKE STRIPS

by: Zac Halfhill, Thomas Johnson, and Nicholas Parshall

Sponsor: No sponsor

Faculty Advisor: Javier Montefort

11:30 a.m. – 11:55 a.m.

High speed vehicle pursuits are extremely dangerous for authorities and civilians alike. Currently the methods to end these pursuits require officers to leave the safety of their vehicle to deploy spike strips. An optimized spike strip that eliminates the need for officers to leave their vehicles for deployment was designed. The completed design drastically increases accuracy, ensuring safety of civilians and officers while efficiently and quickly ending the pursuit. A 3D modeling software, was used to visualize the final design while MATLAB was used for calculations and durability analysis.

MAESTRO OIL-LESS PNEUMATIC SURGICAL DRILL

by: Najeeb Dababneh, Daniel Layton, and Ryan Tintera

Sponsor: *Stryker Instruments*, Corbin Glidden

Faculty Advisor: Pnina Ari-Gur

1:00 p.m. – 1:25 p.m.

Medical instrument sterilization is essential for maintaining patient safety. The current Maestro pneumatic motor requires oil for lubrication. This oil accumulates over time, eventually leaving the drill. During sterilization, this oil must be contained within a sterile barrier. If it escapes the barrier, the device must be re-sterilized before use. By researching and testing different pneumatic motor component materials for the drill, data was obtained for possibility of removing or greatly reducing the need for lubrication. In achieving the objective, the reduction of oil in the device reduces the likelihood of contamination at the surgical wound site.

VERTICAL TAKE-OFF AND LANDING UNMANNED AERIAL VEHICLE FOR PAYLOAD DELIVERY APPLICATIONS

by: David Ajoku

Sponsor: No sponsor

Faculty Advisor: Peter Gustafson

1:30 p.m. – 1:55 p.m.

The role of Vertical Take-off and Landing (VTOL) has expanded greatly in the last few decades. While primarily used in military applications, civilian accessibility to this technology brings numerous new capabilities for fixed wing Unmanned Aerial Vehicles (UAV's). A VTOL vehicle was designed for payload delivery applications. The UAV was designed to meet the weight requirement of 55 pounds under the Federal Aviation Authority's (FAA) current UAV regulations. The current design will provide a platform for future studies on payload delivery applications.

ULTRASONIC TESTING FIXTURE REDESIGN

by: Bryan Harris, Mason Moses, and Chris Vogelheim

Sponsor: *American Axle Manufacturing*, Thomas Moneypenny

Faculty Advisor: Mitchel Keil

2:00 p.m. – 2:25 p.m.

During the manufacturing process of testing welds on 1 speed and 2 speed gear assemblies, product changeovers between the two product lines resulted in machine downtime. This ultimately meant a loss in efficiency and an overall production shut down. This problem was overcome by redesigning the existing testing fixtures to be able to test more than one product line. A prototype was designed in Inventor and machined using a horizontal lathe. The new fixture increased overall process efficiency, total part count run through the machine during a shift, and made the machine easier for the operator to use.

ROLLING CHASSIS DESIGN OF A FORMULA SAE VEHICLE

by: Joseph Jagodzinski and Eric Bontrager

Sponsor: *Western Michigan University*

Faculty Advisor: Richard Hathaway

2:30 p.m. – 2:55 p.m.

Western Michigan University's Formula SAE team continually competes at a higher level with each passing year and thus constantly requires a refinement and enhancement of pre-existing vehicle architecture to remain competitive. To achieve greater vehicle performance, the current rolling chassis platform is to undergo its second design iteration. This iteration includes heightened handling characteristics, strengthened torsional rigidity, weight reduction, and enhanced ergonomics for vehicle packaging. Proof of the conclusive design will be validated through physical, mathematical, and simulation based analysis.

DESIGN OF A VARIABLE OIL PRESSURE REGULATOR

by: Austin Karwacki

Sponsor: *Eaton Corporation*

Faculty Advisor: Yufeng Hu

3:00 p.m. – 3:25 p.m.

During cylinder deactivation in a combustion engine, valve motion is halted in order to shut off the cylinder. With this particular design, there is a chance of failure in the high risk case. The process to solve this started with extensive research on possible benchmarking, engine operation, motor oil, and fluid dynamics. Then, actual analytics were conducted followed by detailed drawings of a proposed design that will lead to a prototype and testing. In the end, the goal was to design a component that successfully meets the requirements and solves the problem.



MECHANICAL AND AEROSPACE ENGINEERING B

Session Chair – Bade Shrestha, Ph.D.

Room D-210

CUBESAT ADCS VALIDATION AND TESTING APPARATUS

by: Jacob Stevens, Nicolas Theoret, and Tyler Chantrenne

Sponsors: *Western Michigan University WALI Team*, Jennifer Hudson

Consort Display Group, Bryan Lepley

Liberty Gears, Tom Sclesky

Faculty Advisor: Jennifer Hudson

9:00 a.m. – 9:25 a.m.

