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College of Engineering and Applied Sciences

12-8-2015

57th 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 8, 2015

Conference on Senior Engineering Design Project



You are invited to attend the fifty seventh Conference on Senior Engineering Design Projects. The conference will be held from 8:00 a.m. to 4:00 p.m., **Tuesday, December 8th** 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	8:30 a.m. to 11:00 a.m.	p. 5
Computer Science	D-202	9:00 a.m. to 11:00 a.m.	p. 8
Electrical and Computer Engineering	D-204	9:00 a.m. to 11:00 a.m.	p. 10
Engineering Design, Manufacturing, and Management Systems	D-201	8:00 a.m. to 3:00 p.m.	p. 12
Industrial and Entrepreneurial Engineering & Engineering Management	D-212	10:30 a.m. to 12:00 p.m.	p. 17
Mechanical and Aerospace Engineering A	D-109	9:00 a.m. to 3:00 p.m.	p. 18
Mechanical and Aerospace Engineering B	D-210	9:00 a.m. to 1:00 p.m.	p. 22
Chemical and Paper Engineering	D-208	9:00 a.m. to 10:30 a.m.	p. 25

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:

<https://cms.wmich.edu/engineer/current/seniors>

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 Engineering and Paper Engineering

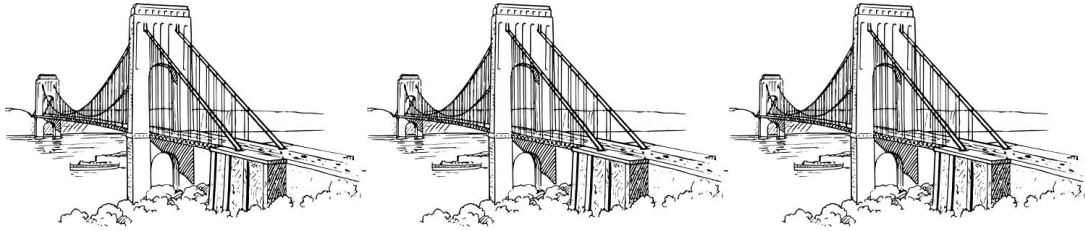
TIME	ROOM/DEPARTMENT	TOPIC
8:00	D-201/EDMMS	Die Casting in a Box, Redux
8:30	D-115/CCE	I-94 at 40 th Street Interchange Replacement
8:30	D-201/EDMMS	Evaluation of Controlled Counter Gravity Casting
9:00	D-115/CCE	Site Development-Corner at Drake and Stadium
9:00	D-208/ChP	Cellulose Nano Fibrils Addition for Improved Barrier Paper Properties
9:00	D-202/CS	Kinect-enabled Stereotypy Contingent Time-Out
9:00	D-204/ECE	Programming Platform for Real-Time Robot Control
9:00	D-201/EDMMS	Machine Control Training Center
9:00	D-109/MAE A	Automatic In Process Measurement and Die Adjustment for Deep Draw Metal Stamping Applications
9:00	D-210/MAE B	Hydrogen Conversion for Internal Combustion Engines
9:30	D-115/CCE	Composite Elevated Water Storage Tank
9:30	D-208/ChP	Titanium Dioxide Reduction in Fine Papers
9:30	D-202/CS	Dror Yaron and Beatrice Dias
9:30	D-204/ECE	Robotic Arm Implemented in a Production Line
9:30	D-201/EDMMS	SBOAT Reverse Engineering
9:30	D-109/MAE A	High-Endurance Helicopter for Towing Capabilities
9:30	D-210/MAE B	Solar Powered Water Filtration System
10:00	D-115/CCE	9 th Street and Safety Corridor Analysis
10:00	D-208/ChP	Optimizing Paper Machine Energy Splits Between Steam and Power for Specialty Grades
10:00	D-202/CS	Small Business Database Renovation
10:00	D-204/ECE	Sunseeker 2016 Battery Protection System
10:00	D-201/EDMMS	Sustainable Shade Seating Structure (S.S.S.S.)
10:00	D-109/MAE A	Push-Rod Suspension Redesign for the FSAE Team
10:00	D-210/MAE B	Automated Leak Bench Design and Fabrication
10:30	D-115/CCE	Evaluation of WWTP Processes for Meat Processing Plant
10:30	D-202/CS	Streetlight and Power Outage Mobile App
10:30	D-204/ECE	Induction Charging of UAV and Dual UAV Control
10:30	D-201/EDMMS	Hydraulic Loading System
10:30	D-212/IEE EM	Process Evaluation & Improvement

10:30	D-109/MAE A	Design of a Tandem Rotor Hovering Vehicle
10:30	D-210/MAE B	Rocking Baby Car Seat
11:00	D-115/CCE	D Avenue Improvements Project
11:00	D-204/ECE	Multi-Rotor Unmanned Aerial Vehicle
11:00	D-201/EDMMS	A Hunting UTV to Support Wounded Veterans
11:00	D-212/IEE EM	Overall Equipment Efficiency Improvement
11:00	D-109/MAE A	Development of an Autonomous Proximity Operations Demonstration System
11:00	D-210/MAE B	Dynamic Energy Input Control System
11:30	D-201/EDMMS	Material Flow Optimization in a JIT System
11:30	D-212/IEE EM	Increasing Capacity at a Hydraulic Rebuild Center
11:30	D-109/MAE A	Brass to Plastic Sleeve Conversion
11:30	D-210/MAE B	Energy Independent Home
1:00	D-201/EDMMS	Redesign of Portable Alignment Stands
1:00	D-109/MAE A	Design of a Quick Connect Coupler for a Surgical Drill
1:00	D-210/MAE B	Optimization of Horizontal Axis Washer Shaft Assembly
1:30	D-201/EDMMS	3D Bone Surgery Simulator with Force Feedback Device
1:30	D-109/MAE A	Design and Fabrication of an Instrumented Cane for the Blind
2:00	D-201/EDMMS	Convertible Bike Frame for Chainless Challenge
2:00	D-109/MAE A	Optimal Design of an Air-to-Air Thermoelectric Generator for Waste Heat Recovery
2:30	D-201/EDMMS	Braking System for a Mobile Robot
2:30	D-109/MAE A	Validation of the MKV Airship through flight testing-a hybrid air vehicle design

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 2015. If you have a project for our students or if you would like more information, please call Tamara Bergman at (269) 276-3248.

