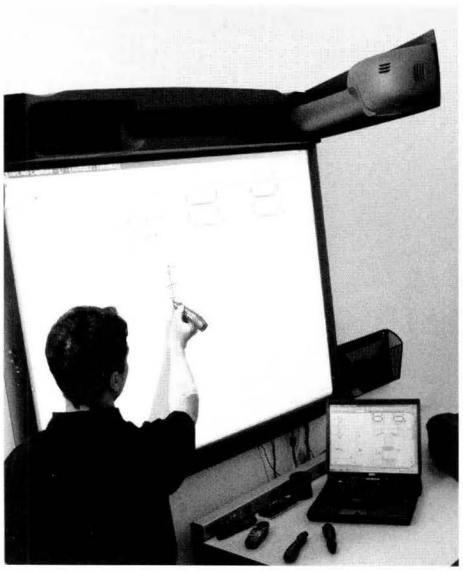
11-2004

# 35th Conference on Senior Engineering Design Projects

College of Engineering and Applied Sciences



*35th Conference on*

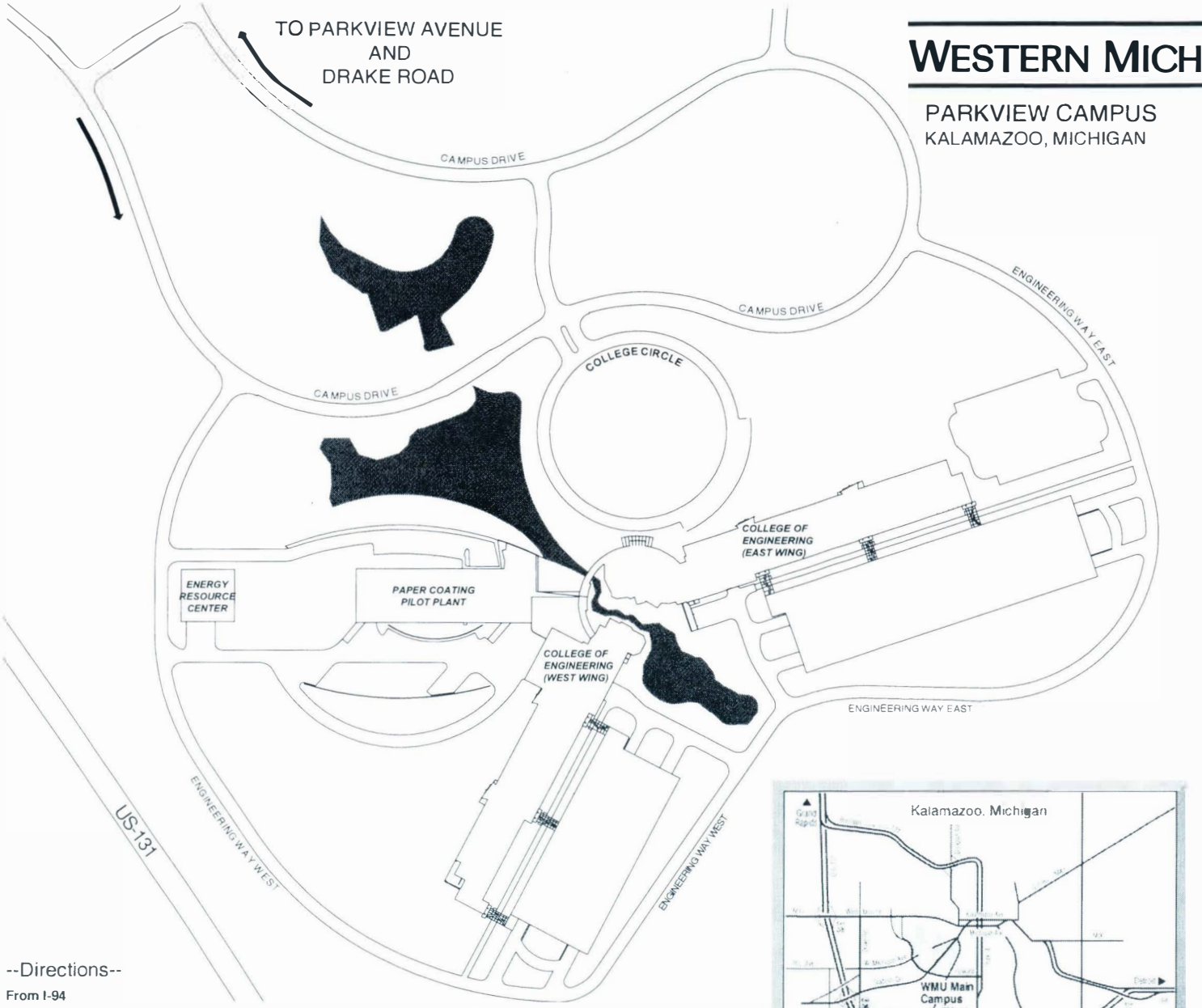
# Senior Engineering Design Projects

Tuesday, November 30, 2004
College of Engineering and Applied Sciences
Parkview Campus
9 a.m. to 4 p.m.

