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66th Conference on Senior Engineering Design

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Conference on Senior Engineering Design Project



You are invited to attend the sixty-sixth Conference on Senior Engineering Design Projects. The conference will be held from 8:00 a.m. to 4:00 p.m., **Tuesday, April 14, 2020** at the College of Engineering and Applied Sciences on the Parkview Campus of Western Michigan University.

The College of Engineering and Applied Sciences sponsors the conference to showcase the work of its graduating seniors, who are required to complete a capstone project that puts into practice what they have learned. Many of the projects are sponsored by business and industry. The conference is free and open to the public. You are welcome to attend all or part of the day's events. Reservations are not necessary.

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

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

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

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

Chemical and Paper Engineering	D-208	9:00 a.m. to 2:30 p.m.	pg. 5
Chemical and Paper Engineering	D-210	9:00 a.m. to 2:30 p.m.	pg. 8
Civil and Construction Engineering	D-115	8:30 a.m. to 12:00 p.m.	pg. 12
Computer Science	D-202	8:00 a.m. to 2:00 p.m.	pg. 15
Electrical and Computer Engineering	D-204	9:00 a.m. to 2:00 p.m.	pg. 19
Electrical and Computer Engineering	D-206	9:00 a.m. to 12:00 p.m.	pg. 22
Engineering Design, Manufacturing, and Management Systems	D-201	8:00 a.m. to 2:00 p.m.	pg. 24
Industrial and Entrepreneurial Engineering and Engineering Management	D-212	9:30 a.m. to 11:30 a.m.	pg. 28
Mechanical and Aerospace Engineering A	D-109	9:00 a.m. to 4:00 p.m.	pg. 30
Mechanical and Aerospace Engineering B	C-136	9:00 a.m. to 4:00 p.m.	pg. 34
Mechanical and Aerospace Engineering C	C-122	9:00 a.m. to 3:30 p.m.	pg. 39

A lunch break is scheduled from 12 p.m. to 1 p.m. There is a café available on site.

For more information about the conference, call Tamara Bergman at (269) 276-3248.

Brochure available electronically at:

<http://www.wmich.edu/engineer/news/seniors>

TIME	DEPARTMENT/ROOM		TOPIC
8:00	CS	D-202	TOWERPINKSTER HELP-HUB
	EDMM	D-201	INTEGRATED AUTOMOTIVE PHONE HOLDER
8:30	CCE	D-115	SITE DEVELOPMENT-5341 SOUTH 9 TH ST, KALAMAZOO, MI
	CS	D-202	BLACKTOP: A SIMPLIFIED PCB FOR CS 2230
	EDMM	D-201	DESIGN OF EXTERIOR RESIDENTIAL LIGHTING FIXTURE
9:00	CHP	D-208	PHARMACEUTICAL PLANT ELECTRICITY GENERATION
	CHP	D-210	FERMENTATION FOR AVASTIN AND LUCENTIS GENERICS
	CCE	D-115	WMU MAIN CAMPUS PARKING AND TRANSPORTATION IMPROVEMENTS
	CS	D-202	OIT-CX
	ECE	D-204	LOW COST E-FIELD METER
	ECE	D-206	LASER SPOT EMULATOR (LSE)
	EDMM	D-201	DIE RACKING SYSTEM SOLUTIONS FOR PROCESS TIME IMPROVEMENTS
	MAE A	D-109	AERODYNAMIC CHARACTERIZATION OF THE 2020 SUNSEEKER SOLAR CAR
	MAE B	C-136	PNEUMATIC PRESS CONTROL
	MAE C	C-122	OPTIMIZING AN AUTONOMOUS RC CAR
9:30	CHP	D-208	EXTRACTION OF CARBON DIOXIDE FROM THE ATMOSPHERE
	CHP	D-210	PRODUCTION OF LUCENTIS
	CCE	D-115	WESTNEDGE AVENUE FLOOD CONTROL AND RETENTION POND EXPANSION
	CS	D-202	CAE CHECK-IN-CHECK-OUT
	ECE	D-204	SELF-IMPLEMENTING AUDIO FILTER
	ECE	D-206	UAV AUTONOMOUS LANDING ON MOVING PLATFORM
	EDMM	D-201	DIE CASTING IN A BOX 4.0
	IEE	D-212	STRATEGIC SCHEDULING IN MANUFACTURING
	MAE A	D-109	RASC-AL THEME 1: SOUTH POLE MULTI-PURPOSE ROVER
	MAE B	C-136	FSAE DRIVETRAIN PERFORMANCE IMPROVEMENT
	MAE C	C-122	INSTRUMENTATION FIXTURES FOR AUTONOMOUS VEHICLE
10:00	CHP	D-208	STEAM VALVE THERMO-PERFORMANCE ANALYSIS
	CHP	D-210	PAPER RECYCLING FIBER RECAPTURE
	CCE	D-115	M-26 REALIGNMENT OVER THE FIRESTEEL RIVER
	CS	D-202	BUMBLEBEE, A WEB-BASED CONTENT AUTHORIZING APP
	ECE	D-204	VRDUINO CLASSROOM
	ECE	D-206	COST-EFFECTIVE DIY ELECTROMETER
	EDMM	D-201	THE FUTURE OF MOLD VENTING THROUGH 3D PRINTING
	IEE	D-212	ALUMINUM CASTING CHANGEOVER PROCESS IMPROVEMENT
	MAE A	D-109	AERODYNAMICS OF WIND LOADING ON BUILDINGS
	MAE B	C-136	LUNAR SURFACE OPERATION INITIAL SAMPLE COLLECTION DEVICE
	MAE C	C-122	SAE FORMULA CONTROL ARM: CARBON FIBER AND ALUMINUM INSERT REPLACEMENT
10:30	CHP	D-208	MANUFACTURING GRANOLA ADDITIVES FOR READY TO EAT CEREAL
	CHP	D-210	BIO-MASS TO BIO-OIL: DIRECT CONVERSION VS COMPANION COAL GASIFICATION
	CCE	D-115	KALAMAZOO RIVER VALLEY TRAIL-SEGMENT 6
	CS	D-202	GRADEBOOK AND ASSESSMENT DASHBOARD
	ECE	D-204	MULTICHANNEL PPG SYSTEM FOR MEDICAL APPLICATIONS
	ECE	D-206	IV CURVE TRACER
	EDMM	D-201	HYDRAULIC TRICYCLE FOR THE FLUID POWER VEHICLE CHALLENGE
	IEE	D-212	PROCESS IMPROVEMENT FOR HIGH VOLUME RESTAURANT CHAIN
	MAE A	D-109	SOLAR POWERED RIGID BODY AIRSHIP
	MAE B	C-136	DESIGN AND DEVELOPMENT OF VARIABLE MAGNETIC DEVICE FOR ACOUSTIC LEVITATION SYSTEM
	MAE C	C-122	SYNTHETIC BUNKER SAND TESTING
11:00	CHP	D-208	PRINGLES CHIP COOLING
	CHP	D-210	PRODUCTION OF A LIFE-SAVING EMERGENCY PHARMACEUTICAL
	CCE	D-115	MILHAM PARK RENOVATIONS
	CS	D-202	POTENT POTABLES INVENTORY SOFTWARE
	ECE	D-204	SUNSEEKER DISPLAY AND DRIVER CONTROLLER

	ECE EDMM IEE MAE A MAE B MAE C	D-206 D-201 D-212 D-109 C-136 C-122	THERAPEUTIC VIRTUAL REALITY PORTABLE, ECO-FRIENDLY BOOT DRYING DEVICE EVALUATION OF A PEDIATRIC MULTIDISCIPLINARY SPECIALTY CLINIC RENEWABLE WIND ENERGY FEASIBILITY ON WMU CAMPUS DESIGN AND VALIDATION OF SPRING STIFFNESS EVALUATION FIXTURE STATIC FLOW DATA ALLOCATION FROM FLOW-COMPACTIBILITY TEST
11:30	CHP CHP CCE CS ECE ECE EDMM MAE A MAE B MAE C	D-208 D-210 D-115 D-202 D-204 D-206 D-201 D-109 C-136 C-122	TECHNO-ECONOMIC ANALYSIS FOR SACCHARIFICATION OF BIOMASS MANUFACTURING FACILITY FOR A BIOPHARMACEUTICAL: MONOCLONAL ANTIBODY RAWSON'S KING MILL PARK FLOOD MITIGATION PARKVIEW VR PROJECT TEST LAB SMALL SCALE SOLAR TRACKING SYSTEM SCHEDULING FOR ASEPTIC MANUFACTURING OPERATIONS IMPROVING WIND TURBINE GENERATOR EFFICIENCY USING THE VENTURI AND NOZZLE EFFECTS THERMOELECTRIC HEATING & COOLING SYSTEM FOR ELECTRIC CARS COUNTER GRAVITY FILLING OF ALUMINUM
1:00	CHP CHP CS ECE EDMM MAE A MAE B MAE C	D-208 D-210 D-202 D-204 D-201 D-109 C-136 C-122	COMPARISON OF PRETREATMENT METHODS FOR CELLULOSIC ETHANOL PAPER RECYCLING FIBER RECAPTURE OPENTRAY SMART PARKING LOT SWING HINGE REDESIGN USING FRICTIONLESS BRAKING OPS CUBE ATTITUDE DETERMINATION AND CONTROL SYSTEM DESIGN INNOVATIVE DESIGN FOR HELMET-TO-HELMET IMPACT REDUCTION AUTOMATED IMPACT TEST ON SAND DISK
1:30	CHP CHP CS ECE EDMM MAE A MAE B MAE C	D-208 D-210 D-202 D-204 D-201 D-109 C-136 C-122	GENERATION OF ELECTRICITY FOR A FOOD INDUSTRY PLANT COMPARISON OF BIO-MASS TO BIO-OILS REACTOR SYSTEMS: DIRECT CONVERSION VS. COMPANION COAL GASIFICATION ARTIST CONTENT MANAGEMENT SYSTEM A PROTOTYPE MODEL OF THE 500 MW SOLAR FIELD FOR SHAYBAH OIL FIELD SAUDI ARABIA PROJECT MANAGEMENT AND PROCESS IMPROVEMENT FOR COMPLEX, LOW VOLUME MANUFACTURING LUNAR DISC: A DEVICE FOR INITIAL SAMPLE COLLECTION SEISMIC DAMPENING OF A SIMULATED EARTHQUAKE USING SUPER- ELASTIC NITINOL DESIGN OF A CARBON FIBER COMPOSITE MONOCOQUE CHASSIS FOR A FORMULA STYLE VEHICLE
2:00	CHP CHP CS MAE A MAE B MAE C	D-208 D-210 D-202 D-109 C-136 C-122	EXTRACTION OF CARBON DIOXIDE FROM THE ATMOSPHERE DEVELOPMENT OF A FLEXIBLE PRINTED PAPER-BASED BATTERY HERB GARDEN MONITORING SYSTEM BIOMEDICAL WEARABLE FOR NARCOLEPSY MORPHING AIRCRAFT WING USING SMART MATERIALS FORMULA SAE RACECAR SUSPENSION COMPLIANCE
2:30	MAE A MAE B MAE C	D-109 C-136 C-122	CEAS MODULAR DRONE PLATFORM DESIGN OF IMPACT ATTENUATOR FOR FORMULA SAE DESIGN OF A PORTABLE STERILIZER FOR ASIAN CUISINE APPLICATIONS
3:00	MAE A MAE B MAE C	D-109 C-136 C-122	HYDRODYNAMIC LUBRICATION TEACHING AID DEVELOPING A METHOD TO MEASURE SURFACE RESIDUAL STRESSES USING AN INSTRUMENTED INDENTATION TEST ADJUSTABLE RESONATOR FOR SUPERCHARGER INTAKE "CONFIDENTIAL PRESENTATION – CLOSED TO THE PUBLIC"
3:30	MAE A MAE B	D-109 C-136	SPUR GEAR-TRAIN DEMONSTRATION TOOL UNSPRUNG AERODYNAMICS MOUNTING PACKAGE FOR A FORMULA SAE PLATFORM

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 2020. 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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Zoobie's Old Town Tavern

CHEMICAL AND PAPER ENGINEERING-A

Session Chair – Said AbuBakr, Ph.D.