Appvion, Inc.
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Road Commission of Kalamazoo County
Stryker Instruments
Surplus Trading Corporation
Tenneco
Whirlpool Corporation
WMU Department of Blindness and Low Vision Studies



CIVIL AND CONSTRUCTION ENGINEERING

Session Chair – Decker Hains, Ph.D.

Room D-115

I-94 AT 40TH STREET INTERCHANGE REPLACEMENT

by: Jared Boone, Trevor Burke, Tyler Cravens, and Jason Grant

Sponsor: Jon Sytsma, *Michigan Department of Transportation*

Advisor: Valerian Kwigizile, Ph.D.

8:30 a.m. – 8:55 a.m.

Interchange alternatives were developed and evaluated for the I-94 at 40th Street interchange in Kalamazoo County, MI. An analysis of the existing interchange was conducted to provide a baseline for what the alternatives needed to improve on. A recommendation will be provided after comparing alternatives based on level of service, safety, right of way, sustainability, environmental impact, and cost.

SITE DEVELOPMENT-CORNER OF DRAKE AND STADIUM

by: Benedicto Hernandez, Muhammad Nauman, Sear Rahimi, and Jimmy Wooten

Sponsor: Todd Hurley, *Hurley & Stewart*

Advisor: Yufeng Hu

9:00 a.m. – 9:25 a.m.

The Corner at Drake and Stadium is a site development project located at the northeast quadrant of the U.S. 131 and Stadium Drive interchange in Kalamazoo, MI. This 40-acre development includes a mixed-use commercial center anchored by a Costco Warehouse. Alternative site layout, grading/earthwork, storm water management, and utilities designs have been made for the 40-acres to determine if the current design was the most practical use of the land. The development of this site has the potential to include two hotels, a bank, restaurants, and several retail stores.

COMPOSITE ELEVATED WATER STORAGE TANK

by: Kyle Areaux, Noah Boyd, Whitney Briggs, and Spencer O'Dell

Sponsors: W. Christopher Barnes, P.E., *Director of Transportation & Utilities*

Kendra Gwin, P.E., *Utilities Engineer*

Advisor: Decker B. Hains, Ph.D.

9:30 a.m. – 9:55 a.m.

The City of Portage operates a municipal water distribution system that supplies water to residential areas and commercial facilities. As requested by the City of Portage, A-Team Engineering has conducted an analysis of alternatives for an elevated water storage tank with the intent of meeting the City's desired fire flow parameter along Sprinkle Rd. Included in this analysis was an evaluation of the perspective locations based on project criteria, including a cost analysis, hydraulic analysis, soil suitability, and airport zoning regulations.

9TH STREET AND SAFETY CORRIDOR ANALYSIS

by: Mohammad Amini and Panyang Li

Sponsors: Michelle O'Neill and Jim Hoekstra, *MDOT*

Advisor: Jun-Seok Oh

10:00 a.m. – 10:25 a.m.

An in-depth traffic analysis was performed along the 9th Street corridor stretching from Cracker Barrel Blvd/EB I-94 off ramp to Stadium Drive. Crash history, along with collected traffic data was considered in the design of a Synchro model used to identify a potential project that could improve traffic safety. Alternatives considered include signalization improvements, non-motorized improvements, and potential roundabouts at locations along the corridor.

EVALUSTION OF WWTP PROCESSES FOR MEAT PROCESSING PLANT

by: William J. Kunesh, Derek, J. Miller, Robert Miller, and Sarah Synnestvedt

Sponsor: Jason Docsa, P.E., *L.D. Docsa Associates, Inc.*

Advisor: Decker B. Hains, Ph.D.

10:30 a.m. – 10:55 a.m.

A large quantity of waste is produced from meat processing plants, including the one being constructed in the city of Coldwater. Alternatives were developed and analyzed for providing a wastewater treatment plant for the meat processing facility. The alternatives include pretreatment, activated sludge treatment, or a fixed-bed biofilm activated sludge process. The focus was on constructability, sustainability, and cost effectiveness. The deliverables consist of general process flow diagrams, drawings of the plant and area, as well as cost estimates. A construction schedule, written report, presentation board and oral presentation are also provided.

D AVENUE IMPROVEMENTS PROJECT

by: Omar Alagel, Grant DePalma, Philip Doorlag, and Khalifa Sylla

Sponsor: Ryan Minkus, PE, PTOE, County Engineer; *Road Commission of Kalamazoo County*

Advisor: Zhanbo Sun

11:00 a.m. – 11:25 a.m.

Design for the widening of D Avenue from Adobe Road to Rolling Meadows Drive to accommodate the addition of a center turn lane. Complete traffic signal warrant to justify signalization improvements at the D Avenue/12th Street intersection, including a design alternative for the construction of a modern roundabout. The roadway design will also include HMA removal of the existing roadway, trenching, resurfacing, drainage improvements throughout the project limits, driveway and cross culvert replacement, curb radii replacement to account for the widened intersection geometry, two new span poles along with span wire, and new signal flashers.



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

KINECT-ENABLED STEREOTYPY CONTINGENT TIME-OUT

by: George Karaszi, David Charles Martinez, and Matthew VanZoest

Faculty Advisor: John Kapenga, Ph.D.

9:00 a.m. – 9:25 a.m.

Millions of people throughout the world are affected by Autism, and the treatment of stereotypy in children with Autism usually requires human interaction. The Microsoft Kinect 2 and Visual Gesture Builder can be used to automatically identify stereotypical behavior such as hand-flapping, and can be employed in a combination response-interruption redirection and differential reinforcement of other behavior protocol as treatment tool. Automated detection and interruption of target behavior allows one to study the effectiveness of treating stereotypy without human interaction.

