EXPO 25

DESIGNING OUR WORLD

APRIL 22, 2014

COLLEGE OF ENGINEERING

UIC UNIVERSITY OF ILLINOIS AT CHICAGO
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Kathy McGuire (2014 EXPO co-chair)
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Bruce Wiatrak
Dear Students, Alumni, Families, and Friends:

As more than a few of my colleagues and I have experienced when chatting with people outside our profession, many are surprised to learn of the extent to which engineering touches people’s lives every day.

But as this twenty-fifth UIC Engineering EXPO resoundingly demonstrates, an engineer’s stock-in-trade is to confront everyday problems in a systematic, team-based way and offer creative solutions that improve lives.

The advanced design, prototyping and applied research projects displayed at EXPO 2014 exemplify our students’ intelligence, creativity, ingenuity, teamwork, and persistence in confronting real-world challenges. This opportunity to publically display them marks the culmination of their undergraduate studies.

On the College’s behalf, I would like to thank our alumni judges, faculty advisors, and corporate partners for assisting the students with their projects and to extend a special “thank you” to our individual and corporate sponsors for their financial support.

Given the talent demonstrated here today, the world can anticipate a great group of new problem-solvers entering the work force tomorrow.

Good luck to our graduating seniors and best regards to all,

Peter C. Nelson
Dean and Professor of Computer Science
We thank our EXPO 25 Honorary Co-Chairs, Arlene Norsym and Kathy McGuire for their foresight and dedication in creating Engineering EXPO!

Engineering EXPO began as the dream of alumna, Kathy McGuire ('89) and with the support of (former) Asst. Dean Arlene Norsym, her dream became a reality! Spanning 25 years, EXPO has evolved into a dynamic capstone event. Senior design students, with the guidance of a faculty and/or industry advisor, develop a project from conception to product design culminating with their presentation at Engineering EXPO. This experience is a crucial one for our seniors as it merges group collaboration, creation, and commitment. With this event our seniors take the first step in engineering their future and designing our world! We wish all participants the best for a great EXPO and extend a special thank you to the College of Engineering and its donors for making EXPO possible!

The College of Engineering EXPO 25 Team
WELCOME TO THE 25TH ANNIVERSARY OF
ENGINEERING EXPO

SCHEDULE

7:00 a.m.         STUDENT REGISTRATION OPENS

7:00-8:15 a.m.   PROJECT SET-UP

8:30 a.m.        STUDENTS: Briefing - Illinois Room (stage area)
                  JUDGES: Registration (by 8:15) & briefing

9:00 a.m.        EXPO OPENS for general public

9:15-12:00 pm.  PROJECT JUDGING

12:00 Noon      ROBOTICS DEMONSTRATION (Illinois Room)
                  Engineering Design Team
                  (1st Place winners of the 2014 Jerry Sanders Competition!)

12:00-1:30 p.m. VOTING TABULATION

1:30-2:30 p.m.  EXPO CEREMONIES – 25th Anniversary and AWARDS
                  PRESENTATION (Illinois Room)
EXPO 2014  Projects by Category

1. Assistance and Living Products
   1.MIE.59  Avery’s Chair
   1.BIOE.68  Mimicking Light Photochronic Contact Lens
   1.BIOE.65  RK Inventions Hand Strengthener
   1.ECE.64  Sailing for the Blind
   1.BIOE.66  Smart Bandage
   1.BIOE.67  Smart Running Shoe

2. Chemical Processes
   2.ChE.57  Corn to Chemicals Polyols Separation
   2.ChE.55  Corn Germ Utilization: Refining and Biodiesel Production via Supercritical Transesterification
   2.ChE.58  Reactor Design for Polyols Production
   2.ChE.56  Sorbitol and Dextrose Production from Corn Starch

3. Chemical Production Methods and Facilities
   3.ChE.60  Corn Receiving and Steeping Process
   3.ChE.63  Corn Wet Milling – Concentration on Centrifuge Separation on Gluten and Starch
   3.ChE.61  Corn Wet Milling Germ Separation
   3.ChE.62  Corn Wet Milling Second Grind and Fiber Drying

4. Efficiency Methods and Studies
   4.MIE.9  Increasing Efficiency of Bus Bar Lamination Process
   4.ECE.8  Occupancy Network with Mobile Tracking
   4.MIE.10  Two-Stage Slurry Utilizing Venturi Effect
   4.ECE.11  Universal Power Supply and Automated Thrust Testing System
   4.ECE.7  Vector Recording Lock-In Amplifier
   4.ECE.12  Wireless DMX

5. Electronic Devices
   5.ECE.28  Access Control and Environmental Monitoring System
   5.ECE.29  Automotive Microcomputer Control Unit
   5.ECE.27  Electromagnetic Communication Band of Tomorrow
   5.ECE.25  Emergency Vehicles Detector
   5.ECE.26  Motor Telemetry System
   5.ECE.30  Vehicle Light Sensor

6. Electronic Products
   6.ECE.19  Analog Dub Delay Pedal
   6.ECE.20  Bicycle Turn Signal
   6.ECE.24  Body-Effective Sensor Temperature (BEST) Vest
   6.ECE.21  A Method for Blocking Distracted Driving
   6.ECE.23  Planting Made Easy
   6.ECE.22  Wallet-Safe
EXPO 2014  Projects by Category

7. Environmental Infrastructure
7.CME.36  City of North Chicago: Water Distribution Phase 1
7.CME.31  Design of Geothermal Pavement for Runway16/34-Chicago Executive Airport
7.CME.32  Drainage Improvement on Bunning Drive, Downers Grove
7.CME.34  Flood Control in Residential Neighborhoods of Greater Chicago
7.CME.33  Heated Re-Pavement System for Bridge Decks
7.CME.35  Sustainable Storm Water Management for Harlem Irving Plaza