WESTERN MICHIGAN UNIVERSITY
College of Engineering and Applied Sciences

# WESTERN MICHIGAN UNIVERSITY

## PARKVIEW CAMPUS
KALAMAZOO, MICHIGAN




BUILDINGS

COLLEGE OF ENGINEERING
ENERGY RESOURCE CENTER
PAPER COATING PILOT PLANT






SCALE IN FEET

--Directions--

**From I-94**

At exit #74, turn north onto U.S. 131, go 2.8 miles, follow the directions listed below for U.S. 131.

**From U.S. 131**

At exit #36A, turn east onto Stadium Drive. Turn right at first light which is Drake Rd. Continue on Drake Rd. through the next light (at Parkview Ave.) into the WMU Parkview Campus. You will now be on Campus Drive.

Parking is available in the ramps behind the College (Lots P3 and P4).
There is no charge for parking for those attending the conference on November 30, 2004.

## Conference on Senior Engineering Design Projects

You are invited to attend the thirty-fifth Conference on Senior Engineering Design Projects. The conference will be held from 9 a.m. to 4 p.m., **Tuesday, November 30**, 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)

Teachers who cannot accompany their students to the conference may ask their students to sign in and out at the information table in the lobby on the first floor of the College. Sign-in sheets will be mailed to teachers the day after the conference.

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

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

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

| | | | |
|---|---|---|---|
| Civil and Construction Engineering | D-202 | 9 a.m. to 10:00 a.m. | p. 4 |
| Computer Science | D-204 | 1 p.m. to 4:00 p.m. | p. 5 |
| Electrical and Computer Engineering | D-201 | 9 a.m. to 2:00 p.m. | p. 8 |
| Industrial and Manufacturing Engineering | D-208 | 9 a.m. to 2:00 p.m. | p. 11 |
| Mechanical and Aeronautical Engineering A | D-109 | 9 a.m. to 1:30 p.m. | p. 14 |
| Mechanical and Aeronautical Engineering B | D-115 | 9 a.m. to 12:00 p.m. | p. 17 |
| Paper Engineering, Chemical Engineering, and Imaging | D-206 | 9 a.m. to 10:30 a.m. | p. 19 |

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

**For more information about the conference**, call Cathy Smith at (269) 276-3244

**CCE** = Civil and Construction Engineering
**CS** = Computer Science
**ECE** = Electrical and Computer Engineering

**IME** = Industrial and Manufacturing Engineering
**MAE** = Mechanical and Aeronautical Engineering
**PCI** = Paper Engineering, Chemical Engineering, and Imaging

| Time | Room | Dept. | Topic |
|---|---|---|---|
| 9:00 | D-202 | CCE | College of Health and Human Services |
| | D-201 | ECE | Solar Car Battery Pack and Battery Management System |
| | D-208 | IME | Design and Installation of Eddy Current Brake to Chassis Dynamometer |
| | D-109 | MAE-A | Testing and Adjustment of Hydraulic Spool Valves Using Compressed Air |
| | D-115 | MAE B | Optimization of a Commercial Vehicle Brake Rotor |
| | D-206 | PCI | Increased MD/CMD Strength Ratio through Impregnation |
| 9:30 | D-202 | CCE | New Grade School Facility |
| | D-201 | ECE | A System for Characterizing Acoustic Properties of Materials |
| | D-208 | IME | Repackaging Area Re-Design |
| | D-109 | MAE A | Electromechanical Motion Control System |
| | D-115 | MAE B | Effect of Reduction of Engine Coolant Flow Rate on Engine Performance |
| | D-206 | PCI | Borosilicate Microparticles for Fines Retention |
| 10:00 | D-201 | ECE | In-Circuit Hall-Effect Device Test Unit |
| | D-208 | IME | Integration Study of a New Controls Application Platform and an Existing Milling Machine |
| | D-109 | MAE A | Military Vehicle Seat Energy Absorption System |
| | D-115 | MAE B | Supercharger Inlet Port Optimization |
| | D-206 | PCI | Output Profile Quality |
| 10:30 | D-201 | ECE | Controller Interface Design |
| | D-208 | IME | Comparing Various Simulation Software in Green Sand Aluminum Castings |
| | D-109 | MAE A | Simple-to-Use Mechanism for Lifting Heavy Grating Doors |
| | D-115 | MAE B | Flight Testing of an Unmanned Aerial Vehicle (UAV) |
| 11:00 | D-201 | ECE | Motor Frequency Response Analyzer |
| | D-208 | IME | Fully Parametric 3-D Model of the Human Spine |
| | D-109 | MAE A | Reduction of Dishwasher Pump Pulsation Sound |
| | D-115 | MAE B | Pressure Optimization of a Dishwasher Feed System |
| 11:30 | D-201 | ECE | Automated Visual Inspection System |
| | D-109 | MAE A | Soapbox Derby Cars-Racing Against Efficiency |
| | D-115 | MAE B | Oxygen Bottle Holder |