GIGAPAN EDUCATION

by: Iain MacQuarrie and Marissa Morgan

Sponsors: Dror Yaron and Beatrice Dias, *CREATE Lab at Carnegie Mellon University*

Faculty Advisor: John Kapenga, Ph.D.

9:30 a.m. – 9:55 a.m.

Secondary-school students and teachers need a safe, secure website where they can experience the life of their peers around the world through GigaPan Panorama images. Using a simple point and shoot camera, students can create deep-zoomable panoramas called GigaPans. A Ruby on Rails website was created to provide a location and interface for sharing and discussing these GigaPan panoramas between students and teachers across the globe. By sharing experiences and culture through this technology, the website aims to create a community of technologically and culturally aware young people.

SMALL BUSINESS DATABASE RENOVATION

by: Alexander Lucy and Dan Pomeroy

Sponsor: Mike Turk, *Surplus Trading Corporation*

Faculty Advisor: John Kapenga, Ph.D.

10:00 a.m. – 10:25 a.m.

Small businesses often lack means to access their data when they need it in the field. This is remedied by moving away from old standards such as Microsoft Access into more modern solutions such as the LAMP stack for servers. More specifically, MySQL and PHP. These solutions were integrated into both a backend database, and frontend menu that is accessible from anywhere with a network connection. The end product being a website serving the same interface and inventory data through a web accessible solution.

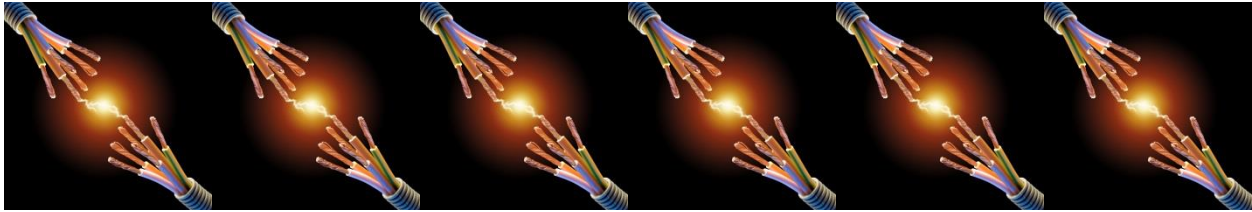
STREETLIGHT AND POWER OUTAGE MOBILE APP

by: Cale Campbell, Jordan Kidd, and Aaron Sieting

Faculty Advisor: John Kapenga, Ph.D.

10:30 a.m. – 10:55 a.m.

Power outage can be distressing. The ability to communicate the status of equipment can be beneficial to energy companies and customers alike. The Ionic framework was used to create an iOS/Android mobile app. Ionic uses JavaScript, HTML5, and CSS to create native-looking user interfaces alongside Cordova to access lower-level device functionality. Flask, Python, and SQLite are used on the server side to simulate and demonstrate user authentication. The application allows users to report the location of streetlights outages. It will also allow customers to stay updated about power outages including estimated duration and a map of the affected area.



ELECTRICAL AND COMPUTER ENGINEERING

Session Chair – Ralph Tanner, Ph.D.

Room D-204/205

PROGRAMMING PLATFORM FOR REAL-TIME ROBOT CONTROL

by: Prabhleen Nanhra and Chris Theunick

Sponsor: Tarun Gupta, Ph.D.

Faculty Advisor: Lina Sawalha, Ph.D.

9:00 a.m. – 9:25 a.m.

Coding for a robotics application can be a tedious and complicated process, especially for those who are relatively new to the subject. The programming platform for real-time robot control application aides the user in selecting the sensors that will be implemented on their robot and then generating the necessary code which will properly set up and utilize sensors and actuators. This platform has been completed to the point where it can produce the code to handle the navigation of a mobile robot.

ROBOTIC ARM IMPLEMENTED IN A PRODUCTION LINE

by: Joan Taveras, Homayoun Hasani, and Abdel Rahman Jaber

Faculty Advisor: Ralph Tanner, Ph.D.

9:30 a.m. – 9:55 a.m.

There is a need for an inexpensive solution with a more efficient hardware and operating system. This project has designed a Control-in-arm system to direct a Robotic-arm, interacting with a conveyor. The arm was implemented and built using Optical sensors, conveyor belt, servo motors and camera. The system was controlled by a Raspberry Pi Controller that used Python coding language. The objective of the arm, picking up objects in different sizes and dropping them in the proper area, was successfully achieved.

SUNSEEKER 2016 BATTERY PROTECTION SYSTEM

by: Anthony Beilman, Geoffrey Munkvold, and Scott Haver

Faculty Advisor: Bradley Bazuin, Ph.D.

10:00 a.m. – 10:25 a.m.

A next generation Sunseeker solar car has been developed by students to utilize some of the latest technology in renewable energy. Sunseeker's new lithium-ion battery system requires an intelligent battery protection system (BPS) that can actively monitor the battery to ensure safe operation. The BPS was designed on a single custom PCB with an embedded microprocessor and software to monitor battery cell voltage, current, temperature, and state of charge; provide operating state and status information for drivers and telemetry; and control power system relays. The BPS has been designed to ensure the safety of both the car and driver.

INDUCTION CHARGING OF UAV AND DUAL UAV CONTROL

by: James Kaijage, Nathaniel Scherer, and Bryan Yuen

Sponsor: Tarun Gupta, Ph.D.

Faculty Advisors: Raghvendra Gejji, Ph.D. and Tarun Gupta, Ph.D.

10:30 a.m. – 10:55 a.m.

Commercially available battery powered Unmanned Aerial Vehicles require users to remove the battery charging. Also, users can only control one device at a time. SPICE, C++, and CAD software were used to simulate, program, and fabricate a 75 watt wireless charging pad and dual UAV control system. The charging pad allows users to charge the battery without the need to remove it. The dual UAV control system enables users to fly two UAVs at the same time. These two systems pave the pathway for further development of high power wireless charging and multi UAV control.