D-208

PHARMACEUTICAL PLANT ELECTRICITY GENERATION

by: Mohammed Alqarni, Cade Armstrong, Jacob Wubbeling, and Benjamin Wyse

Sponsors: WMU Robert M. Beam Power Plant

George Jarvis, Michael Walden, and Kevin Bridge

Faculty Advisor: Said AbuBakr, Ph.D.

9:00 a.m. to 9:25 a.m.

When a power plant announces that it will be closing its doors, the recipients of its service must either find another supplier or generate their own electricity. A pharmaceutical plant in the Kalamazoo, MI area, with a power requirement of 50 MWh, has decided on the latter. Natural gas, solar energy, and wind power were investigated as being potential fuel sources for the power generation. An in-house electricity generation process was designed and economically analyzed. The process is a modified Rankine cycle, which utilizes co-generation to minimize wasted heat and increase process efficiency.

EXTRACTION OF CARBON DIOXIDE FROM THE ATMOSPHERE

by: Sarah Koehler, Mitchell Lapham, Deija Morton, Alison Soares, and Kaitlyn Wolschlager

Sponsor: None

Faculty Advisor: Qingliu Wu, Ph.D.

9:30 a.m. to 9:55 a.m.

Carbon dioxide concentration has increased from 280 ppm to 411 ppm since 1850 and continues to rise. In this project, the extraction of carbon dioxide from the atmosphere is evaluated by designing an efficient process that utilizes sequestration. From an influx of ambient air, 800,000 metric tons of carbon dioxide per year is to be removed. The process incorporates four main reactions and a selected absorber that assists in the removal of carbon dioxide from ambient air. The execution of the process would reduce the amount of carbon dioxide in the atmosphere to prevent the rising global temperatures.

STEAM VALVE THERMO-PERFORMANCE ANALYSIS

by: Ashlee Adams, Benjamin Evans, Turner Slaughter, and Emily Stypinski

Sponsors: American Electric Power, Donald C. Cook Nuclear Plant, Katelin Kohn

Faculty Advisor: Qinglui Wu, Ph.D.

10:00 a.m. to 10:25 a.m.

Steam leaks occur in aging power systems due to heat energy loss from the valves of the system. A model was developed to determine the amount of heat energy lost in an aging power plant steam pipe valve system using PEPSE. In this project, the PEPSE model was used to determine the estimated energy that was lost due to seal leakage and general valve degradation. This energy was quantified, and an economic analysis of the valves was performed to determine the lost revenue experienced by the power plant and compared that to the cost of replacing the valves with newer, more efficient models.

MANUFACTURING GRANOLA ADDITIVES FOR READY-TO-EAT CEREAL

by: William Conkey, Nicholas Kuiper, Alex Logan, Trey Schmitz, and Richard Sutterfield

Sponsor: Kellogg Company, Matt Paxhia, Linnea Riddell, and Nicole Remily

Faculty Advisor: Peter Parker, Ph.D.

10:30 a.m. to 10:55 a.m.

The manufacturing of ready-to-eat cereal is a very competitive industry, resulting in manufacturers looking at many options to lower costs. A new process for the manufacturing of granola additives for cereals was developed, including the installation of new equipment in an existing space. This new process offers diversification to a Kellogg's manufacturing facility and allows for flexibility when creating and optimizing different granola additives.

PRINGLES CHIP COOLING

by: Gem Bhakri, Austin Dosh, Karla Irungaray, Henry Mistrzak, and Alexander Nurmikko

Sponsor: Kellogg Company, Nicole Remily, Brian Bartley, Walter Elms, Marvin VanDerHorst, Joey Carrol, and John Button

Faculty Advisor: Peter Parker, Ph.D.

11:00 a.m. to 11:25 a.m.

The demand for Kellogg's products is growing around the world, with an expected need to increase the production rate of some products by 30%. Cooling is a known bottleneck in the manufacturing of Pringle chips, so there is a need to find an efficient way to cool the chips before seasoning and the seaming of the can. The previous design is subjected to material and energy balance analysis. To address this issue a modification to the process is designed and recommended for implementation. This improved knowledge will lead to optimization of equipment performance and minimization of capital expenses.

TECHNO-ECONOMIC ANALYSIS FOR SACCHARIFICATION OF BIOMASS

by: Jessy Bamany, Bryce DeVore, Dylan Felt, Travis Hunt, and Zachary Kresslein

Sponsor: None

Faculty Advisor: Qiang Yang, Ph.D.

11:30 a.m. to 11:55 a.m.

Renewable energy is a rapidly expanding field of industry. Specifically, biofuels rely on the saccharification of organic material. Saccharification through enzyme hydrolysis of pretreated corn stover biomass will be used to produce commodity sugars. Produced sugars could either be sold or fermented to form ethanol biofuel. The focus of this project will be on product sugar yield and minimizing energy use. An economic analysis will convey the profitability of the project and the feasibility of the process.

COMPARISON OF PRETREATMENT METHODS FOR CELLULOSIC ETHANOL

by: Michael Eaton, India Mclaurin, Chad Sarquiz, Emily Schulte, and Merlin Steffes

Sponsor: None

Faculty Advisor: Qiang Yang, Ph.D.

1:00 p.m. to 1:25 p.m.

Petroleum alternatives such as cellulosic ethanol have the potential to revolutionize the energy industry. Due to the complex structure of the biomass, pretreatment is necessary to modify its structure to make it more susceptible to enzymes. Hot water and dilute acid are among the most common pretreatment methods and are the focus of this study. The treatments will be compared on the basis of cost, safety, efficiency, and overall feasibility.

GENERATION OF ELECTRICITY FOR A FOOD INDUSTRY PLANT

by: Ibrahim Aamri, Abdullah Aldar, Eyad Alfarsi, Khallad Alzahrani, and Turki Alzahrani

Sponsor: WMU Robert Beam Power Plant, George Jarvis and Michael Walden

Faculty Advisor: Said AbuBakr, Ph.D.

1:30 p.m. to 1:55 p.m.

Electricity is what makes any plant operate. Designs of power plants to generate 100 MW of electricity for a food plant by either using traditional natural gas or using renewable energy such as nuclear or solar are designed. Designs will include four options of power generation to a food plant. The preliminary engineering design includes economic analysis, safety and environmental constraints, and the use of engineering standards and specifications.

EXTRACTION OF CARBON DIOXIDE FROM THE ATMOSPHERE (FORMER AICHE DESIGN COMPETITION PROBLEM)

by: Bayan Alfaraj, Bader Alqernas, Khalifah Alsaad, Duke La, and Ahmed Shandudi

Sponsor: None

Faculty Advisor: Qingliu Wu, Ph.D.

2:00 p.m. to 2:25 p.m.

CO₂ levels are dramatically increasing due to industrialization and civilization, which is higher than at any point in at least the past 800,000 years. The DACE (Direct Atmospheric Carbon Extraction) plant is designed to remove 0.8×10^6 metric tons of CO₂ per year or approximately 1/500 of U.S. carbon reduction requirements from Kyoto accords. In this design carbon dioxide is captured using sequestration. The DACE case was based on an absorbent based design. This complete design will aid in reducing the CO₂ levels in the atmosphere, one of the factors causing the greenhouse effect on Earth

CHEMICAL AND PAPER ENGINEERING-B

Session Chair – James Springstead, Ph.D.

D-210

FERMENTATION FOR AVASTIN AND LUCENTIS GENERICS

by: Erin Dowd

Sponsor: None

Faculty Advisor: James Springstead, Ph.D.

9:00 a.m. to 9:25 a.m.

Pharmaceuticals are evolving as the technology to produce “humanized” proteins within cells improves. The anti-VEGF antibody inhibits blood vessel growth, making it useful for treating cancers and wet-AMD. Avastin (bevacizumab) and Lucentis (ranibizumab) are two major anti-VEGF pharmaceuticals on the market. In this project, the fermentation that is used in the production of their generic versions of these two medications is optimized, where cells are grown and harvested. By using Chinese hamster ovary cells for bevacizumab and E.coli for ranibizumab, resulting in important design differences between the fermentation of mammalian and microbial cell cultures. Economic analysis and design considerations help improve understanding of how host selection and novel research impact design in commercial pharmaceutical production.

PRODUCTION OF LUCENTIS

by: Deric Blanchett, Bassey Offiong, Audrey Searles, Zachary Sharp, and Gerald Tran

Sponsor: None

Faculty Advisor: James Springstead, Ph.D.

9:30 a.m. to 9:55 a.m.

In recent years monoclonal antibodies have been used as therapeutic agents to treat several conditions. These drugs have been used in several therapies, early examples including drugs such as ReoPro, an anti-clotting agent. Lucentis®, a biopharmaceutical made using humanized monoclonal antibodies, is used in the treatment of wet age-related macular degeneration as a blood vessel growth inhibitor. Production of Lucentis was analyzed and optimized for efficiency and economically viability. Processes were devised in order to maximize key economic measures in Lucentis production. Escherichia coli cells were used as a bacterial platform for the production of this drug.

PAPER RECYCLING FIBER RECAPTURE

by: Ryan Binkowski, Abigail Cortright, William Hettel, Erin Riley, and Ivan Soto

Sponsor: None

Faculty Advisor: James Springstead, Ph.D.

10:00 a.m. to 10:25 a.m.

In the papermaking process, fiber loss is inevitable. In order to reduce fiber loss, waste streams were evaluated to see if they contained usable fiber that could be re-routed back into the process. The waste streams that were analyzed included the top liner, back liner, and filler liner tertiary reject streams on the K1 machine, the under the machine common rejects on the K3 machine, and the stock preparation tertiary common reject. The streams with the most potential for fiber recovery were identified and the cleaners currently implemented were optimized to reduce furnish and landfill costs.

BIO-MASS TO BIO-OIL: DIRECT CONVERSION VS COMPANION COAL GASIFICATION

by: Alexander Cook, Jared Cousino, Gabriel Hayes, Cammi Schneider, and Noah Wood

Sponsor: None

Faculty Advisor: Abdus Salam, Ph.D.

10:30 a.m. to 10:55 a.m.

Bio-mass is produced in agriculture and forestry, and can be converted to use as a fuel substitute for petroleum. Direct Conversion of bio-mass was compared to companion coal gasification. The comparison used inputted information to estimate the conversion of bio-mass into bio-oils for both methods. The conversions were then compared to determine the more efficient method. Almost half of the United States' petroleum products were imported in 2011, which is economically dangerous. The simulations show which method of bio-oil production is able to reduce the reliance on foreign petroleum products the most.

PRODUCTION OF A LIFE-SAVING EMERGENCY PHARMACEUTICAL

by: Branden Bodfish, Lindsay Gubow, Lucy Fellows, Megan Stempky, and Tyler Quader

Sponsor: Nicholas Muller and Zachary Wolf, Pfizer

Faculty Advisor: James Springstead, Ph.D.