| | | |
|---|---|---|
| 1:00 | D-204 CS | EvaluWeb |
| | D-201 ECE | ISM Band Receiver and RF Component Development for an RFID Laboratory |
| | D-208 IME | Developing a Shift Scheduling System and New Facilities Layout for a Non-Profit Distributor of Donated Goods |
| | D-109 MAE A | Flour "Swift-Sift" Mechanism |
| 1:30 | D-204 CS | Kalamazoo Calendar Consolidation System |
| | D-201 ECE | Telerobotic Controller |
| | D-208 IME | Re-engineering of Office Storage Unit Using Design for Manufacturing and Assembly (DFMA) |
| 2:00 | D-204 CS | Faculty Publication and Research Database |
| 2:30 | D-204 CS | Electronic Textbook Support Database |
| 3:00 | D-204 CS | Academic Major/Minor Form Creation System |
| 3:30 | D-204 CS | Cemetery Database System |

## CIVIL AND CONSTRUCTION ENGINEERING

Session Chair – Osama Abudayyeh
Room D-202

### COLLEGE OF HEALTH AND HUMAN SERVICES

by Jason Evelyn, Michael Herbon, and Chad Neely
Sponsor: Chris Scharlach, Chris Pyzic, and Tom Owens – Granger Construction Company
Faculty Advisor: Osama Abudayyeh
9:00 a.m. to 9:25 a.m., Room D-202

The College of Health and Human Services building is a state-of-the-art facility. The total building space is roughly 195,000 square feet, with the lab building comprising approximately 115,000 square feet. Project management techniques were analyzed for the lab portion of the building and included evaluation of scheduling, estimating, and project delivery, as well as a safety program.

### NEW GRADE SCHOOL FACILITY

by Christopher Cogan, Rebecca DePotter, and Jason Huber
Faculty Advisor: Osama Abudayyeh
9:30 a.m. to 9:55 a.m., Room D-202

A new K-8 facility was desired because the needs of the user exceeded the space available in the existing facility. In order to complete the project within the owner's specifications, detailed estimates and schedules were carefully developed and the proper project management systems and safety regulations were created.

## COMPUTER SCIENCE

Session Chair – Mark Kerstetter
Room D-204

### EVALUWEB

by Salman A. Bodla, Joseph M. Fearnley, Zia M. Malik, Soujanya Venkatesh, and Yvette R. Yoder
Faculty Advisor: Mark Kerstetter
1:00 p.m. to 1:25 p.m., Room D-204

EvaluWeb was developed to provide a centralized interface and repository of resource modules to help manage evaluation theory and process. Historically, these applications were managed separately by multiple administrators with no centralized user authentication. The Coordinated Login System (CLS) was created to provide a unified login page to grant varying levels of access based on a user's database profile. Resource modules were built for EvaluWeb with a focus on applications that aid the daily internal functions of the client staff, such as the Website Administration Module and Center Staff Listing. Tuning and design review activities were performed on the database, and a database backup routine was created. A duplicate environment was configured to allow for incremental testing and eventual deployment of all application modules.

### KALAMAZOO CALENDAR CONSOLIDATION DATABASE

by William B. Hartman, William C. Kennedy, Derek E. Lyttle, Erin E. Woodcock, and Mark C. Young
Faculty Advisor: Mark Kerstetter
1:30 p.m. to 1:55 p.m., Room D-204

Ourcalendar.org is an ongoing project aimed at developing a universal calendar on the Internent containing events in the Kalamazoo area. The project was brought up-to-date by replacing the existing calendar creation software with PHP iCalendar, an open source program that was easier to navigate and more modern looking. Event storage was restructured to comply with the iCalendar open standard defined in RFC 2445, and a utility was written to convert existing data into the new format. This new format and a design for its storage in a database were documented to facilitate the eventual implementation of an interface to add and delete events. Documentation was also created on the use and administration of the new software for future work on the project.

## FACULTY PUBLICATION AND RESEARCH DATABASE

by Wai Loon Choy, Michele Hsu, Karla Menezes, and Azhar Zaheer
Faculty Advisor: Mark Kerstetter
2:00 p.m. to 2:25 p.m., Room D-204

The Faculty Publication and Research Database is a centralized point to store faculty publications while allowing the public to view it. The database was improved to include added functionality and better user-interface. Templates for publications were uploaded into the database for standardized publications entries and an "Upload" function had been incorporated to allow the users to directly upload publications into the database. The user-interface was redesigned and uses less storage capacity while maintaining user-friendliness and efficiency. The implementations were done using the PHP, mySQL and HTML languages for compatibility with the already existing database. Users can view, upload, and update publications easily in one site without hassle.