MULTI-ROTOR UNMANNED AERIAL VEHICLE

by: Jacob Dean, Jimmy Mixter, and Jordan Barr

Sponsor: Tarun Gupta, Ph.D.

Faculty Advisors: Johnson Asumadu, Ph.D. and Tarun Gupta, Ph.D.

11:00 a.m. – 11:25 a.m.

An open-source Unmanned Aerial Vehicle (UAV) capable of performing at the same capacity as many top commercially available multi-rotor vehicles is developed. The system will allow users unfamiliar with multi-rotor vehicles to achieve flight and safely land, while also serving as a flexible foundation for other UAV projects and opening the door to features that are not currently available. Applications of drone technology are explored.



ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS

Session Chair – Betsy Aller, Ph.D.

Room D-201

DIE CASTING IN A BOX, REDUX

by: Christopher Carpenter and Peter Leblang

Sponsor: Jim Hoenle, *MFP Automation Engineering*

Faculty Advisor: Sam Ramrattan, Ph.D.

8:00 a.m. – 8:25 a.m.

A need to interest the next generation in the vital metal casting industry, coupled with costs of full-sized machines, have driven the need for a mobile die casting training aid (the DCIB). The hydraulic system of an existing 1/8 scale machine was upgraded, a new die was built, and the Visi-Trak system was converted to full control while maintaining a high level of safety. The die was designed (using SolidWorks), flow simulations were performed (using EKK simulation software), and process parameters and programming fail safes were set (using Visi-Trak software). The machine's mobility and ease of use will allow DCIB to be taken into K-12 classrooms to spark students' interest, and will maintain industry standards when used as a training aid in manufacturing settings.

EVALUATION OF CONTROLLED COUNTER GRAVITY CASTING (CCGC)

by: Eric Valentine and Adam Wise

Faculty Advisor: Sam Ramrattan, Ph.D.

8:30 a.m. – 8:55 a.m.

Because casting defects are extremely common in conventional cast metal parts, industry needs a process able to decrease these defects. The controlled counter gravity casting (CCGC) machine was previously fabricated to solve the problems of casting defects, but needed to be tested to prove its potential use in industry. Computer aided design (CAD) software such as SolidWorks and SolidCast were used in development of fixtures and test molds. Tooling and fabrication of the parts required CNC machining, plasma cutting, and welding. CCGC now reduces casting defects by smooth and controlled flow of clean metal into the part cavity.

MACHINE CONTROL TRAINING CENTER (MCTC)

by: Jonathon Warner, Christopher D'Agostino, and Elliott Klose

Sponsor: David Warner, *Homer Controls Inc.*

Faculty Advisors: Betsy Aller, Ph.D. and Kevin Barnes

9:00 a.m. – 9:25 a.m.

Programmable Logic Controls (PLCs) are used widely throughout industry, where they help to automate production. However, many students graduating out of Manufacturing Engineering programs at the university level are not receiving sufficient background or training on PLCs. Using SolidWorks, a mobile training aid (the MCTC) was designed and plans produced. This training aid can be brought into any college classroom to acquaint students with PLCs and provide hands-on practice in their basic electrical programming concepts. The MCTC may also be used in industry settings to train or to update the knowledge of those already working with PLCs.

SBOAT REVERSE ENGINEERING

by: Clay Binkowski, Sinan Mandwee, and Joshua Massey

Sponsor: Hussein Akl, MD, *Native Sun Manufacturing*

Faculty Advisor: Mitchel Keil, Ph.D.

9:30 a.m. – 9:55 a.m.

The SBOAT is a product designed to provide an underwater viewing experience without the vessel or its occupants being fully submerged. The current generation SBOAT is a hand-built fiberglass model. In order to facilitate a planned increase in production, a parametric CAD model was created by reverse engineering. A FARO 3D laser scanner was used to create a 3D point cloud representation of the SBOAT, which was then converted to a parametric CAD model using Geomagic Design X. The newly reverse-engineered SBOAT will serve as a model for future improvements and modifications.

SUSTAINABLE SHADE SEATING STRUCTURE (S.S.S.S.)

by: Steve Bromiel, Josh Ellison, Baxter Gill, and Souleyman Saddy

Sponsors: Nate Brooks and Mike Rekeny, *Landscape Forms*

Faculty Advisor: David Middleton

10:00 a.m. – 10:25 a.m.

The natural gathering place at Fountain Plaza had underutilized space for seating. Previously, a seating structure was commissioned by Western Michigan University and a design selected. Using SolidWorks, a solid model of the approved design was created in order to study and improve its manufacturability. The solid model underwent Finite Element Analysis to ensure structural stability and safety. The model allowed manufacturing issues to be anticipated and corrected, and was submitted for fabrication of the seating structure. The finished product will create a more inviting atmosphere in the plaza.

HYDRAULIC LOADING SYSTEM

by: Scott Geile, Nicholas Law, Remy McCay, and Ryan Schultz

Sponsor: *Parker Hannifin Corporation*

Faculty Advisor: Alamgir Choudhury, Ph.D.

10:30 a.m. – 10:55 a.m.

The functionality of hydraulic systems while under a load can be difficult to study. A hydraulic loading system was developed to record the behavior of a motor and pump at different operating conditions. Prior to this process, the performance was simulated using Automation Studio. Following the creation of the hydraulic loading system, LabView was partnered with pressure, flow-rate, and torque sensors to compile data. The results are used to better understand how the hydraulic motors and pumps perform under a load.

A HUNTING UTV TO SUPPORT WOUNDED VETERANS

by: Scott Billings, Jesse Cline, Ron Schweiger, and Ryan Wassink

Faculty Advisor: Betsy Aller, Ph.D.

11:00 a.m. – 11:25 a.m.