11:00 a.m. to 11:25 a.m.

The previous process by which a low-demand, life-saving medication is manufactured suffers from low yield as a result of poor resolution during column chromatography. A lack of repeatability and process knowledge exist due to the infrequency at which the processes are run. Students investigated potential technology solutions at a smaller scale to determine the cost benefit of running smaller batch sizes across three major steps involving partial oxidation, hydrolysis, and subsequent purification of the target molecule. Students worked directly with process chemistry experts, engineers, and vendors to determine likely product resolution and costing of chromatography technologies for implementation.

MANUFACTURING FACILITY FOR A BIOPHARMACEUTICAL: MONOCLONAL ANTIBODY

by: Christopher Clark, Michael Hettlinger, Dan Hogan, Allison Lemons, and Ana Mata

Sponsor: None

Faculty Advisor: James Springstead, Ph.D.

11:30 p.m. to 11:55 p.m.

Monoclonal antibody products are gaining an increased demand for various medical purposes that include, but are not limited to, cancer treatment, rheumatoid arthritis, and Crohn's disease. By researching the known small-scale process, various calculations can be done to determine sizing and production rates. From these calculations, our group designs a process to produce Lucentis Monoclonal Antibody at a lower and more affordable price for consumers. To ensure good manufacturing practices in the design of the plant, proper safety procedures would have to be followed. The largescale production of these monoclonal antibodies will lead to a larger market as well as the opportunity for expanding clinical studies.

PAPER RECYCLING FIBER RECAPTURE

by: Zachary Blakewell, Nicholas Catania, Geordin Craun, Erick Daschner, and Seth Eldridge

Sponsor: None

Faculty Advisor: James Springstead, Ph.D.

1:00 p.m. to 1:25 p.m.

In this project, a process is designed to recover fiber from current waste streams in a paper mill in order to reduce landfill costs and purchased fiber costs. Two separate proposals of fiber recovery systems for the paper mill were considered, recovering fiber from two alternative sets of waste streams. The purpose of processing the waste streams is to recover the usable fiber from the rejects prior to sending the rejects to the landfill.

COMPARISON OF BIO-MASS TO BIO-OILS REACTOR SYSTEMS: DIRECT CONVERSION VS. COMPANION COAL GASIFICATION

by: Ana Blasco, Carolyn Guzman, Gabriela Castillo, Nhimallan Suparamaniam, and Corey Tall

Sponsor: None

Faculty Advisor: Abdus Salam, Ph.D.

1:30 p.m. to 1:55 p.m.

As the production of petroleum in the United States is not reaching its current demand, alternative sources such as the production of bio-oils for biomass have grown in importance, given the fact that these could decrease the dependence on foreign oil. Coal pyrolysis and biomass pyrolysis are the two most widely used processes in the production of bio-oils. A novel process combining both methods has been designed to optimize the production of bio-oils, reducing both cost and complexity.

DEVELOPMENT OF A FLEXIBLE PRINTED PAPER-BASED BATTERY

by: JustOne M. Crosby

Sponsor: CASSS, MSGC, and LSAMP

Faculty Advisors: Massood Atashbar, Ph.D., Qingliu Wu, Ph.D., Brad Bazuin Ph.D., and Matthew Stoops

2:00 p.m. to 2:25 p.m.

Many of the batteries manufactured today are harmful to the environment, expensive, and too rigid to satisfy the evolution of the electronics industry. A battery that incorporates printed electronics technology, flexible characteristics, and fiber-based substrates (i.e. paper) in one cell is not commercially available. Zinc-based chemistry provided an excellent pathway to develop a disposable battery that can be discarded in existing waste streams. Printed techniques, flexible packaging, and fiber-based substrates have been combined to fabricate a zinc electrochemical cell that is thin, elastic, high performing, sustainable, and feasible for large scale manufacturing. A process to commercially produce these batteries is designed, and key economic indicators for the designed process are estimated.

CIVIL AND CONSTRUCTION ENGINEERING
Session Chair – Decker Hains, Ph.D., P.E., PMP, F.ASCE
Room D-115

SITE DEVELOPMENT-5341 SOUTH 9TH ST, KALAMAZOO, MI

by: Shon'Quase Dawkins, Nelson Hatheway, Christopher Henry, and Scott Morris

Sponsor: Stonefield Engineering & Design, J. Reid Cooksey

Faculty Advisors: Decker Hains, Ph.D., P.E. and Sid Bhandari, Ph.D.

8:30 a.m. to 8:55 a.m.

The owner of 5341 S. 9th St, Kalamazoo, Michigan is interested in re-developing the site to create business opportunities for potential tenants. The surrounding area includes many industrial businesses, hotels, and recreational facilities that attract customers. Various engineering skills are used to develop the site layout, calculate cost estimations, and analyze design alternatives. Alternatives include comparing a multi-tenant building to separate buildings, stormwater drainage options, and concrete as opposed to asphalt for the parking lot. The completed design provides the owner with a variety of choices that will best suit their needs.

WMU MAIN CAMPUS PARKING AND TRANSPORTATION IMPROVEMENTS

by: Noah Bushaw, Kevin Dwyer, Parker Foote, and Jonah Henckel

Sponsor: WGI, Greg Ehmke, PE

Faculty Advisor: Xiaoyun Shao, Ph.D., P.E.

9:00 a.m. to 9:25 a.m.

Student parking congestion has been a rapidly growing issue on Western Michigan University's Main Campus. The development of a new, multi-level parking facility near the Haworth College of Business will be designed to match the parking demands while improving traffic flow in the area. Project elements include a detailed design of the parking structure to ensure a pedestrian and automobile friendly environment. The project will provide adequate parking spaces to meet the growing demands of WMU students and faculty in the future. These improvements will not only increase transportation safety but also add an aesthetically pleasing feature to the landscape.

WESTNEDGE AVENUE FLOOD CONTROL AND RETENTION POND EXPANSION

by: Khalid Alquraini, Alex Hoelscher, Adam Jacqmain, and Carl Rasch

Sponsor: Portage Transportation and Utilities

Faculty Advisors: Hexu Liu, Ph.D. and Decker Hains, Ph.D., P.E.

9:30 a.m. to 9:55 a.m.

Significant flooding occurs frequently on South Westnedge Avenue near Portage Drive in Portage, Michigan. A hydrological analysis was performed to determine design flow rates and an additional storm sewer was designed to divert water from the road to an existing retention basin located east of the area. Design modification to the existing retention pond was made to accommodate the increase in demand. This project will alleviate the flooding and improve vehicular safety in the area.

M-26 REALIGNMENT OVER THE FIRESTEEL RIVER

by: Ethan Carpenter and Kyle Provost

Sponsors: Fishbeck, Inc. – Chris Sikkema and Michael Vought

Faculty Advisor: Valerian Kwigizile, Ph.D., P.E.

10:00 a.m. to 10:25 a.m.

Annual bridge inspections have identified the bridge over the Firesteel River as structurally deficient and in need of immediate replacement. There were no viable detours for traffic around construction, so the design requires a vertical and horizontal realignment of M-26 to match the new bridge, which will be constructed adjacent to the existing structure to allow traffic to continue to use M-26. A full plan set was prepared along with quantities and estimated cost. The completed project retires the existing bridge before failure and allows for continued use during and after completed construction.

KALAMAZOO RIVER VALLEY TRAIL-SEGMENT 6

by: Carolyn Nauta, Andrew Wright, and Jacob Zahm

Sponsor: AR Engineering, Whitney Pizalla and Jason Raleigh

Faculty Advisor: Valerian Kwigizile, Ph.D., P.E.

10:30 a.m. to 10:55 a.m.

As the public starts to focus on more environmentally friendly living habits, the demand for more nature trails and bike paths has risen. This section of the Kalamazoo River Valley Trail, located in Galesburg, Michigan, will be designed to incorporate the needs of the community by considering different trail layouts, materials, and parking options that would make the most economic and sustainable sense. The stormwater management system and affected culverts was assessed and redesigned to accommodate the new trail. This new addition to the trail is part of the Kalamazoo County master plan to connect two existing trails and ends in Fort Custer in Augusta, Michigan, with the eventual goal of connecting Lake Michigan and Lake Huron. This trail will benefit the local economies and increase the activity levels of the surrounding citizens.

MILHAM PARK RENOVATIONS

by: Sara Al Saadi, Benjamin DeVries, Tristan Richarson, and Stephen Timmer

Sponsor: The City of Kalamazoo Parks and Recreation Department, Patrick Mcverry

Faculty Advisors: Decker Hains, Ph.D., P.E. and Yufeng Hu, Ph.D., P.E.

11:00 a.m. – 11:25 a.m.

Milham Park is a popular destination for picnic goers and nature lovers in the Kalamazoo area. This 110-year-old park has structures and wetland areas that require renovation and new designs. This project includes plans for the removal of a weir in the Portage Creek, the construction of new playgrounds, and renovation of a large picnic shelter. HEC-RAS was used to model hydraulic flow of the Portage Creek. Several design options for the playgrounds and picnic shelter were considered. All of these improvements will be designed to keep Milham Park a sustainable and beautiful historic icon in Kalamazoo.

RAWSON'S KING MILL PARK FLOOD MITIGATION

by: Moosa Al Balushi, Jason Parker, and Thwin Zan

Sponsor: Fleis & VandenBrink, Jeff Wingard

Faculty Advisors: Upul Attanyake, Ph.D. and Decker Hains, Ph.D.

11:30 a.m. to 11:55 a.m.

Rawson's King Mill Park is a historic, picturesque park where St. Joseph County's restoration efforts are being threatened by flood waters. To protect the mill and neighboring residence, a fill of the flood plain, new adjustable spillway design, and flood gate were designed. Due to these major changes, alternative designs to the landscape and pedestrian bridges were developed. All design alternatives comply with ADA, FEMA, EGLE, and St. Joseph County regulations.

COMPUTER SCIENCE

Session Chair – John Kapenga, Ph.D.

Room D-202

TOWERPINKSTER HELP-HUB

by: Ryan Cwynar, Spencer Hunt, Ibrahim Itani, and Noah Wochaski

Sponsor: TowerPinkster, Ron Blake

Faculty Advisor: John Kapenga, Ph.D.

8:00 a.m. to 8:25 a.m.

Employees needed a way to install software and access technology resources quickly without the burden of waiting for IT support staff to respond. The self-help application was created to organize a list of software and plugins that can be accessed and downloaded by any employee. Furthermore, the application features a Google Calendar interface to eliminate scheduling conflicts that can occur when checking in and out of technology resources. The application will efficiently grant users access to software in a timely manner, reducing interruption in the work environment.

BLACKTOP: A SIMPLIFIED PCB FOR CS 2230

by: Tyler Henniges, Erron Johnson, Allin Kahrl, and Skyler Sheler

Sponsor: Computer Club WMU, Colin MacCreery

Faculty Advisors: Colin MacCreery and John Kapenga, Ph.D.

8:30 a.m. to 8:55 a.m.

WMU's Computer Organization & Assembly Language course (CS 2230) is taught using MSP430 microcontrollers and breadboards that students use to connect devices like lights and switches. While there are benefits to breadboarding, the student-configured hardware requires significant troubleshooting by the instructor while not representing any intended learning outcomes. A printed circuit board has been developed carrying the same peripheral devices, enabling both instructor and student to focus on low-level system programming without the added challenge of circuit design. Custom drivers for the board's EEPROM chip and a manufacturing plan for the boards themselves were also developed.