## ELECTRONIC TEXTBOOK SUPPORT DATABASE

by Todd M. Bythrow, Christopher Littell, Andrew J. McKenna, Jeffrey J. Mueller, and Kean Loong Tan
Faculty Advisor: Mark Kerstetter
2:30 pm. to 2:55 p.m., Room D-204

A Website was created to support traditional textbooks with easy online chapter access to each chapter and specially designed quizzes. Students are able to access the textbook from the web using an individually assigned username and password. There are tests on the content from each chapter. These tests refer students to locations in the book that correspond to the questions. The site was designed from scratch as well as the database to store the book, tests, and usernames. Ways for the book to be entered into the database, to create tests, and for users to be added were provided.

## ACADEMIC MAJOR/MINOR FORM CREATION SYSTEM

by Marie E. Maddix, Timothy H. Miley, Dustin S. Rohdy, Philip J. Rowan, and Benjamin O. Slater
Faculty Advisor: Mark Kerstetter
3:00 p.m. to 3:25 p.m., Room D-204

The Academic Major/Minor Form Creation System (MMFS) that is used by academic advisors was updated to increase its flexibility and efficiency. The new system includes a separate database for storing forms and class lists, along with the ability to create, delete, copy, modify, hide/reveal, and backup new and existing forms. Forms can now be created from a variety of user-defined sections including student information, departmental requirements, and assorted course combinations. The MMFS is a dynamic web application implemented using the PHP scripting language and the mySQL database management system hosted on an Apache server. It presents the user an interface for creating and maintaining major/minor forms to be used as a reference for auditing credits upon a student's application for graduation.

## CEMETERY DATABASE SYSTEM

by Abimbola Ogunleye, Pooja K. Shah, Razaq T. Sule, and Corey H. Viegelahn
Faculty Advisor: Mark Kerstetter
3:30 p.m. to 3:55 p.m., Room D-204

A new database management system (DBMS) was developed for a local genealogical society. The DBMS organized information regarding burials in Kalamazoo County and southwest Michigan. The client required a user-friendly program to facilitate the insertion, deletion, search, update, listing and formatting of data for printing of relevant information. There was a need for two levels of access to information. The User interface had access for data entry and duplication checking. The Administrator interface had complete access for manipulation of data. The data could be retrieved in any of three different formats for printing: Row Block format, Lot format and Name format. The DBMS was implemented using Visual Basic and Microsoft Access.

## ELECTRICAL AND COMPUTER ENGINEERING

Session Chair – John Gesink
Room D-201

### SOLAR CAR BATTERY PACK AND BATTERY MANAGEMENT SYSTEM

by Ryan Asmus, Rick Churchill, and Matt Krauss
Faculty Advisor: Johnson Asumadu
9:00 a.m. to 9:25 a.m., Room D-201

The Lithium Ion battery pack consists of 37 battery modules connected in series to provide 150 volts DC to the solar car. The temperature and voltage data is monitored by a microcontroller to maintain the safety of the battery pack. If any temperature or voltage measurements are outside the design range, the battery pack is disconnected. A fuse protects the battery pack against any short circuit or high currents.

### A SYSTEM FOR CHARACTERIZING ACOUSTIC PROPERTIES OF MATERIALS

by Paul Spindler, Ryan VanSolkema, and Michael Ziemelis
Sponsor: Josh Barr and Mark Larson – Magna Donnelly
Faculty Advisor: Damon A. Miller
9:30 a.m. to 9:55 a.m., Room D-201

A system for measuring acoustic properties of microphone windscreens was designed and implemented. The measured frequency dependent acoustic properties are reflection, absorption, and transmission coefficients. The system is comprised of a waveform generator, speaker, sample-holding acoustic waveguide, microphones, data acquisition hardware, and a personal computer for data processing and a graphical user interface. System operation was verified using a sample of known acoustic properties.

### IN-CIRCUIT HALL-EFFECT DEVICE TEST UNIT

by David Godin, Shahrizal Rojali, and Thomas Miller
Sponsor: Alex Morrissey and Jim Thompson – Safari Technologies, Inc.
Faculty Advisor: Debbie Dawson
10:00 a.m. to 10:25 a.m., Room D-201

In order to reduce costs associated with returned circuit boards from customers, a device was designed and built to test the functionality of circuit boards that employ Hall-Effect devices. The unit was designed to achieve a rapid through-put while accurately testing all of the customer defined specifications for a passing, or "good" circuit board. The test unit utilizes a C-language based microcontroller for motor control and voltage pulse verification; short-circuit testing capabilities, and a specially designed circular magnet for the purpose of testing the Hall-Effect devices in-circuit.

## CONTROLLER INTERFACE DESIGN

by Prathibha Easwaran, Hussein Kassem, and Jason Lillrose
Sponsor: Jeffery Fields – Whirlpool Corporation
Faculty Advisor: Ralph Tanner
10:30 a.m. to 10:55 a.m., Room D-201

Today's modern appliances are controlled by microcontrollers. The new interface device allows an appliance to be repaired without replacing a control board. This is accomplished through the use of auto detection and flash programming. The interface device detects the type of controller used in the board and then reprograms the controller through its flash memory. The use of this process instead of simply replacing the board will result in both cheaper repairs and also a longer life of the system components.