Wounded or disabled Veterans have their lives altered forever. Hunting and getting into the outdoors can provide comfort and companionship, and may be therapeutic to some of these Veterans. A Kawasaki Mule was selected and altered to reduce the difficulties these people face getting outdoors. Utilizing SolidWorks, designs for an actuated seat, shooting platform, camouflage system, and modified throttle and braking controls were built and installed. Main focus areas were eliminating the need to transfer in and out of a wheelchair and providing a mobile blind to get to the best hunting locations. This specialized vehicle will provide hunting opportunities to many disabled Veterans who otherwise would be unable to experience the fulfillment the outdoors provides.

MATERIAL FLOW OPTIMIZATION IN A JIT SYSTEM

by: Bill Butler, Kenneth Cao, Dave Heise, and Miles Staton

Sponsor: *Tenneco*

Faculty Advisor: Joseph Petro

11:30 a.m. – 11:55 a.m.

A local exhaust manufacturer provides products for automotive and commercial vehicle suppliers. The volume of daily production has grown, and with it the need for an improved material handling system. Using time and delay studies, Pareto analysis, flow diagrams, Plan For Every Part, and work scheduling, a precise delivery system was developed. In addition, a Human Machine Interface (HMI) was installed to improve response time of material handlers, reducing downtime and delays. Precise delivery routes using standard work will increase productivity of material handlers and line workers alike.

REDESIGN OF PORTABLE ALIGNMENT STANDS

by: Brad Kot, Nate Meinzer, Bert Mudroch, and Karl Riggs

Sponsors: Emilio Banchs, Oscar Ferreyra, and Zak Ford, *Cartek-Kodiak Engineering, Inc.*

Faculty Advisor: Jorge Rodriguez, Ph.D.

1:00 p.m. – 1:25 p.m.

The automotive service industry lacks a cost-effective way to perform a 4-wheel alignment efficiently using a standard 2-post lift. Cartek's Universal Service Bay (USB) strives to solve this problem and to exceed industry standards by reducing setup time and improving overall performance. Various prototypes were constructed with the assistance of CAD softwares PTC Creo and Siemens' NX. Finite Element Analysis (FEA) was also used to simulate stress, strain, and deformation to perfect overall model form and function. A finalized working prototype went through rigorous testing and a production-ready solution was provided.

3D BONE SURGERY SIMULATOR WITH FORCE FEEDBACK DEVICE

by: Jared Buck, Michael Foster, Spencer Hoin, and Benson Vande Streek

Faculty Advisor: Pavel Ikononov, Ph.D.

1:30 a.m. – 1:55 a.m.

Typical ways to practice bone surgery require synthetic or actual bones on which surgeons practice. An inexpensive and easy-to-use simulator would allow surgeons better opportunities to practice to achieve perfection. Therefore, a simulation was built in Unity 3D, which allowed use of real physics to act on bone models from CT scans of patients that were produced using 3D Slicer. A haptic feedback device was also programmed to allow the user to experience the feeling of a real surgery for unique situations. This new simulator costs less compared to other simulators on the market, and allows for personalized surgical situations.

CONVERTIBLE BIKE FRAME FOR CHAINLESS CHALLENGE

by: Chris Goulet and Joseph M. Hagye

Faculty Advisor: Jorge Rodriguez, Ph.D.

2:00 p.m. – 2:25 p.m.

The Chainless Challenge, a national competition for hydraulic-powered cycles, requires increasingly innovative and flexible designs in order to be competitive. Thus, a convertible frame design may allow the best chance for superior performance in the competition. A lightweight, aluminum modular bike frame was designed to be capable of easily converting from a recumbent seating position to a traditional upright cycle. These two modes are ideal for different races during the competition, i.e., sprint, efficiency, and endurance. Use of CAD software was integral in this development, and finite element analysis (FEA) was used to analyze the proposed design in both driving modes. Once the design was established, a conceptual prototype was built and tested.

BRAKING SYSTEM FOR A MOBILE ROBOT

by: Timothy Drahokoupil, Greg Frechette, Shaun Kovach, and Brett Rybski

Faculty Advisor: Tarun Gupta, Ph.D.

2:30 p.m. – 2:55 p.m.

National competitions encourage innovation and creativity in the growing field of mobile robots. Competition robots operate at speeds that require an effective braking system. The robots must be able to decelerate quickly and stop completely to prevent collision with other units. Different concepts were drafted in SolidWorks. The SolidWorks assemblies aided in computing the weight/force specifications and failure levels of the proposed systems to find which design would work best. The selected design allows a robot to stop quicker than its competitors and prevents outside forces from moving it out of position. Implementation of the braking system gives the operator more control, aiding in accomplishing designated tasks without compromising speed.



INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING

Session Chair – Azim Houshyar, Ph.D.

Room D-212

PROCESS EVALUATION & IMPROVEMENT

by: Samwel Muraguri, Shinya Nishizawa, and Kevin Ogwa

Sponsors: Tom Darby, Brian Devereaux; *TMD Machining*

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

10:30 a.m. – 10:55 a.m.

The project is a process improvement of a production cell in a company that manufactures aerospace products. The aerospace industry has process inefficiencies including excess inventory, wait time, and defect rates. IE tools such as facility planning, simulation, cost analysis, and time studies were used to collect data, perform analysis, and develop solutions. Based on the analysis conducted, specific recommendations were made to address these inefficiencies. The application of these recommendations have increased machine utilization time and reduced wait time, the number of scraps per order, and the production cycle time. The improvements have shortened the lead time, increased the throughput, and improved the company's profitability.

OVERALL EQUIPMENT EFFICIENCY IMPROVEMENT

by: Case Kleppe, Brandon O'Neill, Ben Page, and Satveer Thind

Sponsor: Chris Reed, *American Axle*

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

11:00 a.m. – 11:25 a.m.

American Axle assembly lines have been producing quality parts for years. The General Motors manufacturing line produces parts which are part of the production of GM vehicles. Utilizing knowledge of simulation, work design, engineering economy, ergonomics, operations control and management, the project focused on increasing overall equipment efficiency by decreasing the cost and improving the efficiency of this line.