OIT-CX

by: Joseph Manto and Jared Teller

Sponsor: WMU Office of Information Technology Help Desk

Dylan Ledbetter and Tony Hendrix

Faculty Advisor: John Kapenga, Ph.D.

9:00 a.m. to 9:25 a.m.

The maintainability of information technology software services is critical to ensure long term software stability and usability. An application was built using modern tools such as Docker, Jest, and a user interface built in React, resulting in an intuitive method to maintain a previously built internal tool. A nonconflicting runtime environment with static dependencies was used to circumvent third party actions and updates. The union of all these tools provided a simple application interface to non-technical actors, allowing for manipulation of a mutable application environment and database, thus ensuring maintainability and usability.

CAE CHECK-IN CHECK-OUT

by: Jesse Meachum and David Mikovits

Sponsor: CAE Center

Faculty Advisor: John Kapenga, Ph.D.

9:30 a.m. to 9:55 a.m.

The CAE engineering computer lab is in high demand, and to help the CAE administrators web-based software was developed. This software will allow the lab attendants to quickly check out computers for students as well as see what computers are in use. A list of software available to each lab will also be displayed. The frontend utilized Javascript, React.js, and CSS, while the backend is based around the Python MVC Framework Django. This application will help the administrators to check in and check out students efficiently, quickly, and accurately.

BUMBLEBEE, A WEB-BASED CONTENT AUTHORIZING APP

by: Daniel Desnoyer, Erik Larson, Richard Schaefer, and Matthew Schutz

Sponsor: Maestro Design & Technology, Justin True

Faculty Advisor: John Kapenga, Ph.D.

10:00 a.m. to 10:25 a.m.

Many large organizations require some basic training for their employees that can be accomplished without background knowledge. A web-based content authoring application built with Angular 8, a TypeScript framework, was an ideal solution as specific modules could be created to provide accessible employee training. Modules can be created or modified from their original design to best fit their objectives. This allows for flexible adaptation when procedures or technologies change to avoid any unnecessary delay between creating and learning.

GRADEBOOK AND ASSESSMENT DASHBOARD

by: Holly Locke, Travis Siebenmark, and Sean Thompson

Sponsor: Lansing Community College, Karen Hicks-Director of Assessment

Faculty Advisor: John Kapenga, Ph.D.

10:30 a.m. to 10:55 a.m.

Sparse and variable data sets are common in higher education, a fact that limits the usefulness of what a college can do with student data. The data tool provides methods of delivering individual section-level data in an aggregate and cleaned format for reporting purposes. The Assessment Dashboard allows stakeholders throughout the college to access course-level information in a digestible and secure manner for use in improving course curriculum. The data tool is built with Python to quickly manage the processing of large amounts of data. The dashboard leverages SAS Visual Analytics to deliver data as a dashboard.

POTENT POTABLES INVENTORY SOFTWARE

by: Jacob Colegio, Kevin Stuible, and Scott Vanderweide

Sponsor: Zoobie's Old Town Tavern, Jim McMahon

Faculty Advisor: John Kapenga, Ph.D.

11:00 a.m. to 11:25 a.m.

Zoobie's Old Town Tavern is a small bar in Lansing, MI that has expressed difficulty in keeping track of their inventory of craft beers, wines, and liquors. Being a small bar, it is difficult to justify spending money on commercial software for this purpose. This project's goal was to provide an accurate, effective inventory tracking application specifically aimed towards Zoobie's needs as a small business. The project is a web-based application which manages access via the company iPad or a smartphone, providing the tools to quickly take accurate inventory of their products. The technologies used in this project were NodeJS, Angular JS, HTML/CSS, and Cloud Firestore.

PROJECT TEST LAB

by: Alex Boyd, Sean Kerrigan, Daniel Musallam, and Matt Wyant

Sponsor: John Kapenga, Ph.D.

Faculty Advisor: John Kapenga, Ph.D.

11:30 a.m. to 11:55 a.m.

Students in WMU's Senior Design course are given the opportunity to provide solutions to real world problems. The Testing Lab will allow them to approach security concerns on their applications and systems by either plugging in their host system to the network, or putting their applications on a test system already on the network and using the various security tools to scan for vulnerabilities.

OPENTRAY

by: Jason Gunderson and Jonathan Kelly

Sponsor: Metron Integrated Health Systems

Faculty Advisor: John Kapenga, Ph.D.

1:00 p.m. to 1:25 p.m.

OpenTray is a centralized web service for managing dining information of residents at multiple care facilities. OpenTray was implemented using Laravel, an open source PHP framework that follows the model-view-controller design architectural pattern. OpenTray lets users modify residents' dining schedules, create a list of what foods need to be prepared for each day, and print tray cards all from a simple and easy to use web browser interface.

ARTIST CONTENT MANAGEMENT SYSTEM

by: Andrew Baxter and Adam Johnson

Sponsor: Alistair Baxter

Faculty Advisor: John Kapenga, Ph.D.

1:30 p.m. to 1:55 p.m.

Every artist needs a platform to display their work. A web application was designed and created with Laravel to provide a simple interface that allows artists to upload and display their artwork as well as provide them with their own blog to discuss their techniques and current projects. The interface also allows an artist to inform their viewers of their current commission status and prices. This application will provide an artist with greater visibility and help them attract new followers and potential employers.

HERB GARDEN MONITORING SYSTEM

by: Vinicius Cicerone, Dylan LaFleur, and Paxton Plum

Sponsor: None

Faculty Advisor: John Kapenga, Ph.D.

2:00 p.m. to 2:25 p.m.

The drying process for many herbs leads to a significant reduction in vitamin content. In order to experience the full health benefits of fresh herbs at a reasonable price, many people grow their own herb garden at home. A system was created to automatically test growing conditions and keep the owner of the herb garden informed of those conditions through a mobile device. The completed system keeps growers informed of humidity, temperature, and soil moisture, allowing them to grow herbs in ideal conditions.

ELECTRICAL AND COMPUTER ENGINEERING-A

Session Chair ~ Massood Atashbar, Ph.D.

Room: D-204

LOW COST E-FIELD METER

by: Lie Jie Kim and Shawn Weese

Sponsor: None

Faculty Advisors: Pablo Gomez, Ph.D., Juan Villanueva-Ramirez

9:00 a.m. to 9:25 a.m.

All electrical devices leak some energy while operating. The radiated power of electronic devices must be measured to ensure that they remain at safe levels for human exposure and to limit unwanted interference with nearby equipment. A handheld E-field measurement device was designed to measure the strength of electric fields radiating at frequencies used by common consumer electronics. By limiting the measurement to a narrower frequency range, such devices can be made more economically than commercially available broadband sensing devices of this type.

SELF-IMPLEMENTING AUDIO FILTER

by: Andrew Kaczor and Jacob Menheer

Sponsor: None

Faculty Advisors: Ikhlal Abdel-Qader, Ph.D. and Benjamin Sanda

9:30 a.m. to 9:55 a.m.

A real-time speaker equalization system has been developed that improves sound quality in any environment. All speakers are imperfect and have irregularities in their audio reproduction that reduce sound quality. Objects and materials in a room with the speaker also further impact sound quality. These effects can be compensated for by using acoustic room treatment, but this imposes a high cost. The system will dramatically lower costs by using a microphone to measure a speaker's performance coupled with computer processing to dynamically adjust the audio being played. This compensates for the inaccuracies of the speaker and effects of the environment, increasing audio quality.

VRDUINO CLASSROOM

by: Alyaa Alosaimi and Anthony Lasiewicki

Sponsor: Dean Johnson, Ph.D.

Faculty Advisor: Dean Johnson, Ph.D.

10:00 a.m. to 10:25 a.m.

A virtual electrical engineering lab is visualized by employing a custom VR headset that is designed to improve the learning process of potential engineering students. The goal of this project was to create a VR classroom using a "VRduino" based headset to make the process of keeping the high barrier-to-entry relatively smooth for electrical engineering freshmen. Virtual laboratory environments were created using a software modeling program called LiveMaker. Some virtual laboratory instrumentation was also created, which can be manipulated in the virtual environment.

MULTICHANNEL PPG SYSTEM FOR MEDICAL APPLICATIONS

by: Christopher Kosik and Jose Ignacio Rodriquez-Labra

Sponsor: None

Faculty Advisor: Massood Atashbar, Ph.D.

10:30 a.m. to 10:55 a.m.

Peripheral arterial disease and atherosclerosis affect millions of Americans through the reduction of blood flow to the extremities and precipitate cardiovascular disease, the leading cause of death in the United States. A multichannel Photoplethysmography (PPG) sensor system was developed for monitoring and assessment of the subject's local extremity health factors with a focus on blood flow transient analysis. The utilization of multiple PPG sensors enables improved feature extraction and motion artifact filtering. Development of the modular PPG sensor system could lead to millions of saved dollars on healthcare through active monitoring and assessment of localized health factors.

SUNSEEKER DISPLAY AND DRIVER CONTROLLER

by: Nathan Heffington, Alec Kwapis, and Conner McCarthy

Sponsor: WMU Solar Car Team

Faculty Advisor: Brad Bazuin, Ph.D.

11:00 a.m. to 11:25 a.m.

Digital dashboard displays with critical driver information are found in all modern vehicles. The 2020 Sunseeker solar car required a next generation driver display that supports strict power, weight, and space considerations. The new Display and Driver Control (DDC) unit integrates in a single subsystem driver switches, controls, accelerator measurements, and CAN bus communications with interfacing for a 7-inch full-color LCD touch-screen display. CAN bus data and software programming allow multiple screens of customized vehicle information to be available to the driver. A custom-printed circuit board and housing has been designed, developed, and tested, resulting in a DDC with fewer electronic modules, fewer wires and cables, and significantly greater capability than before.

PARKVIEW VR

by: Abdullah Allahim, Ibrahim Albrahim, and Khalid Yousuf

Sponsor: None

Faculty Advisor: Dean Johnson, Ph.D.

11:30 a.m. to 11:55 a.m.

A virtual visit of elements of the Parkview Engineering Campus was developed using a custom headset that could view virtual environments created using LiveMaker, a 3-D content creation tool. Users can interact and manipulate the virtual 3D environment by using hand gestures enabled by flex sensors. The Parkview virtual model will support Virtual tours to assist potential tenants to view a range of properties, enhancing both digital and human dialogue with clients. The completed model provides tools that will aid in the future development of VR application such as in the residential and commercial real estate markets.

SMART PARKING LOT

by: Khalid Alharbi and Feras Alkhalaf

Sponsor: None

Faculty Advisor: Dean Johnson, Ph.D.

1:00 p.m. to 1:25 p.m.

A prototype Smart Parking Lot (SPL) which can help park up to four vehicles at any given time is presented. The SPL is based on IoT based cloud integrated smart parking system that is used to monitor and notify the state of availability of each single parking space. The SPL consists of a control unit and sensors that will help drivers find an empty parking spot in outdoor as well as indoor parking environments. The SPL will be a mobile application that can show the status of a parking lot.

A PROTOTYPE MODEL OF THE 500 MW SOLAR FIELD FOR SHAYBAH OIL FIELD, SAUDI ARABIA

by: Abdulaziz Alnaim and Abdulaziz Alanazi

Sponsor: None

Faculty Advisor: Raghvendra Gejji, Ph.D.

1:30 p.m. to 1:55 p.m.