## MOTOR FREQUENCY RESPONSE ANALYZER

by LaTesha Adams, Chaw Ching Leong, and Hong Juin Jack
Faculty Advisor: Frank Severance
11:00 a.m. to 11:25 a.m., Room D-201

Transfer functions are often used in electrical engineering courses; however, it is rarely explained where parameter values come from. Therefore, a test-stand to measure the transfer function of a particular component was designed. This device finds the transfer function of a DC motor from voltage input to output shaft velocity. The speed-dynamics of a DC motor was measured using sinusoidally varying voltage excitation thus producing frequency response data which is presented in Bode plots. From the Bode plots, it is possible to obtain the magnitude and phase of a transfer function.

## AUTOMATED VISUAL INSPECTION SYSTEM

by Carlos Cruz, Wendy Dohm, and Navin Gupta
Sponsor: Jon Lubbers – Innotec
Faculty Advisor: Frank Severance
11:30 a.m. to 11:55 a.m., Room D-201

An automated visual inspection system (AVIS) was designed to inspect a plastic mirror frame called the Millenium Vanity Frame (MVF). The AVIS's purpose is to reject parts based on defective measures such as splay, swirl, surface scratches, spots, burns, and knit line. A high resolution digital camera is used to take pictures of a MVF. Each picture is compared to a reference template that is stored in the computer. Image processing is done to determine whether the part is defective or not. An actuator will either move the part to a rejection bin or place it in the good parts tote.

## ISM BAND RECEIVER AND RF COMPONENT DEVELOPMENT FOR A RFID LABORATORY

by Diep Dao, Rolando Garcia, Naser Khan, and Faiz Syed
Faculty Advisor: Bradley Bazuin
1:00 p.m. to 1:25 p.m., Room D-201

A radio frequency (RF) receiver and supporting RF component modules were designed and built to receive signals in the instrumentation, scientific, and medical (ISM) frequency band from 902 to 928 MHz. The laboratory will use the developed electronics to monitor, analyze and study the RF communications signals generated by RF identification (RFID) readers and tags. Receiver and components designs were specified and constructed based on testing and characterization of an RFID system. The RF modules include discrete implementations of bandpass and lowpass filters, a low-noise amplifier, an RF mixer, and synthesized phased locked oscillator.

## TELEROBOTIC CONTROLLER

by Michael Fewless, George Slater, and Steve Waldron
Faculty Advisor: Norali Pernalete
1:30 p.m. to 1:55 p.m., Room D-201

A telerobotic interface was designed and tested using a Phantom 1.5 Premium haptic device and a UMI RTX robotic arm with a gripper claw. A personal computer bridges the connection between the two devices. A pressure sensor system relays the status of the gripper back to the PC. This setup provides a training tool for any teleoperation tasks that involves the use of force feedback.

## INDUSTRIAL AND MANUFACTURING ENGINEERING

Session Chair – Betsy Aller
Room D-208

### DESIGN AND INSTALLATION OF EDDY CURRENT BRAKE TO CHASSIS DYNAMOMETER

by Mark J. Keefer and Jeffrey A. Weber
Faculty Advisor: James VanDePolder
9:00 a.m. to 9:25 a.m., Room D-208

Chassis dynamometers, using inertia based testing only, perform necessary tests to validate vehicle design and capabilities. Adding an eddy current brake allows simulation of real-world road conditions by applying a steady state load to a vehicle during testing. Design, analysis, and fabrication of the structure and components were evaluated to meet safety and testing requirements. Installation of the eddy current brake expands testing and teaching capabilities.

### REPACKAGING AREA RE-DESIGN

by Michael Carlisle, James McEachan, and Ali Moreno
Sponsor: Kent Clayton and David Hemmerlien – Hi-Lex Corporation
Faculty Advisor: David Lyth
9:30 a.m. to 9:55 a.m., Room D-208

Adequate capacity is necessary for a manufacturing facility to meet its customer demands. A current repackaging area for a local manufacturer is being moved from an outside warehouse back to its main manufacturing facility and needs to be optimized to allow for greater capacity and to cut costs. Facility design, supply chain management, and work analysis techniques were used in designing alternatives for a repackaging area with the main objective of increasing efficiency. The new facility layout and work standards proposed may optimize the repackaging area by increasing capacity and reducing cost.