The WALI team at Western Michigan University requested a test environment to validate their CubeSat's de-tumbling control system and hardware. The test environment required a Helmholtz cage and spherical air bearing. The Helmholtz cage provides an adjustable magnetic field to simulate low earth orbit; the spherical air bearing simulates the friction free environment the CubeSat will experience in space. In conjunction, the two components create an adjustable system that simulates a satellite in low earth orbit.

MOTOR CONTROLLED DIRECT-DRIVE VALVE

by: Tyler Farrington and Aaron LaBomascus

Sponsor: *FEMA Corporation*, Jerry Boza

Faculty Advisor: Alamgir Choudhury

9:30 a.m. – 9:55 a.m.

Hydraulic proportional pressure-control valves (PPCs) are used in many industrial and off-highway applications for control of hydraulic systems. Conventional PPCs operate using open-loop control, but are vulnerable to transient instabilities that interfere with closed-loop control. A PPC valve was designed using MathCAD and SOLIDWORKS with the intent of removing the source of these transient instabilities. This Motor Controlled Direct-Drive Valve (MCDDV) utilizes a brushed DC motor with an eccentric engagement pin, and a closed-loop controller receiving feedback from a pressure transducer and magnetic encoder. A MCDDV prototype was built and tested to evaluate its performance with a closed-loop control system.

VEHICLE MOUNTED DEPLOYABLE SPIKE STRIP

by: Jake Peraino and Jon Silvenis

Sponsor: Larry Campbell

Faculty Advisor: Muralidhar Ghantasala

10:00 a.m. – 10:25 a.m.

High speed chases continue to be one of the most dangerous aspects of a police officer's profession. This is in part because of how exposed the officers are when hand deploying spike strips. A system was designed to keep the officer safe inside the police cruiser, while also stopping the speeding vehicle. Compressed air inside a tube attached to the vehicle allows for safe deployment of the spikes by the officer with a simple press of a button. Spike strips are still necessary to hinder reckless drivers in order to limit further damage. With the addition of our system, this can be properly done without the risk of loss of life.

ENERGY HARVESTING FOR POWERING A WHITE CANE

by: Robert Rodriguez and Amanuel Sedi

Sponsor: No sponsor

Faculty Advisor: Pnina Ari-Gur

10:30 a.m. – 10:55 a.m.

White canes have been in use for nearly a century as the primary device that helps visually impaired people navigate and locate their surroundings. Some of these canes are equipped with devices that are composed of battery-powered sensors, but the frequent charging of the batteries can be problematic. An energy harvesting system was designed and built to use piezoelectric materials for harvesting the energy produced by the motion of the cane to power the sensors. Frequent analyses were made using data acquisition systems to record the energy harvested. The model will benefit the user by eliminating the need to remove the batteries for recharging.

ELECTRICAL CONNECTION TO A MOVING ROCKER ARM

by: Tyler Brown and Brooks McLaughlin

Sponsor: *Eaton Corporation*, Mark Van Wingerden

Faculty Advisor: Muralidhar Ghantasala

11:00 a.m. – 11:25 a.m.

NOTE: CLOSED PRESENTATION TO PUBLIC

Variable valve actuation (VVA) technology for internal combustion engines allows engines to operate more efficiently by giving increased control over engine air valve movement. Current production technology uses a hydraulically controlled latching mechanism while the use of an electronically actuated method could de-couple constraints due to oil pressure and temperature from the actuation system. The goal of this project is to explore different methods of power transmission for an electronically actuated VVA system and how they can be applied in a harsh engine environment.

MODULAR OVEN ACCESSORIES FOR WHIRLPOOL

by: Kyle Boyce and Josh Zantello

Sponsor: *Whirlpool*, Zachary Bruin-Slot

Faculty Advisor: Ho Sung Lee

11:30 a.m. – 11:55 a.m.

NOTE: CLOSED PRESENTATION TO PUBLIC

The oven holds a very important role in the kitchen. It is an appliance that many kitchens are centered around. The kitchen can be referred to as the “hub of the home”, so the importance of a high quality functioning oven is essential. While the oven is very important, it has a limited capability in methods of cooking. One method to alleviate this issue is to create special oven in oven accessories to expand the possibilities of cooking. For this Senior Design project, the team worked with Whirlpool to design modular oven accessories for an oven cavity. This project was centered around the design of two modular accessories. The deliverables of this project included CAD drawings, a FMEA, a DVP&R, a BOM, a concept safety review, design simulations, and prototyping if possible.



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- 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.

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- 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
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- CEAS Advising Office: (269) 276-3270
- CEAS Dean's Office: (269) 276-3253
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