A prototype of the Shaybah oil field solar system was designed and developed. The PSPV solar field ~~that~~ will generate stable power under various loads. Modeling and simulation were done of the solar inverter with Simulink and Simscape. Applied the simulation model to emulate the PV panel and designed the boost converter stage of the inverter. The model helped this design project to tune the controller to adjust the boost converter duty cycle to adjust voltage for changing loads. The main feature of the PSPV will be a boost converter that will contribute a stable power output, ultimately helping the future energy plan for Saudi Arabia.

ELECTRICAL AND COMPUTER ENGINEERING-B

Session Chair ~ Bradley Bazuin, Ph.D.

Room: D-206

LASER SPOT EMULATOR (LSE)

by: Nate Bunton and Marcus Gill

Sponsor: None

Faculty Advisor: Steve Durbin, Ph.D.

9:00 a.m. to 9:25 a.m.

A common visual aid tool used to enhance presentations and lectures is a laser pointer; however, these are limited when used in a large space that contains multiple projectors. The Laser Spot Emulator (LSE) is a device that utilizes a USB webcam and a laser turret to detect a laser spot on one projector screen and precisely reproduce the laser location on the other screen. The emulation of a laser spot is not only important for the entire audience, but it can also improve the delivery of the presenter's message.

UAV AUTONOMOUS LANDING ON MOVING PLATFORM

by: Tyler Carr and Zhi Yan (Ian) Leong

Sponsor: None

Faculty Advisor: Ralph Tanner, Ph.D.

9:30 a.m. to 9:55 a.m.

Increasing shipping efficiency using a sustainable approach is increasingly a goal. A drone has been created that can autonomously fly itself toward a moving platform that it can continuously track. Once the drone has reached the moving platform, it will start the landing sequence. Computer aided engineering software such as Simulink, MATLAB simulated the mathematical models. Sensors such as global position system (GPS) and a camera are used to locate the platform. The drone to moving platform, representing a drone to delivery truck, could change the way delivery routes are used in the shipping process.

COST-EFFECTIVE DIY ELECTROMETER

by: Ben Hahn and Emily Johnson

Sponsor: WMU Neurobiology Engineering Laboratory

Faculty Advisor: Damon Miller, Ph.D.

10:00 a.m. to 10:25 a.m.

An electrometer is used to generate minuscule currents for intracellular stimulation of biological neurons. An electrometer also enables simultaneous measurement of the neuron membrane voltage response. The cost of commercial electrometers may be prohibitive, particularly at the high school or introductory college level. Graduate student Lucas Essenburg designed a basic electrometer for \$210. This project focused on improving his design and developing a complete kit that can be consumer-built. The kit includes three printed circuit boards, electronic components, other hardware, and detailed assembly procedures.

IV CURVE TRACER

by: Alysia Zimmerman and Michael Callaway

Sponsor: None

Faculty Advisor: Bradley Bazuin, Ph.D.

10:30 a.m. to 10:55 a.m.

Solar cell, panel, and array expected efficiency and maximum power point can be determined by measuring the current-voltage (IV) curve. The IV Curve Tracer has been constructed for the Sunseeker Solar Car Team to support the manufacturing and testing of current and future solar panels for the car and determine car solar array performance. The battery operated, portable system uses an embedded processor to vary an electronic load and take voltage and current readings. The collected data are transmitted by the system using Bluetooth to allow a smart phone or tablet computer to relay the information for cloud storage or provide immediate visual feedback of the data collected.

THERAPEUTIC VIRTUAL REALITY

by: Albert Batu, Brandon Kerby, and Nicholas Kirkendall

Sponsor: WMU Department of Electrical and Computer Engineering, Dean Johnson, Ph.D.

Faculty Advisor: Dean Johnson, Ph.D.

11:00 a.m. to 11:25 a.m.

A variety of 3-D models have been produced and programmed for use with a custom-built VR headset which can monitor the heartbeat of the user from an infrared pulse sensing glove. This is an effort to explore the new field of Therapeutic Virtual Reality, an alternative medical practice that provides a unique and personalized experience to the user that may have health benefits in the areas of PTSD, anxiety, or even personal phobias.

SMALL SCALE SOLAR TRACKING SYSTEM

by: Zachary Mathews, Dane Maxwell, and Jalen Smith

Sponsor: Consumers Energy

Faculty Advisor: Pablo Gomez, Ph.D.

11:30 a.m. to 11:55 a.m.

Photovoltaic systems are becoming increasingly prevalent in today's society as a clean, emission-free alternative to generate electricity. Solar tracking is a type of technology used to increase the amount of energy produced by a photovoltaic generation system. In this project, a solar tracking system has been implemented into a previously built small-scale solar generation station using Arduino circuit boards programmed via MATLAB Simulink, as well as 3-D printing technologies. The solar tracking system will show how the addition of this technology to a solar farm can greatly improve its efficiency. It will also support further improvements to the ongoing project of a small-scale solar generation station for research and demonstration purposes.

ENGINEERING DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS

Session Chair – Betsy Aller, Ph.D.

Room D-201

INTEGRATED AUTOMOTIVE PHONE HOLDER

by: Grace Hansen, Jeffrey Oard, Luis Ruiz, and Jackson Sage

Sponsor: None

Faculty Advisor: David Middleton, IDSA

8:00 a.m. to 8:25 a.m.

The integration of smartphones in automobiles poses a gray area in prevention of smartphone use while driving. Following concept sketches, phone holder prototypes were created using CAD software and 3D printing. The proposed integration can safely merge smartphones with vehicles, providing an important feature in the automobile industry's goal of reducing accidents caused by texting while driving.

DESIGN OF EXTERIOR RESIDENTIAL LIGHTING FIXTURE

by: Nicholas Corey, Christopher English, Jordan Lentz, and Joseph Sulpizio

Sponsor: Cedaridge Condominium Association

Faculty Advisor: David Middleton, IDSA

8:30 a.m. to 8:55 a.m.

There's a need to replace outdated wall-mounted lighting fixtures and reduce upward blue light pollution. A local condominium association has asked for a redesign of their existing lights to match the mid-century modern aesthetics of their buildings. Several models were made for the community to vote on. Metal working, welding, and 3D printing were used to create the prototype light fixtures. Creo Parametric was used to create the final models as well as the 3D-printed light holder. The proposed light fixture uses a simple screw-in LED light bulb that provides 800 lumens and 2700 Kelvins of visible light, and complies with the International Dark Sky Association guidelines.

DIE RACKING SYSTEM SOLUTIONS FOR PROCESS TIME IMPROVEMENT

by: Tristan Bloomer, Nicholas Brookens, Blake Groves, Jared Heffelbower, Jeff Meldrum, and Patrick Shubnell

Sponsor: Amhawk Steel Fabrication, Inc., Regi Kurien, P.E.

Faculty Advisor: Timothy Greene, Ph.D.

9:00 a.m. to 9:25 a.m.

A local metal fabrication company was experiencing long changeover times in their press brake system, resulting from disorganized tooling, plant layout, and poor tool inventory. A time study was conducted and the plant layout was analyzed for potential non-value added time that could be eliminated from the process. New racks were designed and existing racks were reorganized to be placed in easily accessible locations. Following a tooling inventory audit, dies were identified by number and location, and then matched to specific racks in the shop. The new racking system was designed with the intent of lowering the average changeover time from 45 minutes to 15 minutes or less while promoting a safer work environment.

DIE CASTING IN A BOX 4.0

by: Daniel Niekrasz, Khoo Yee Keong, Van Mang, and William Mason

Sponsor: NADCA Chapter 3 and Visi-Trak

Faculty Advisor: Sam Ramrattan, Ph.D.

9:30 a.m. to 9:55 a.m.

Companies and educational institutions are looking for a miniaturized and mobile die caster to train students and employees on the operation of standardized casting technology. In order to make the die caster meet industry standards, an electrical enclosure was installed, electrical components were reworked, brackets were fabricated, a SolidWorks CAD model was generated, and an operations manual was created. Standardizing the machine included the use of tools such as SolidWorks, Gantt charts, fabrication tools, hydraulic schematics, and wiring diagrams. The completed project improved upon the learning material available to educate people on the die casting machinery that is currently used in industry.

THE FUTURE OF MOLD VENTING THROUGH METAL 3D PRINTING

by: Dillon Fort, Michael Francisco, Zachary Glascock, and Luis Hernandez

Sponsor: DENSO, Joseph Worden

Faculty Advisor: Jay Shoemaker

10:00 a.m. to 10:25 a.m.

The automotive injection molding industry is plagued with defects caused by the entrapment of volatiles. 3D-printed inserts with varied venting structures were created with the goal of alleviating these issues, as venting structures will help trapped gases escape injection molds. The types of ventable structures used were lattice structure, variable density, and vertical channels. Decision matrices were created to determine which venting structure best fit the specified criteria. Design and simulation software such as NX, Autodesk Netfabb, and Autodesk Moldflow were used to generate the product process and mold; and cost analysis and testing determined the best method of venting. Using the appropriate structure, companies will now be able to integrate this method of venting, which will lead to cost savings and the reduction of time and resources.

HYDRAULIC TRICYCLE FOR THE FLUID POWER VEHICLE CHALLENGE

by: Chris Frank, Eric Hudson, Chris Root, and Jason Topp

Sponsor: NFPA Education and Technology Foundation

Faculty Advisors: Alamgir Choudhury, Ph.D. and Jorge Rodriguez, Ph.D.

10:30 a.m. to 10:55 a.m.

This project team assembled and modified a tricycle to compete in the national Fluid Power Vehicle Challenge (FPVC) by increasing the vehicle's propulsion through hydraulic power. After removing the standard chain and sprocket drivetrain, a tricycle was altered to incorporate a hydraulic-powered system with the goal of increasing energy output while decreasing rider work. Tasks that were completed included designing a fluid circuit, calculating component efficiencies, and establishing best-suited gear ratio between pump and motor, all while reducing vehicle weight. The completed hydraulic tricycle can serve as an economical and alternative method of transportation.

PORTABLE, ECO-FRIENDLY BOOT DRYING DEVICE

by: Emily Barshaw, Nathan Hurlbert, Pierce Lonsbery, and Marissa Poth-Miller

Sponsor: KMS Designs, Inc., Karen Smoots

Faculty Advisor: Jorge Rodriguez, Ph.D.

11:00 a.m. to 11:25 a.m.

Wet boots can cause a multitude of medical afflictions and can be difficult to dry outdoors with existing dryer options. Military personnel, outdoor workers, and nature enthusiasts will appreciate a portable, eco-friendly boot drying device. Standard military boots were methodically wetted, and a variety of available boot dryers were analyzed using a pitot tube and moisture meter to measure air velocity and moisture content within the boots. Following testing, CAD software was utilized to develop multiple models before finalizing the prototype design. Users will not have to cut their adventures short; this powerful device will dry their boots anywhere.

SCHEDULING FOR ASEPTIC MANUFACTURING OPERATIONS

by: Kristofer Green, Alexander Morris, Sydney Rearick, and Nicholas Vorac

Sponsor: Pfizer, Inc., Robyn Cornish

Faculty Advisors: David Lyth, Ph.D. and Balmatee Bidassie, Ph.D.

11:30 a.m. to 11:55 a.m.

A local pharmaceutical manufacturer is planning to expand their workforce with the addition of a new manufacturing line, raising concerns of overcrowding their aseptic gowning rooms. These gowning rooms are environments free of harmful bacteria and are a vital part of manufacturing pharmaceuticals; they are required by federal and international laws. Following data collection, simulations, and modeling, a new schedule was created to accommodate an influx of additional workers. Using Six Sigma, 5S, lean manufacturing, and the design process, the new schedule was finalized using ProModel. The updated scheduling affects the quality of life for workers as well as the productivity of the processing line.