INCREASING CAPACITY AT A HYDRAULIC REBUILD CENTER

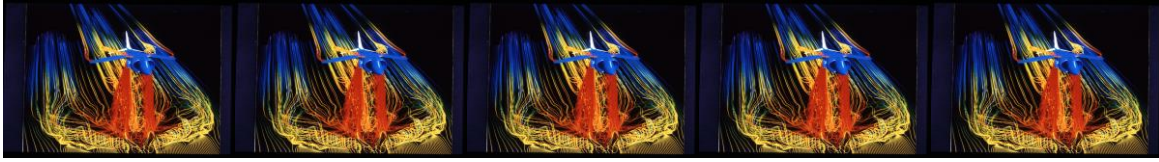
by: Sary Bugis, Holly Gadzinski, Matt Garvin, and Bandar Murad

Sponsor: Dave Enger, *Grand Traverse Hydraulics*

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

11:30 a.m. – 11:55 a.m.

A hydraulic rebuild center wants to increase capacity. This required analysis of the purchase of new equipment, development of a new shop layout, and the design of waste-eliminating tools and fixtures. This project will use traditional industrial engineering techniques to identify alternatives that will increase rebuilding capacity subject to the facility's physical and financial constraints.



MECHANICAL AND AEROSPACE ENGINEERING A

**Session Chairs – Claudia Fajardo, Ph.D., William Liou, Ph.D. and Peter Gustafson, Ph.D.
Room D-109**

AUTOMATIC IN PROCESS MEASUREMENT AND DIE ADJUSTMENT FOR DEEP DRAW METAL STAMPING APPLICATIONS

by: Benjamin Bregg and Ronald Yannone

Sponsor: Jeff DeVries, *Metal Flow Corporation*

Faculty Advisor: Javier Montefort, Ph.D.

9:00 a.m. – 9:25 a.m.

Variances in incoming raw material thickness can cause deep drawn metal stamped parts to become out of specification, causing the press to shut down and to be manually adjusted. Using Solid Edge, an automatic in process measuring station and die adjustment system were designed to eliminate the need for manual die adjustment when parts become out of specification. Using a linear variable differential transformer and programmed logic controller the measuring station records the critical dimension and sends feedback to the adjustment system. The completed design eliminates downtime for manual adjustment while ensuring all parts are within specification.

HIGH-ENDURANCE HELICOPTER FOR TOWING CAPABILITIES

by: Paul Blais, Christopher Pleasant, and Tyler Wall

Sponsor: Zeal Blades, *MSH USA*, and *Applied IE*

Faculty Advisor: Kapseong Ro, Ph.D.

9:30 a.m. – 9:55 a.m.

The applications of unmanned rotorcraft systems (URS) have grown in modern times, but many of these vehicles fall short in their endurance capabilities. For example, the US NAVY is seeking a high endurance URS platform which may tow various sensors systems for marine surveillance. In this project, a gas powered collective helicopter was chosen to develop a multi-functional high endurance URS platform, capable of a one hour flight endurance. Using the helicopter, an analysis of towed body effects was conducted to simulate sling loaded objects. Flight dynamic modeling based on computational fluid dynamic analysis were carried out to analytically study the motion of the towed body, and the results were compared to the flight testing. This application and more were considered in order to evaluate collective pitch helicopters for use in unmanned systems as part of a global movement towards expanding autonomous vehicle capabilities.

PUSH-ROD SUSPENSION REDESIGN FOR THE FSAE TEAM

by: Dustin Cook and David Wilson

Sponsor: Claudia Fajardo, *Formula SAE*

Faculty Advisor: Mitchel Keil, Ph.D.

10:00 a.m. – 10:25 a.m.

A car's suspension is one of the most important subsystems. Without proper suspension design car will handle poorly. The suspension geometry was designed using WinGeo, a suspension optimization suite, and then using the created geometry the suspension components were modeled in SolidWorks CAD software. Finite Element Analysis was used to prove proper design and selection of materials. The resulting models were then dynamically simulated in Adams software to confirm the suspension designs improvements. The new design will be provided to the FSAE team to produce a prototype vehicle for the yearly competition hosted by SAE international.

DESIGN OF A TANDEM ROTOR HOVERING VEHICLE

by: Steven Beuerle, Brent Kostich, Nicole St. Louis, and Andrew Verstraete

Faculty Advisor: Kapseong Ro, Ph.D.

10:30 a.m. – 10:55 a.m.

An investigation of thrust vectoring and an examination of existing tandem rotor dynamics was used to develop a structural body for a tandem rotor vehicle, derive the equations of motion of the system, and simulate a dynamic model of the vehicle. Also, a vehicle prototype was constructed while further application of remote control capabilities, flight testing, and control development were researched. This project can be scaled and applied to recreation vehicles of the future, specifically in the growing area of hover vehicle technology.

DEVELOPMENT OF AN AUTONOMOUS PROXIMITY OPERATIONS DEMONSTRATION SYSTEM (A-PODS)

by: Spencer Watza and Christopher Proctor

Sponsor: *Michigan Space Grant Consortium and Lee Honors College*

Faculty Advisors: Jennifer Hudson and Tianshu Liu

11:00 a.m. – 11:25 a.m.

An Autonomous Multirotor vehicle was developed in order to demonstrate the capabilities of low cost hardware and software performing proximity operations. The vehicle system was designed, built and tested to complete the mission of flying in a GPS-Denied environment. Using MATLAB/Simulink, system models were created for rapid prototyping, simulation and embedding. A SLAM Algorithm was implemented in order to perform situational awareness for the flying vehicle.

BRASS TO PLASTIC SLEEVE CONVERSION

by: Zachary Gordon and Jordan Nieboer

Sponsors: Marc Larson and Todd Bordewyk; *Humphrey Products*

Faculty Advisor: Pavel Ikononov, Ph.D.

11:30 a.m. -11:55 a.m.