## INTEGRATION STUDY OF A NEW CONTROLS APPLICATION PLATFORM AND AN EXISTING MILLING MACHINE

by Seth Churchill, Bryant McCauley, and Joshua Moore
Faculty Advisor: Tarun Gupta
10:00 a.m. to 10:25 a.m., Room D-208

A detailed feasibility analysis was needed to determine if a cutting-edge controls application platform could be programmed and integrated for use with an existing Computer Numerical Code (CNC) milling machine, with the goal of improving teaching and research capabilities. Integration was attempted through a specific type of Programming Logic Controller (PLC). The PLC was expected to communicate through different cards or modules that send and receive electrical signals with the milling machine. Various studies were conducted to examine the feasibility of a program with several different subroutines commonly used in milling machine programs. Adjustments and modifications were made to successfully evaluate the integration of the new control application platform and the existing CNC milling machine. If successful the developed methodology will have potential to operate the CNC machine by completely bypassing its black box.

## COMPARING VARIOUS SIMULATION SOFTWARE IN GREEN SAND ALUMINUM CASTINGS

by Walter Christel and Michael Farney
Faculty Advisor: Sam Ramrattan
10:30 a.m. to 10:55 a.m., Room D-208

Simulation software is used to aid foundries by representing the filling and solidification process for various types of casting techniques to optimize efficiency. Aluminum was poured into green sand molds in a controlled laboratory environment. The same parameters were mimicked to simulate the processes in a variety of state-of-the-art solidification and fill software. Numerous parameters were monitored to assist in comparing the accuracy of casting defects, fill times, and solidification times obtained in the foundry to those collected from the simulation software. The use of simulation software will allow foundry engineers to avoid casting defects and help generate a design that can be implemented precisely with minimal process modifications.

## FULLY PARAMETRIC 3-D MODEL OF THE HUMAN SPINE

by Aaron Koerth and Anthony Rizzo
Faculty Advisor: Jorge Rodriguez
11:00 a.m. to 11:25 a.m., Room D-208

Orthopedic conditions of the human spine are unique because each displays different conditions or situations that need to be analyzed individually. Currently there is no way of accurately modeling a specific individual's spine and its orthopedic condition. By using parametric modeling techniques with advanced 3-D CAD software, a fully parametric model of the human spine was created. This model is capable of quickly and easily displaying the human spine in a wide variety of configurations, thus providing an excellent tool for biomechanical studies. Replacement intervertebral discs, scoliosis, and kyphosis were modeled, analyzed, and verified using this model.

## DEVELOPING A SHIFT SCHEDULING SYSTEM AND NEW FACILITIES LAYOUT FOR A NON-PROFIT DISTRIBUTOR OF DONATED GOODS

by Zubin A. Dudhwala and Dan M. Graff
Sponsor: John Dillworth and Mariah Coffey – Goodwill Industries
Faculty Advisor: Kailash Bafna
1:00 p.m. to 1:25 p.m., Room D-208

A local non-profit distributor of donated clothing and household goods needed to improve employee scheduling and their processing of these goods. A time study recommended standard times for employees, and a new facilities layout was created to improve receiving, shipping, processing, and retail selling of merchandise. Project outcome should create the best implementation of employee workspace, minimize costs, and increase sales.

## RE-ENGINEERING OF OFFICE STORAGE UNIT USING DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA)

by David Burke, Kiana Dennis, Paul Kerekes, Gregory Parent, and Anthony Pulcini
Sponsor: Greg Russo – Herman Miller
Faculty Advisor: Mitch Keil
1:30 p.m. to 1:55 p.m., Room D-208

An office storage unit was redesigned to alleviate issues associated with the cost of manufacturing and assembly. Design for Manufacturing and Assembly (DFMA) concepts were utilized to correct problematic features. Through research and analysis a practical design solution was conceived to optimize multiple objectives. A design concept was modeled using Pro/Engineer software, and the new design was tested for feasibility. Once implemented, the improved product will result in more efficient manufacturing and assembly, thus lowering costs.

## MECHANICAL AND AERONAUTICAL ENGINEERING – A

Session Chair – Jerry Hamelink
Room D-109

### TESTING AND ADJUSTMENT OF HYDRAULIC SPOOL VALVES USING COMPRESSED AIR

by Josh Lambrix
Sponsor: Rory Adams – FEMA Corporation
Faculty Advisor: Jerry Hamelink
9:00 a.m. to 9:25 a.m., Room D-109

Adjustment and testing of hydraulic spool valves has typically been done hydraulically. Due to the mess involved, it is desired that a method of adjustment and testing be attained with compressed air. The feasibility of this alternative method was researched through analytical analysis and experimental testing.

### ELECTROMECHANICAL MOTION CONTROL SYSTEM

by Paul Fakler and Steve Unwin
Sponsor: Parker Hannifin
Faculty Advisor: James Kamman
9:30 a.m. to 9:55 a.m., Room D-109

A test stand was designed and built to demonstrate electromechanical motion control principles in an undergraduate laboratory setting. The system was designed for integration with a previously designed variable mass sled system, to expand existing capability to include an electromechanical actuation system for controlling motion. Mechanical components were selected, and the system was integrated with a PC using LabVIEW software. Mathematical models were formed for computer simulation of actual motion characteristics to allow for comparisons.