SWING HINGE REDESIGN USING FRICTIONLESS BRAKING

by: Jake Clark, Matt Hensler, Adrian Torres, and Steffan Werth

Sponsor: Landscape Forms

Faculty Advisor: David Middleton, IDSA

1:00 p.m. to 1:25 p.m.

A local outdoor furniture manufacturer's previously designed swing had been experiencing damaged components caused by misuse and over-extension of the swing radius. An redesign of the main hinge mechanism that controls the range of motion has been developed to replace the original design. Using the design process, computer-aided modeling software (SolidWorks) rendered brainstormed ideas into the final design. Finite element analysis (FEA) and physical testing were also used to analyze mechanical and material constraints. This newly engineered hinge extends the life of the product and protects it from any further misuse.

PROJECT MANAGEMENT AND PROCESS IMPROVEMENT FOR COMPLEX, LOW VOLUME MANUFACTURING

by: Joshua Bilski, Kevin Kuiper, Will Massey, Ben Sinclair, and Matt Tomkiel

Sponsor: Landscape Forms – Studio 431

Faculty Advisor: Larry Mallak, Ph.D.

1:30 p.m. to 1:55 p.m.

Developing a concrete, repeatable process is essential to a productive manufacturing system. Growth, coupled with increasing complexity, made timeline predictability and efficiency significantly more difficult for a manufacturer of custom outdoor environments. The project team deployed a blend of quantitative and qualitative techniques to improve the process. Working with designers, procurement, and manufacturing to obtain input, the team built a new process that is repeatable and allows for flexibility and predictability in complex projects.

**INDUSTRIAL AND ENTREPRENEURIAL ENGINEERING
AND ENGINEERING MANAGEMENT DEPARTMENT**

Session Chair – Dana Hammond

Room D-212

STRATEGIC SCHEDULING IN MANUFACTURING

by: Amjad Homad, Rami Alkatiri, and Mujahid Alrahbi

Sponsor: TecNiq Inc., Jeff Condon

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

9:30 a.m. to 9:55 a.m.

A local lighting manufacturer wants to improve its scheduling strategy to meet anticipated growth in demand for their top selling products. The existing facility was studied using fundamental Industrial Engineering tools including work design, cost analysis, and forecasting. A forecasting system was developed to improve the existing forecasting method. Also, an aggregate plan was developed to reduce shortages and related costs.

ALUMINUM CASTING CHANGEOVER PROCESS IMPROVEMENT

by: Ben Jeglic, Anna Ryan, and Cortney York

Sponsor: Kaiser Aluminum, Jeff Heimstra

Faculty Advisors: Dana Hammond and Jim Burns, Ph.D.

10:00 a.m. to 10:25 a.m.

Kaiser Aluminum is an extrusion plant that casts, presses, and fabricates aluminum products. Changeover from one cast size to another frequently requires lengthy periods of downtime, which negatively impacts throughput. An expected increase in demand will make the reduction of changeover time of strategic importance. A thorough evaluation using root cause analysis, time and motion studies, and other industrial engineering tools resulted in the improvement and standardization of the changeover process.

PROCESS IMPROVEMENT FOR HIGH VOLUME RESTAURANT CHAIN

by: Lydia Bajema, Victoria Blaine, Madison Post, and Brenna Roti

Sponsor: Chick-fil-A, Idris and Marcia Rashid, Scott Leep

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

10:30 a.m. to 10:55 a.m.

Chick-fil-A Westnedge is a restaurant that opened its doors in 2017. As the restaurant continues to increase sales, problems associated with operating procedures also continue to grow. Data indicates the most significant problem is increased food waste and related costs. Using root cause analysis, process improvement techniques and operational methods, the team has developed improved procedures and recommendations to reduce the operating costs for Chick-fil-A Westnedge.

EVALUATION OF A PEDIATRIC MULTIDISCIPLINARY SPECIALTY CLINIC

by: Sean Fitzsimons, Paul Geyer, Sam Olmstead

Sponsor: WMed Health Pediatric Multiple Disability Care, Lukas Swoboda

Faculty Advisors: Tycho Fredericks, Ph.D. and Dana Hammond

11:00 a.m. to 11:25 a.m.

Quality of care, clinical efficiency, and profitability play vital roles in the success of any healthcare organization. To evaluate the Pediatric Multiple Disability Care Clinic at WMed Health, root cause analysis, time studies, flow mapping, and cost were examined. The results from this quantitative study provided evidence-based recommendations to positively impact patient care and the organization alike.

MECHANICAL AND AEROSPACE ENGINEERING-A

Session Chairs a.m.– William Liou, Ph.D. and Tianshu Liu, Ph.D.

Session Chairs p.m. – Jennifer Hudson, Ph.D. and Peter Gustafson, Ph.D.

Room D-109

AERODYNAMIC CHARACTERIZATION OF THE 2020 SUNSEEKER SOLAR CAR

by: Grace Dybing and Kyle Lyman

Sponsor: None

Faculty Advisor: William Liou, Ph.D.

9:00 a.m. to 9:25 a.m.

In order to remain competitive, the Sunseeker Solar Car must find ways to improve efficiency by decreasing drag. The computational fluid dynamics software Star CCM+ was used to test a new asymmetric catamaran design. The analysis focused on the effects of gaps between the body panels of the car on the overall drag of the vehicle. Different wheel shape cutouts were also studied. The resulting models allow for future design decisions to be implemented that will help the solar car prevail in its events.

RASC-AL THEME 1: SOUTH POLE MULTI-PURPOSE ROVER

by: Jonathan Krebs, Nathan Kueterman, Hannah Powell, and Chase Raglin

Sponsor: None

Faculty Advisor: William Liou, Ph.D.

9:30 a.m. to 9:55 a.m.

A rover was designed to support autonomous and manned exploration of the lunar south pole while also expanding crewed capabilities future missions. The ability to deploy infrastructure, excavate lunar regolith, explore varied terrain, and perform high priority science were achieved through the validation of an omnidirectional and module-based concept. An optimized structure was created with componential testing/validation performed in SOLIDWORKS. The rover and pertinent systems were designed with the capability to be deployed using state of the art launch vehicle technologies. Per competition requirements, the rover and its systems will cost less than \$300M given current manufacturing processes.

AERODYNAMICS OF WIND LOADING ON BUILDINGS

by: Kayla Burch, Timothy Holleque, and Anna Litvinova

Sponsor: WMU Research and Excellence Award

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

10:00 a.m. to 10:25 a.m.

With the patterns of weather changing, strong winds are formed more than ever before while causing significant damages to homes, and in worst cases, leading to loss of lives. A three-dimensional model of a standard-sized residential building, with an emphasis on the roof, was constructed using CATIA, a computer-aided design program. The model was used in the WMU wind tunnel to obtain the aerodynamic characteristics. The effect on the aerodynamic characteristics of the building due to adding solar panel and parapet prototypes was evaluated. The interpretation of lift, drag, skin friction, and pressure gradient provides safer models for building construction.

SOLAR POWERED RIGID BODY AIRSHIP

by: Ryan Rothley and Arthur Woodworth

Sponsor: None

Faculty Advisor: Tianshu Liu, Ph.D.

10:30 a.m. to 10:55 a.m.

The transportation sector produces a significant amount of greenhouse gas emissions. A conceptual design of a rigid body solar airship capable of lifting 80,000lbs was created using Computer-aided Design software. The model was analyzed under structural and aerodynamic loads using Finite Element Analysis to determine an optimal design. With further development, this airship design can reduce emissions in the transportation sector.

RENEWABLE WIND ENERGY FEASIBILITY ON WMU CAMPUS

by: Meshal Alkinani, Jacob Norman, and Pritesh Patil

Sponsor: None

Faculty Advisor: Tianshu Liu, Ph.D.

11:00 a.m. to 11:25 a.m.

Wind energy is one of the clean energy sources. The project focused on the availability and feasibility of harvesting wind energy on WMU Parkview campus to advise on the installation design, placement, and cost. The study area was narrowed down using the Computational Fluid Dynamics (CFD) simulation. Parkview and its surrounding structures were modelled in Solidworks and tested using average windspeed and direction. Data was verified using wind tunnel testing and LabVIEW was used to control the SSWT. WMU provided the required resources. Flow patterns and speed were compared to simulated data. Collected data can be used for future planning and installation of wind-focused alternative energy sources at the Parkview campus and its vicinity.

IMPROVING WIND TURBINE GENERATOR EFFICIENCY USING THE VENTURI AND NOZZLE EFFECTS

by: Jack Born, Austin Henderson, and Alec Moore

Sponsor: None

Faculty Advisor: Kapseong Ro, Ph.D.

11:30 a.m. to 11:55 a.m.

Design improvements for wind turbine generators has been considered. Since these turbines are designed based on constant weather conditions, the efficiency may be not be at its best considering unstable and varying weather conditions. The wind flow was analyzed and studied around building using computer modeling and analysis software package (ANSYS), which includes location and height of building structures and wind speeds. The flow field analysis results of both the venturi and nozzle effects are used to understand effective wind characteristics to operate the turbines even at the off-design conditions. The turbine blades are designed in SolidWorks and tested in ANSYS to achieve drag reduction such that the wind's energy can be more efficiently harnessed. Using these two engineering analysis methods, an improved system design is suggested to create a cheaper and more efficient wind turbine generator to harness clean energy.

OPS CUBE ATTITUDE DETERMINATION AND CONTROL SYSTEM DESIGN

by: Reza Jalali, James Mostek, and Andrew Wilchynski

Sponsor: None

Faculty Advisor: Jennifer Hudson, Ph.D.

1:00 p.m. to 1:25 p.m.

The OPS-Cube mission focuses on the development of a new plasma plume diagnostics technique to measure engine performance and health on board a spacecraft. Throughout the mission, the OPS-Cube spacecraft must measure and control its attitude and rotation rate in order to perform orbital maneuvers and communicate with ground stations. The goal is to design an Attitude Determination and Control System (ADCS) to enable this capability. A variety of hardware and their configurations on boards the spacecraft are also designed to ensure mission success.

LUNAR DISC: A DEVICE FOR INITIAL SAMPLE COLLECTION

by: Daniel Hagan and Jameel Saeed

Sponsor: NASA Johnson Space Center

Faculty Advisor: Jennifer Hudson, Ph.D.

1:30 p.m. to 1:55 p.m.

With NASA's plan to return to the moon with their upcoming manned Artemis mission, the need has arisen for new tools during lunar surface operations. An aluminum arm capable of being stored in a pocket on an astronaut's suit was manufactured to satisfy one specific NASA request. The tool can efficiently retrieve and store lunar regolith samples during emergency situations where time on the Moon's surface is extremely limited. The design is lightweight, resistant to lunar dust, and has been tested underwater to simulate a lunar environment. It will also be tested in the Johnson Space Center's Neutral Buoyancy Laboratory.

BIOMEDICAL WEARABLE FOR NARCOLEPSY

by: Jacqueline Barreto and Chandler McFalls

Sponsor: None

Faculty Advisor: Peter Gustafson, Ph.D.

2:00 p.m. to 2:25 p.m.

One-in-2,000 people in the US suffers from a neurological disorder called Narcolepsy, which results in the sudden uncontrollable urge to fall asleep. The Narcolepsy smart sensor creates alerts through a user-friendly wearable device to counteract a person's uncontrollable tendency to fall asleep. This interaction results from the compilation and interpretation of data received as a result of frequent heart rate and oxygen saturation monitoring. After the data is collected, it can be stored and filtered utilizing statistical analysis software. This prototype sensor is the only device to use probabilistic modeling to allow the wearer to predict oncoming subconscious relaxation.