A component used in pneumatic valves that is essential to their functionality is the sleeve. Traditionally, sleeves are machined from brass. Injection molding sleeves from plastic offers an opportunity to cut cost while providing the same quality and functionality. Tests were conducted to measure the roundness criteria required for functional parts. A material selection study was completed to provide a cost-benefit analysis of various materials, and mold flow simulation software was utilized to test various molding strategies. The results provided justification for changes made to the mold and resulting parts were built into valves to confirm their functionality and durability.

DESIGN OF A QUICK CONNECT COUPLER FOR A SURGICAL DRILL

by: Alex Auer, Zechariah Chester, Anderson Egerer, and Ryan Neal

Sponsor: Jim Beachnau, Mark Xie, *Stryker Instruments*

Faculty Advisor: Koorosh Naghshineh, Ph.D.

1:00 p.m. – 1:25 p.m.

The medical industry currently offers a wide range of engineered products including a quick connect for surgical drills. The drills are used for a variety of drilling and cutting operations during joint replacement and trauma surgeries. Keyed chucks are great in high torque applications but are slow to load. Keyless chucks are fast to load but can tear surgical gloves. An advantage of the quick connect over other types of connections is that it transmits high torque and is quick to load. A drawback associated with the quick connect is that the coupler does not offer a rigid connection between the drill and the cutting tool. This results in wobble of the cutting tool felt by the surgeon. Through multiple redesigns, use of finite element analysis (FEA), and testing of a prototype to validate performance the Total Indicated Runout (TIR) and wobble were reduced.

DESIGN AND FABRICATION OF AN INSTRUMENTED CANE FOR THE BLIND

by: James Bowman, Aaron Dean, and Nathan Wortman

Sponsor: Dae Kim, Ph.D. and Robert Wall Emerson, Ph.D.; *Western Michigan University Department of Blindness and Low Vision Studies*

Faculty Advisor: Koorosh Naghshineh, Ph.D.

1:30 p.m. – 1:55 p.m.

The most commonly used tool for navigation by the blind is the white cane. A greater understanding is essential in improving the design and performance of these canes. An existing cane was modified with integrated force and acceleration sensors, in order to study the relation between cane vibration characteristics and obstacle or drop-off detection. Data was gathered by these sensors, and then transmitted wirelessly to a computer workstation, where it was recorded and analyzed. Exertion of the forearm muscles was also measured. Care was taken to ensure that the cane sensors and transmitter are ergonomically unobtrusive for the user. The accuracy of the force, vibration, and muscular data was verified using laboratory test cases, and preliminary results were collected during actual navigation conducted using this instrumented cane.

OPTIMAL DESIGN OF AN AIR-TO-AIR THERMOELECTRIC GENERATOR FOR WASTE HEAT RECOVERY

by: Alicia Akhmatdinov, Mitchell Pitman, and Heather Potter

Faculty Advisor: Hosung Lee, Ph.D.

2:00 p.m. – 2:25 p.m.

An analysis of existing thermoelectric generator (TEG) designs shows a lack of air-to-air TEG designs in favor of fluid-to air designs. An optimal design model for an air-to-air TEG was constructed using MathCAD, a mathematical computer assisted design (CAD) package. An experimental model built on the basis of the optimal design model was then used to construct a full prototype. The prototype created provides an insight on the differences in design between air-to-air and fluid-air TEG designs and illustrates the unique benefits of air-to-air design and its disadvantages. This study provides the fundamental basis for future designs in thermoelectric technologies.

VALIDATION OF THE MKV AIRSHIP THROUGH FLIGHT TESTING – A HYBRID AIR VEHICLE DESIGN

by: John Harmon and Joseph Kawka, and Patrick Wewengkang

Sponsor: *Michigan Aerospace Corporation*

Faculty Advisors: Tianshu Liu, Ph.D. and William Liou, Ph.D.

2:30 p.m. – 2:55 p.m.

As the aviation industry push the limits of technology, hybrid flight platforms need to be developed to provide solutions to cater to the needs of the industry. The hybrid airship is an air vehicle that was designed with a combination of a conventional wing and an airship. The combination of aerodynamic and aerostatic lift allowed for high altitude flight at low speed as well as short take-off characteristics, providing solutions to the problems associated with personal, high altitude, and planetary flights. The main objective was to get the airship airborne and to optimize for sustained flight. Computer Aided Design software such as AutoCAD and SolidWorks were used to redesign the tail as the previous design suffered irreparable damage during ground tests. After years of design and development, the hybrid airship was able to take off and achieve a controlled flight.



MECHANICAL AND AEROSPACE ENGINEERING A
Session Chairs – Bade Shrestha, Ph.D. and Ram Sharma, Ph.D.
Room D-210

HYDROGEN CONVERSION FOR INTERNAL COMBUSTION ENGINES

by: Christopher Curran and Weston Genovese

Faculty Advisors: Bade Shrestha, Ph.D. and Muralidhar Ghantasala, Ph.D.

9:00 a.m. – 9:25 a.m.

The use of fossil fuels is an ever growing issue of engine emissions adding to the pollution of the environment. Hydrogen is a combustible fuel that can be extracted from water using electrolysis. A compact electrolysis device was designed to be directly attached to an IC engine. Computational solutions along with physical testing of an IC engine using this electrolysis device will prove hydrogen as a combustible fuel will result in little to zero emissions as well as the ease of transition from gasoline fuel to hydrogen fuel in the future to help preserve the environment.

SOLAR POWERED WATER FILTRATION SYSTEM

by: Kyle Messman, Matthew Bruinsma, Nicolas Landowski, and Travis Welton

Faculty advisors: Bade Shrestha, Ph.D. and Muralidhar Ghantasala, Ph.D.

9:30 a.m. – 9:55 a.m.

In many remote areas of the world it is a daily struggle to acquire water. A full scale system consisting of a solar powered submersible pump, a chlorine injection filter, and a storage tank was developed. This design will allow a small village to have a sustainable source of clean, safe water without the burden of walking miles to obtain it. A scaled down prototype design was created to test and improve the proposed system.