### MILITARY VEHICLE SEAT ENERGY ABSORPTION SYSTEM

by Brandon S. Ferriman and Troy A. Flodin
Sponsor: Gregory Wolfe, Steve Hoffman, and Steve Gentner – U.S. Army RDECOM-TARDEC
Faculty Advisor: James Kamman
10:00 a.m. to 10:25 a.m., Room D-109

The use of a deforming material coupled with a shock absorption system was investigated to provide occupant protection against undercarriage explosions. Fitted to the seat of a military vehicle, the system is designed to reduce blast forces to a non-lethal level. Project work was focused on the development of a mathematical representation as well as an investigation into the benefits of adding a deformable "Sigma Bracket" to assist in energy dissipation. The mathematical model can now be used to determine resultant occupant loads.

## SIMPLE-TO-USE MECHANISM FOR LIFTING HEAVY GRATING DOORS

by Edwin Kuang Teh
Faculty Advisor: Koorosh Naghshineh
10:30 a.m. to 10:55 a.m., Room D-109

Two heavy grating doors form the entrance to a pit that contains a 6,000 lb. shaker system. The excessive weight of these doors makes their operation difficult and unsafe. A new mechanism was designed and built that made it possible for one person to easily open the grating door in a safe manner. A safety lock was integrated into the design to avoid accidental release of the doors. The new mechanism is safe and requires no maintenance during its life span.

## REDUCTION OF DISHWASHER PUMP PULSATION SOUND

by Joseph Allen, Adam Elenbaas, and Arren McCormick
Faculty Advisor: Koorosh Naghshineh
11:00 a.m. to 11:25 a.m., Room D-109

A centrifugal pump is used to circulate the water through standard household dishwashers. Pressure pulsations in this particular pump design resulted in a characteristic pump noise. The dishwasher pump was redesigned to reduce the sound it generates. Impeller and housing prototypes were developed and tested for improvements in sound levels. The data collected during the testing of these prototypes will be used in the future development of dishwasher pump systems.

## SOAPBOX DERBY CARS – RACING AGAINST EFFICIENCY

by Lorik Abdullai and Joseph R. Dunn
Faculty Advisor: Richard Hathaway and Iskender Sahin
11:30 a.m. to 11:55 a.m., Room D-109

A soapbox derby car was designed, analyzed and fabricated with a focus on quantifying and minimizing energy losses. A mathematical model was created to depict losses that occur due to aerodynamic drag and rolling resistance among other factors. Experimentation and research was conducted to verify the mathematical model and determine which factors accounted for the greatest losses. Upon completion, the vehicle was entered in a local racing competition.

## FLOUR "SWIFT-SIFT" MECHANISM

by Steve Schultz
Faculty Advisor: Koorosh Naghshineh
1:00 p.m. to 1:25 p.m., Room D-109

This exciting design opportunity focused on the automation of flour sifting. The process removes pieces of chicken and particles of flour that have absorbed moisture and formed clumps. The design is based on a simple slider crank mechanism and is powered by an electric motor. The justification for the project was to ensure the flour gets sifted, to reduce labor costs, and also to make the process cleaner with less waste. WorkingModel was used to simulate the motion and aid in the design process. On site testing focused on functionality and implementation was immediate.

## MECHANICAL AND AERONAUTICAL ENGINEERING - B

Session Chair – Ho Sung Lee
Room D-115

### OPTIMIZATION OF A COMMERCIAL VEHICLE BRAKE ROTOR

by Brian Cavanaugh and Michael Preston
Sponsor: Jim Clark and Alan Hendershot – Bendix Spicer Foundation Brakes, LLC
Faculty Advisor: Ho Sung Lee
9:00 a.m. to 9:25 a.m., Room D-115

The structural features of a commercial vehicle cast iron brake rotor were redesigned. The objective was to increase cooling characteristics while decreasing component weight. Tests conducted on the current production brake rotor and prototype design supplied benchmarking information, which was used for computer analysis correlation. The final design recommendation was supplied through analytical equations and Finite Element Analysis (FEA).

### EFFECT OF REDUCTION OF ENGINE COOLANT FLOW RATE ON ENGINE PERFORMANCE

by Gin Foo Lim and Wen Shiuan Ling
Faculty Advisor: Ho Sung Lee
9:30 a.m. to 9:55 a.m., Room D-115

Modification was done to the engine cooling system allowing the manual control of various engine coolant flow rates. The engine was first run on a dynamometer to collect data required and then analysis was done on the data to obtain the results of the engine performance due to the modification. It was proven that by lowering the coolant flow rate, the heat transfer at the hotspots of the engine was increased due to active boiling and hence, better performance. This favorable result will provide the automotive industry a new way to cool the engine and increase the performance of internal combustion engines.