CEAS MODULAR DRONE PLATFORM

by: Brody Brewis, Karl Calkins, and John Hungerford

Sponsor: CEAS

Faculty Advisor: Peter Gustafson, Ph.D.

2:30 p.m. to 2:55 p.m.

Unmanned aerial drones are becoming more commonly used in the delivery industry. Most applications have begun to utilize multi-rotors to deliver a payload to a destination. While these drones are generally optimized for load capacity, the drones are not optimized for maximum horizontal flight speed when unloaded. This drone has been designed to address this issue by rotating the direction of the blades to convert lift ability to forward thrust. Additionally, this drone is reconfigurable for a wide variety of applications to promote further development and research into drone systems.

HYDRODYNAMIC LUBRICATION TEACHING AID

by: Craig Herweyer, Brandon Joseph, and Nick Williams

Sponsor: None

Faculty Advisors: Judah Ari-Gur, D.Sc. and Parviz Merati, Ph.D.

3:00 p.m. to 3:25 p.m.

In a journal bearing the bearing surface is separated from the rotating shaft by the lubricant film generated by this rotation, in a process known also as hydrodynamic lubrication. These bearings are commonly used to minimize friction in rotating machinery. A demonstration device was designed and built to show the effects of shaft rotational speed and oil viscosity on the clearance and bearing load, with a focus on the hydrodynamic lubrication phenomena.

SPUR GEAR-TRAIN DEMONSTRATION TOOL

by: Edward McWilliams and Nicholas Schnobel

Sponsor: None

Faculty Advisor: Judah Ari-Gur, D.Sc.

3:30 p.m. to 3:55 p.m.

The spur gear-train demonstration tool shows students in the Machine Design course how gear position affects gear contact, motion, and shaft loads. The demonstration tool includes a gear-train of spur gears mounted on shafts and powered by a crank mechanism. One of the gears on the demonstration tool is able to be added or removed to show the effects of a more complex gear-train. This design benefits students learning about gear systems and transmission design.

MECHANICAL AND AEROSPACE ENGINEERING-B

Session Chairs a.m. – Richard Meyer, Ph.D. and Muralidhar Ghantasala, Ph.D.

Session Chairs p.m. – Pnina Ari-Gur, D. Sc. And Jinseok Kim, Ph.D.

Room C-136

PNEUMATIC PRESS CONTROL

by: Alec Craig and George Delgado

Sponsor: Humphrey Products, Dave Phaneuf

Faculty Advisor: Richard Meyer, Ph.D.

9:00 a.m. to 9:25 a.m.

Industrial manufacturing and assembly processes typically utilize pneumatic presses and clamps. Presses are cycled by two-hand control devices requiring simultaneous and synchronized inputs from both hands of the machine operator for their protection. Often, such control devices execute these functions electronically, which require the addition of an electrical supply to the pneumatic machine; in contrast, a pneumatic control unit operates on the existing machine supply air. A pneumatically powered control unit was designed to provide an output pressure only when synchronous (within 500 milliseconds) inputs from both hands are applied. Various operating scenarios were simulated to develop and refine controller performance characteristics and assess risk based on industrial standards and regulations. A physical test was employed to ensure the design requirements were met. The control unit is easily inserted into existing pneumatic circuitry, functional at a wide range of input pressures, protected against easy defeat of the safety provided (i.e. anti-tie-down), and cost-effective to manufacture on a large scale.

FSAE DRIVETRAIN PERFORMANCE IMPROVEMENT

by: Mason Chase, Gabe Hendrickson, and Matthew Irvin

Sponsor: Western Michigan University Formula SAE Team

Faculty Advisor: Richard Meyer, Ph.D.

9:30 a.m. to 9:55 a.m.

The FSAE race car team uses a drivetrain that has a higher safety factor than that required for a limited life race car. The drivetrain factor of safety is directly related to mass assuming that it is a function of the shape of the drivetrain components. Thus, there is an opportunity for performance improvement by reducing the mass of dynamic components to achieve lower car mass and lower translational and rotational inertias. All dynamic components of the drivetrain, from the piston to the drive axle sprocket, were considered for mass and inertia reduction. Component designs were modified and then simulated to verify they met the required life. Specifically, the improvements were validated through kinematic simulation of the drivetrain and compared against the performance of the original components.

LUNAR SURFACE OPERATION INITIAL SAMPLE COLLECTION DEVICE

by: Jasmine Henderson and Bao Trinh Quan Nguyen

Sponsor: None

Faculty Advisors: Richard Meyer, Ph.D. and Muralidhar Ghantasala, Ph.D.

10:00 a.m. to 10:25 a.m.

The US intends to return to the moon in 2024 in preparation for the trip to Mars. One crucial target for the astronauts is to collect a lunar soil sample from moon's surface. NASA has specified the need for a soil collection tool that fits within a 6 in x 6 in x 2 in volume, uses only manual power, is entrapment free without any sharp edges, and should be able to obtain a sample of 0.5 in to 2 in diameter within 2 minutes. The design is a cylinder device containing a gripper that pierces the topsoil with a scoop (blade), grabs and stores the sample in a vacuum condition like a capsule. This design was evaluated based on its ability to function successfully in a lunar environment simulation with an abrasive-dust terrain and testing if the soil is obtained is within an acceptable tolerance range. The complete model is capable of encapsulating the sample within the specified size dimensions and time frame.

DESIGN AND DEVELOPMENT OF VARIABLE MAGNETIC DEVICE FOR ACOUSTIC LEVITATION SYSTEM

by: Joshua Brower, Alannah Chenez, Francisco Mendoza, and Nickolas Roussey

Sponsor: Argonne National Laboratory, Kamlesh Suthar

Faculty Advisor: Muralidhar Ghantasala, Ph.D.

10:30 a.m. to 10:55 a.m.

Nanotechnology is a growing research area and magnetic ferrofluid particle behavior has been extensively studied due to their possible applications in technology, biomedicine, and chemistry. To facilitate testing of the magnetic nanoparticle distribution in a ferro fluid using small angle x-ray scattering (SAXS), we designed a magnetic device to be integrated into an existing acoustic levitation system. Magnetic device comprises of Helmholtz coils as well as electromagnetic coils having a magnetic core, which are fixed onto a designed experimental frame. Simulation was carried out using ANSYS software and the design calculations were performed using analytical methods. The device will be tested in an experiment on the Advanced Photon Source beamline to perform SAXS characterization of nanoparticle distribution in a ferrogel sample.

DESIGN AND VALIDATION OF SPRING STIFFNESS EVALUATION FIXTURE

by: Nathan Dalton, Benjamin Schintgen, and Jared Winters

Sponsor: None

Faculty Advisor: Muralidhar Ghantasala, Ph.D.

11:00 a.m. to 11:25 a.m.

Precise knowledge of the linear stiffness of springs used in various mechanical systems is necessary to perform accurate engineering predictions of the machine's performance. An assembly of a motor actuator, encoder position feedback, and load cell were integrated through an Arduino microcontroller into an experimental setup to examine a spring's stiffness by relating force output and its displacement. Effortless operation and safety features were implemented using an optimal and efficient algorithm with an appropriate code. Accuracy and precision were determined through rigorous testing and statistical analyses. The final output is a robust tool that can reliably assess spring stiffness.

THERMOELECTRIC HEATING & COOLING SYSTEM FOR ELECTRIC CARS

by: Joe Abbey, Anna Agge, and Alanis Peguero

Sponsor: None

Faculty Advisor: HoSung Lee, Ph.D.

11:30 a.m. to 11:55 a.m.

Electric vehicles are rapidly gaining popularity due to environmental advantages however, design of current HVAC system limits the battery life. A compact solid-state device based on the Peltier effect is proposed. The device is composed of thermoelectric modules along with heat sinks to effectively accomplish both heating and cooling with a simple change in the voltage polarity. The system was designed using ANSYS simulation and MathCAD, then tested with the construction of a simplified version for demonstration. This HVAC alternative presents potential advantages and with further optimization can be used in future electric vehicles.

INNOVATIVE DESIGN FOR HELMET-TO-HELMET IMPACT REDUCTION

by: Rajan Alazmi, Blake Agy, and Kyle Demski

Sponsor: WMU Undergraduate Research Excellence Award

Faculty Advisor: Pnina Ari-Gur, D. Sc.

1:00 p.m. to 1:25 p.m.

American football has high rates of concussions which are strongly linked to CTE (Chronic Traumatic Encephalopathy). A super elastic material, known as Nitinol, was used to reduce the impact due to its energy absorption properties. Nitinol was positioned between the padding and exterior shell of the helmet in critical positions of impact during helmet-to-helmet contact. The new design reduced the amount of impact acceleration observed within the helmet and, as a result, will reduce the amount of CTE cases in American football.

SEISMIC DAMPENING OF A SIMULATED EARTHQUAKE USING SUPER-ELASTIC NITINOL

by: Nathan Kincaid and Andy Lin

Sponsor: National Science Foundation

Faculty Advisor: Pnina Ari-Gur, D. Sc.

1:30 p.m. to 1:55 p.m.

Natural disasters post a great threat to structures and as a result to humans. To improve the structural integrity of buildings, bridges, and other structures, energy absorption mechanisms must be put in place. One way of doing this, is to support them with super-elastic material. The objective of this project was to investigate the effectiveness of using super-elastic Nitinol as a protection of structures against seismic damage under a wide range of temperatures. Simulated earthquake, operating on a 3-story building was used to test the Nitinol and, compared with steel bracing, to prove its dampening capability.

MORPHING AIRCRAFT WING USING SMART MATERIALS

by: Abdulrahman Alanazi and Joseph Zvonek

Sponsor: None

Faculty Advisor: Pnina Ari-Gur, D. Sc.

2:00 p.m. to 2:25 p.m.

The wing of an aircraft is a very complicated structure due to the numerous functions it must provide for various flight conditions, such as takeoff/landing, climbing, or turning. Traditional aircraft wings are equipped with flaps, slats, and ailerons that provide additional control for the pilot. Eliminating these control surfaces by implementing an adaptable wing leads to a reduction in weight and mechanical complexity. A flexible wing was constructed using smart materials to transform to the desired configuration for various flight conditions. Simulated wind tunnel testing was conducted on the wing and compared to traditional methods to determine effectiveness of design.

DESIGN OF IMPACT ATTENUATOR FOR FORMULA SAE

by: Aaron Scovill and Jeffrey Tavarez

Sponsor: None

Faculty Advisor: Jinseok Kim, Ph.D.

2:30 p.m. to 2:55 p.m.

Impact attenuators (IA) are used to protect vehicles, operators and non-crushable components inside the vehicle in the event of crashes. An impact attenuator for a formula SAE car was optimized using the Topology Optimization method in ANSYS, a finite element analysis software, to maximize the performance of IA. The functional requirements of Formula SAE engineering design competition are met in the new design. This project proves the viability of topology optimization to minimize material usage while still meeting functional requirements.

DEVELOPING A METHOD TO MEASURE SURFACE RESIDUAL STRESSES USING AN INSTRUMENTED INDENTATION TEST

by: Jet Chayawattana and Salch Mohamed

Sponsor: None

Faculty Advisor: Jinseok Kim, Ph.D.

3:00 p.m. to 3:25 p.m.