AUTOMATED LEAK BENCH DESIGN AND FABRICATION

by: Olivia Palajac and Thomas Webb

Sponsor: Matt Zerilli, *MANN+HUMMEL USA*

Faculty Advisor: Christopher Cho, Ph.D.

10:00 a.m. – 10:25 a.m.

Leak testing is an evaluation process that is used throughout many industries to control the quality of products. An automated leak bench was designed and fabricated for the testing of air filter systems, intake manifold systems, cabin filters, and sound-design components. The previous method of leak testing these components was tedious and time consuming for lab technicians, requiring manual adjustments of the pressure regulators and selection of flow meters. Through the use of LabVIEW programming it is now possible for the operator to set a target pressure, initiate the test, and have no further input for test completion.

ROCKING BABY CAR SEAT

by: Jimmy Muiruri and Mohammad-Bilal Suleman

Faculty Advisor: Judah Ari-Gur

10:30 a.m. – 10:55 a.m.

When in slow moving traffic, infants in a car seat tend to become fussy due to lack of car movement. The solution to this problem is to create movement to sooth the infant. A device that fits under the base of an infant car seat, which produced rocking motion, was designed and a prototype was built. The end user will be able to turn the device on/off and adjust frequency of motion. Also, the device has dual functionality for indoor use.

DYNAMIC ENERGY INPUT CONTROL SYSTEM

by: Nicolas Hughes and Daniel Jones

Sponsor: Anil Verma, *Parker Hannifin Corporation*

Faculty Advisor: Yufeng Hu, Ph.D.

11:00 a.m. – 11:25 a.m.

Parker Hannifin's Fluid System Connectors Division in Otsego, Michigan utilizes inefficient means of control on their coolant pump motors. These motors pull full load amps 24 hours a day, 365 days a year. Effectively implementing a Variable Frequency Drive and a downstream pressure transducer allowed a dynamic control loop to be set and programmed in a fashion that optimized the input frequency, yet still allowed the pump to operate in an efficient window via the specified pump curve. Adding this control system minimized energy costs and improves plant safety.

ENERGY INDEPENDENT HOME

by: Nathan Buist and Thomas Cseter

Faculty Advisor: Bade Shrestha, Ph.D.

11:30 a.m. – 11:55 a.m.

With energy prices increasing, people are at the mercy of the large corporate energy suppliers. Also with a greater emphasis on the environment, there has been a large push towards renewable energy substitutes. A house, based in the Kalamazoo area, has been designed to provide its own energy. The technology in this house contains a combination of solar, wind, and geothermal systems to meet all of the energy needs. This has eliminated the need to purchase energy from a cooperate supplier. The savings produced have allowed for a payback period to make this a good investment.

OPTIMIZATION OF HORIZONTAL AXIS WASHER SHAFT ASSEMBLY

by: Alexander Bernstein and Gavin Brinley

Sponsor: Steven Lentz, *Whirlpool Corporation*

Faculty Advisor: Daniel Kujawski, Ph.D.

1:00 p.m. – 1:25 p.m.

Wear is very common within appliances that are used in every household, even within a washer. A revised design was needed within the shaft assembly to help reduce the amount of deflection in the shaft due to larger loads and to minimize the wear on the shaft. Multiple designs were developed which were tested using computer simulation and experimental testing. Tradeoff curves were created based on load sizes, bearing spacer design, cost, and clamp loads to determine the optimal assembly. In the end, an optimized shaft assembly design was recommended.



CHEMICAL AND PAPER ENGINEERING

Session Chair – Andrew Kline, Ph.D.

Room D-208

CELLULOSE NANO FIBRILS ADDITION FOR IMPROVED BARRIER PAPER PROPERTIES

by: Kendra Fein

Sponsor: Paul Proxmire, Ph.D., *Appvion, Inc.*

Advisor: Margaret Joyce, Ph.D.

9:00 a.m. – 9:25 a.m.

Nanotechnology interest is growing rapidly because of its unique characteristics. Cellulose nanofibrils (CNF) are manufactured through specialized mechanical refining and could potentially replace non-renewable materials in a variety of applications. If the upscaling of CNF is successful to reduce its costs, CNF could provide many industries with a sustainable, biodegradable and exceptional material. This research project implemented CNF into the base sheet of paper to improve its barrier properties. Two pilot scale paper machine trials were performed to evaluate the runability of the CNF containing furnish on machine and resultant paper properties after lab-scale testing. If successful, the CNF containing paper could replace products such as plastic candy wrappers.

TITANIUM DIOXIDE REDUCTION IN FINE PAPERS

by: Trevor Cooper

Faculty Advisor: Raja Aravamuthan, Ph.D.

9:30 a.m. – 9:55 a.m.

Titanium dioxide is used across all fine paper grades to achieve the target opacity; however, it is very costly (\$1.50/lb.). Increasing the precipitated calcium carbonate (\$0.30/lb) dosage on each grade allowed for a noticeable reduction in titanium dioxide usage. These trials were conducted on twelve different grades, with them showing a fifteen to thirty-five pound per ton reduction in titanium dioxide usage. For each fine paper grade the mill produces, the amount of carbonate was increased by twenty to forty pounds per ton. The reduction in titanium dioxide application will result in a minimal savings of \$150,000 annually. These savings will be offset to a certain extent by the increased use of calcium carbonate. The net savings should amount to \$110,000 annually.

OPTIMIZING PAPER MACHINE ENERGY SPLITS BETWEEN STEAM AND POWER FOR SPECIALTY GRADES

by: Lexi Pierce

Faculty Advisor: Raja Aravamuthan, Ph.D.

10:00 a.m. – 10:25 a.m.

In a paper mill, it is important to understand energy requirements. Too often, a mill will calculate an average usage across all grades. This can be inaccurate, and lead to a false assumption of the profitability of these grades. For this study, steam and power data was gathered on three different specialty grades all made on the same machine. The data set was analyzed to determine process steam and power usage for each grade. The overall aim is to optimize the split of energy usage in an attempt to reduce the requirement of 182 lb steam.



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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.

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