### SUPERCHARGER INLET PORT OPTIMIZATION

by Lucas Kroeger, Bryan Lewis, and Jason Streeter
Sponsor: Eaton Corporation, Supercharger Division
Faculty Advisor: Parviz Merati
10:00 a.m. to 10:25 a.m., Room D-115

The efficiency of a larger displacement supercharger was improved by optimization of the Inlet Port. The M112 Supercharger was used to investigate changes in the inlet port that improved the overall efficiency of the supercharger. The changes were simulated in Fluent to predict improvements in airflow through the inlet port. The modifications of the inlet port geometry were also tested on performance test stands. The results of the simulation and testing were used to improve the performance of the supercharger.

## FLIGHT TESTING OF AN UNMANNED AERIAL VEHICLE (UAV)

by Nicholas Tan
Faculty Advisor: Kapseong Ro
10:30 a.m. to 10:55 a.m., Room D-115

Flight testing is an integral part in the design process of any aircraft. The objective of flight testing is to acquire real-time in-flight data to compare against simulated data acquired during the design process. The end result of the tests is to correlate both sets of data and make certain that the aircraft will perform its intended tasks within its designed performance envelope. The tests were conducted on a UAV that was retrofitted to carry the data acquisition system and all the relevant sensors while at the same time kept close to the original specifications of the aircraft. The final objective of this project was to attain a solid and reliable base of system and understanding to use for flight-testing competition aircrafts in the years to come.

## PRESSURE OPTIMIZATION OF A DISHWASHER FEED SYSTEM

by Jordan Garrison and Shane LaChappelle
Faculty Advisor: Chris Cho
11:00 a.m. to 11:25 a.m., Room D-115

At the top rack of a dishwasher it is desirable to have a high pressure water system. This improves the quality of the wash and the efficiency of the dishwasher. Improving the water pressure in the feed tube that leads to the top rack was the scope of this project. To accomplish this, pressures were taken at several points along the feed system using pressure sensors and the computer program LabView. Using the data obtained through LabView, changes were made to the original CAD data and a computer analysis was run on each new design. After several changes were analyzed, the optimal design was chosen.

## OXYGEN BOTTLE HOLDER

by Anush Adhikari, Eric J. Walker, and Michael Kifle Desta
Sponsor: Ashley Nolen Akerman – Stryker Medical
Faculty Advisor: Judah Ari-Gur
11:30 a.m. to 11:55 a.m., Room D-115

There was a need for proper oxygen bottle management during transportation of emergency products. An oxygen bottle holder was designed that can be placed in different kinds of ambulance cots and stair chair. This holder can accommodate different sizes of oxygen bottles. A 3D model of the design was created in Pro-E and Finite Element Analysis was performed. The design was then built, tested and verified.

## PAPER ENGINEERING, CHEMICAL ENGINEERING AND IMAGING

Session Chair – Peter Parker
Room D-206

### INCREASED MD/CMD STRENGTH RATIO THROUGH IMPREGNATION

by Melissa Rivard
Faculty Advisor: Thomas Joyce and Margaret Joyce
9:00 a.m. to 9:25 a.m., Room D-206

A reduction in machine direction/cross machine direction (MD/CMD) strength by means of saturation is a result of fiber orientation contributing less to the strength properties of the sheet, as the add-on increases. Varied levels of penetration are achieved by the pilot impregnator. The MD and CMD strength is maximized through impregnation by increasing the density of the sheet. Tensile index, tear index, porosity and stiffness were analyzed on the impregnated samples and the basesheets. Comparisons were made between the physical properties versus coat weight to understand the effect of the coating.

### BOROSILICATE MICROPARTICLES FOR FINES RETENTION

by Scott Oertel
Faculty Advisor: Dewei Qi
9:30 a.m. to 9:55 a.m., Room D-206

There are many different types of silica used in the paper industry today. These range from micro gels, to structured or unstructured silica sols. The paper industry used these micro particles to obtain better drainage and fines retention of the sheet. Fines retention is especially critical when a paper mill has a closed water system. When fines are not retained in a closed water system, the fines will build up in the white water system. Once a significant amount of fines accumulates in the water system, the machine starts to have breaks and runnability problems. A borosilicate was made by reacting water glass with a borax solution and by forming a silicic acid and then reacting it with a borax solution. The pH of the borax solution was adjusted to optimize efficiency of micro borosilicate particles related to performance of retention and drainage. The borosilicate was tested in a micro particle analyzer to better understand the reaction mechanism of forming a borosilicate and its performance.

### OUTPUT PROFILE QUALITY

by Brooke Pertner
Faculty Advisor: Abhay Sharma
10:00 a.m. to 10:25 a.m., Room D-206

Device dependent color needs to be controlled if output is used for color proofing. A proofing device must reproduce specific colors with the limitations of its process. Output profiles are needed to make proofing devices adapt for color limitations. This experiment used two independent proofing devices with three proprietary output profiles. The output colors were compared to specified color targets using CIE LAB. The quality of each profile was then assessed.

## 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 November 2004. If you have a project for our students or if you would like more information, please call Cathy Smith at (269) 276-3244.

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