Residual stresses occur after removing the cause of the stresses. The residual stresses are crucial in the long-term behavior of materials. Currently, residual stresses are measured in a destructive manner such as the hole drilling method. The process of measuring residual stresses can be resource intensive. In this project, a non-destructive method to measure residual stresses was developed using a numerical simulation. ABAQUS, a finite element analysis software, is utilized to conduct numerical instrumented indentation test using a spherical style indenter. The results from the simulation will help with developing an algorithm to measure residual stress.

UNSPRUNG AERODYNAMICS MOUNTING PACKAGE FOR A FORMULA SAE PLATFORM

by: Abdul Esatanboli, Drew Plensdorf, Patrick Murphy, and Ty Swenor

Sponsor: None

Faculty Advisor: Jinseok Kim, Ph.D.

3:30 p.m. to 3:55 p.m.

The Western Michigan University Formula Society of Automotive Engineers (WMU FSAE) team required the design of a low drag method to mount a full aerodynamics package on the FSAE car, so the downforce avoids passing through the suspension system. Solidworks and ANSYS were the main program used for designing and analyzing, by applying computational fluid dynamics (CFD), and testing the components needed to create an un-sprung aerodynamics mounting design. The components of the current wing configuration were torsion tested in the FSAE laboratory and the results from simulation were compared and validated.

MECHANICAL AND AEROSPACE ENGINEERING-C

Session Chairs a.m. – Christopher Cho, Ph.D. and Judah Ari-Gur, D. Sc.

Sessions Chairs p.m. – Christopher Cho, Ph.D. and Daniel Kujawski, Ph.D.

Room C-122

OPTIMIZING AN AUTONOMOUS RC CAR

by: Alexandra Adent, Taylor Arsenault, Juan Manuel Ortega, and Samuel Pavletic

Sponsor: None

Faculty Advisor: Zachary Asher, Ph.D.

9:00 a.m. to 9:25 a.m.

94% of car accidents are caused by human error with a total of 40, 237 fatalities in 2017 in the United States alone. Self-driving vehicles take the human error out of the equation and their influence on the automotive industry is already evident. Applying autonomous driving equipment and exploring artificial intelligence capabilities of a raspberry pi were used to develop a small-scale self-driving car. This car has the ability to avoid objects as well as self-learn a designed racetrack. The final product created provides an in depth look at current autonomous vehicle capabilities and the technology's great potential.

INSTRUMENTATION FIXTURES FOR AUTONOMOUS VEHICLE

by: Bret Korytkowski, Diaa Alshubbar, and Samuel Wagner

Sponsor: None

Faculty Advisor: Zachary Asher, Ph.D.

9:30 a.m. – 9:55 a.m.

The future of driving is changing rapidly with emerging autonomous vehicle technology. The purpose of the design was to create a solution to the instrumentation mounting needs for an experimental autonomous vehicle. An effective and reliable mounting fixture was designed, fabricated, and implemented onto the car allowing for easy adjustability for the radars, lidars, and cameras the car would need to operate. Every design that was implemented onto the car was tested for bending and vibration. The completed design can be modified in the future by adding additional instrumentation using the same mounting brackets as the other sensors.

SAE FORMULA CONTROL ARM: CARBON FIBER AND ALUMINUM INSERT REPLACEMENT

by: Ian Mackey, Carson Malinowski, and Frederick Pajtas

Sponsor: None

Faculty Advisor: Javier Montefort, Ph.D.

10:00 a.m. to 10:25 a.m.

The SAE Formula car is a competition racing vehicle that focuses solely on performance, which is limited by many aspects, a major one being weight. To reduce the weight of the car, and thus increase performance, the steel control arms on the suspension were replaced with carbon fiber and aluminum. The control arms were designed using Solidworks, tested for simulated failure using Abaqus and Solidworks, then tested again physically in both compression and tension to find the critical load. The weight reduction gained from the replacement allowed for faster acceleration and a greater top speed for the formula car.

SYNTHETIC BUNKER SAND TESTING

by: Luis Avdulla and Jordan Born

Sponsor: Weaver Material Service, Inc. Jeff Cieplewski

Faculty Advisors: Sam Ramrattan, Ph.D. and Judah Ari-Gur, D. Sc.

10:30 a.m. to 10:55 a.m.

Currently, when playing golf, the bunker sand performs much differently at different moisture levels. In an attempt at uniformity, a company believes to have developed a synthetic bunker sand that performs similarly when dry and at a high moisture content. A test apparatus was designed using an impact tester and a customized golf club fixture, to collect data on how the synthetic bunker sand performs at different moisture content levels. Due to the designed test method, the synthetic bunker sand was successfully analyzed and compared to the natural bunker sand.

STATIC FLOW DATA ALLOCATION FROM FLOW-COMPACTIBILITY TEST

by: Ryan Conkey and Dustin Thorne

Sponsor: East Jordan Iron Works

Faculty Advisors: Sam Ramrattan, Ph.D. and Judah Ari-Gur, Ph.D.

11:00 a.m. to 11:25 a.m.

A Flow-Compactibility test was developed for foundry grade sand. This test measures the static and dynamic flowability of the green sand. During static testing a standard AFS tube is filled while four receptacles collect sand samples as it flows through individually sized channels. The sample is then dynamically tested by compressing it under 1MPa. Utilizing amplified load cells and data acquisition Arduino circuitry, a sensor was designed to record and sort data from each static sample. This aids in developing an index for the static and dynamic flow data for the sand to be rated for manufacturer usability.

COUNTER GRAVITY FILLING OF ALUMINUM

by: Juan Wei Foo, Puravindran Sandaran, and Zheng Qie Wong

Sponsor: WMU Metal Casting Lab

Faculty Advisors: Sam Ramrattan, Ph.D. and Judah Ari-Gur, D. Sc.

11:30 a.m. to 11:55 a.m.

Conventional gravity pouring of metal causes many problems, two of them are turbulence and air entrainment, which creates biofilms and porosity. This can cause stress-risers and defects inside the casting that lowers product quality. An existing semi-automated counter gravity filling system was used to produce an aluminum 356 casting using both green sand and chemically bonded sand molds. The smooth quiescently flow of aluminum upwards into the mold reduces turbulence and therefore reduce the negative defects associated with conventional pouring. This technology will be implemented in the Metal Casting Laboratory at WMU.

AUTOMATED IMPACT TEST ON SAND DISK

by: Owen Herner and Max Reed

Sponsor: General Motors Saginaw Metal Castings, Robert Smith

Faculty Advisors: Sam Ramrattan, Ph.D. and Daniel Kujawski, Ph.D.

1:00 p.m. to 1:25 p.m.

Defects in metal castings are costly problems in the industry. The materials used for this process is silica sand and a chemical binder. Although silica binder systems are cheap and available, the sand is reclaimable; but material is susceptible to variance. This project recreates the standardized Charpy impact test with a linear automated system that eliminates the safety issues that come with the original test. The American Foundry Society cookie samples enter a metal housing unit where they are tested for impact energy and disposed of once the test is complete. This test is efficient enough to be used in a lab or assembly line. Precision sand casting for powertrain components is the fastest growing segment of metal castings.

DESIGN OF A CARBON FIBER COMPOSITE MONOCOQUE CHASSIS FOR A FORMULA STYLE VEHICLE

by: Alex Carline, Mitchell Hiller, and Riley Masters

Sponsor: None

Faculty Advisor: Daniel Kujawski, Ph.D.

1:30 p.m. to 1:55 p.m.

Western Michigan University's Formula SAE team, Bronco Racing, designs and manufactures a formula-style vehicle to compete annually at an international collegiate design and racing competition. In order to remain competitive, Bronco Racing required a lighter chassis for the 2021 vehicle. To achieve this, the full 2020 carbon fiber monocoque chassis system was redesigned to be lightweight while considering packaging constraints and chassis stiffness. The determined monocoque geometry was modeled using Solidworks and the carbon composite was simulated, tested, and verified using ANSYS and quasi-static load frame testing. A comprehensive manufacturing plan was then produced, allowing Bronco Racing to manufacture the monocoque to design specifications.

FORMULA SAE RACECAR SUSPENSION COMPLIANCE

by: Eric Bontrager and Austin Schmidt

Sponsor: Western Michigan University Formula SAE Racing Team, Alex Carline

Faculty Advisor: Daniel Kujawski, Ph.D.

2:00 p.m. to 2:25 p.m.

Suspension systems greatly impact a vehicles performance in racing conditions. The Formula SAE racecar's suspension is subjected to intense loading as the racecar advances through a course. Idealized 3D models of the front and rear suspensions were generated using ANSYS modeling software, however they were inaccurate. Identical suspension components from previous years' racecar models were put through stress tests to determine the actual compliance of the components. The computer model was altered to more accurately represent the feedback from the forces experienced under track conditions. Using the improved model, the suspension was improved to meet the Formula SAE team's requirements.

DESIGN OF A PORTABLE STERILIZER FOR ASIAN CUISINE APPLICATIONS

by: Liyu Wang and Jiadong Zhou

Sponsor: None

Faculty Advisor: Claudia Fajardo, Ph.D.

2:30 p.m. to 2:55 p.m.

Chop sticks are widely used as eating utensils. In communal dining, also intrinsic to many Asian cultures, inserting the chopsticks multiple times in a single dish increases the possibility of cross-contamination. A portable apparatus for disinfecting wood chopsticks from *Escherichia* (E.) *Coli* bacteria was designed. Multiple disinfecting methods were evaluated, and special emphasis was placed on the need for fast decontamination to preserve eating flow in a communal setting.

ADJUSTABLE RESONATOR FOR SUPERCHARGER INTAKE

by: Austin Ott, Bryar Peters, and Jacob Ridenour

Sponsor: Eaton, Xin Hua, Ph.D.

Faculty Advisor: Koorosh Naghshineh, Ph.D.

3:00 p.m. to 3:25 p.m.

“CONFIDENTIAL PRESENTATION – CLOSED TO THE PUBLIC”

Superchargers, on internal combustion engines, create air pulsation resulting in noise radiation that can propagate into the cabin of a vehicle. This is an undesirable trait for most consumers and can be reduced by installing a resonator in the intake ducting. A tunable intake Helmholtz resonator that can be adjusted to a target frequency for any supercharger operating point was designed in order to reduce the tonal noise sourced from the supercharger intake. This device was manufactured from plastic material and inserted into the test stand ducting path. The product reduces the tonal noise, proven through measured insertion losses.



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

Electrical and Computer Engineering (269) 276-3150

- Computer Engineering
- Electrical Engineering

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

- Industrial and Entrepreneurial Engineering

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

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

Mechanical and Aerospace Engineering (269) 276-3420

- Aerospace Engineering
- Mechanical Engineering

Chemical and Paper Engineering (269) 276-3500

- Chemical Engineering
- Paper Engineering
- Graphic and Printing Science

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

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



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

CEAS Mission

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

CEAS Vision

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

CEAS Four Cornerstones

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

CEAS Administration

- Interim Dean of Engineering and Applied Sciences: Dr. Steven Butt
- Chair of Civil and Construction Engineering: Dr. Osama Abudayyeh
- Chair of Computer Science: Dr. Steven Carr
- Chair of Electrical and Computer Engineering: Dr. Bradley Bazuin
- Interim Chair of Engineering Design, Manufacturing Engineering, and Management Systems: Dr. Tim Greene
- Interim Chair of Industrial and Entrepreneurial Engineering and Engineering Management: Dr. Tim Greene
- Chair of Mechanical and Aerospace Engineering: Dr. Koorosh Naghshineh
- Chair of Chemical and Paper Engineering: Dr. Li Kecheng

CEAS Contact Information

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