8. Environmental Sustainability
8.ChE.42  Combined Heat and Power for Corn Wet Milling Plant
8.CME.38  Edgebrook Metra Station Upgrade Utilizing LEED Construction
8.CME.40  Geothermal Applications for Overpass De-Icing
8.CME.37  Nutrient Removal Using a Constructed Wetland
8.CME.39  Sustainable Design of Signalized Intersections
8.ChE.41  Water Treatment Facility in Corn Wet Milling Plant

9. Mechanical Devices and Products
9.MIE.45  Conceptualization & Implementation of Replacement Heat Exchanger within Reverse Osmosis Water System
9.MIE.48  Flip Seats
9.MIE.44  Motorized Venturi Vacuum
9.MIE.46  Snack Tray
9.MIE.43  SAE Mini-Baja Rear Suspension System
9.MIE.47  Spray Nozzle for Spraying Systems Company

10. Medical Devices and Products
10.BIOE.54  Computer Simulation of Ultrasonic Wave Behavior through Lower Lumbar Abdomen
10.BIOE.50  Hacking Syringe into Micropipette using 3D Printer
10.BIOE.49  Industrial Water Antimicrobial Purification System
10.BIOE.51  Mobile Health Android App and Low-Cost Health Kit
10.BIOE.53  Mouth Guard and Oral Airway Device
10.BIOE.52  Vascular Impedance Monitoring of Internal Carotid Artery

11. Optimization and Production Systems
11.MIE.15  CINTAS Inventory Maintenance
11.MIE.16  Gourmet Gorilla Efficiency Improvement Project
11.MIE.14  Labjacks
11.MIE.13  Modeling of Pantographic/Catenary Interaction
11.MIE.17  PEER into the Future
11.MIE.18  SAE Shop Layout Optimization

12. Sustainability and Infrastructure for UIC (University of Illinois at Chicago)
12.CME.2  A Resource for Commuters and a Building for UIC
12.CME.3  Storm Water Repurposing System for Lecture Center E, UIC Campus
12.CME.4  Sustainable Student Housing
12.CME.5  UIC East Campus Sustainable Pedestrian Bridge
12.CME.6  UIC’s Sky Garden: A Green Escape
12.MIE.1  Solar Heating Solutions for UIC Student Center East (SCE) Building
EXPO 2014
Projects by Department

Bioengineering

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1.BIOE.65   RK Inventions Hand Strengthener
1.BIOE.66   Smart Bandage
1.BIOE.67   Smart Running Shoe
10.BIOE.52  Vascular Impedance Monitoring of the Internal Carotid Artery

Chemical Engineering

8.ChE.42    Combined Heat and Power for Corn Wet Milling
2.ChE.55    Corn Germ Utilization: Refining, and Biodiesel Production via Supercritical Transesterification
2.ChE.57    Corn to Chemicals-Polyols Separation
3.ChE.60    Corn Receiving and Steeping Process
3.ChE.63    Corn Wet Milling-Concentration on Centrifugal Separation of Gluten and Starch
3.ChE.61    Corn Wet Milling Germ Separation
3.ChE.62    Corn Wet Milling Second Grind and Fiber Drying
2.ChE.58    Reactor Design for Polyols Production
2.ChE.56    Sorbitol and Dextrose Production from Corn Starch
8.ChE.41    Water Treatment Facility in Corn Wet Mill Plant

Civil and Materials Engineering

7.CME.36    City of North Chicago: Water Distribution Phase I
7.CME.31    Design of Geothermal Pavement for Runway 16/34 at Chicago Executive Airport in Wheeling, IL
7.CME.32    Drainage Improvement on Bunning Drive, Downers Grove
8.CME.38    Edgebrook Metra Station Upgrade Utilizing LEED Construction
7.CME.34    Flood Control in Residential Neighborhoods of Greater Chicago
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6.ECE.19 Analog Dub Delay Pedal
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5.ECE.30 Vehicle Light Sensor
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4.ECE.12 Wireless DMX

Mechanical and Industrial Engineering

1.MIE.59 Avery's Chair
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12.MIE.1 Solar Heating Solutions
9.MIE.47 Spray Nozzle for Spraying Systems Company
4.MIE.10 Two-Stage Slurry Utilizing the Venturi Effect
Thank You EXPO Judges

EXPO FACULTY ADVISOR COMMITTEE

Special thank you to our Senior Design Instructors and Dean of Undergraduate Affairs:

Terry N. Layton, PhD
Department of Bioengineering
Christopher Burke, PhD
Department of Civil and Materials Engineering
Jeffery Perl, PhD
Department of Chemical Engineering
Vahe Caliskan, PhD
Department of Electrical and Computer Engineering
Michael Brown, PhD
Department of Mechanical and Industrial Engineering
Michael McNallan, PhD
Dean of Undergraduate Affairs
Computational Simulation of Ultrasonic Wave Behavior through Lower Lumber and Abdomen
Jon Hohol, Tanvishri Jatla, Leon Joseph, Natasha Relwani, Minh Tran

Advisor: William Thompson, PhD, Glenn Research Center, NASA. Richard Magin, PhD, UIC Dept. of Bioengineering

Osteoporosis is a disease in which bone mineral density (BMD) decreases over time, reducing the overall strength of bone. During extended periods of time in space astronauts tend to develop osteoporosis. Upon returning to the gravitational environment of Earth, astronauts often experience fractures and extreme lower back pain. According to NASA, osteoporosis can result in fractures, most commonly in the lower back, making that region the focus of our preliminary design. BMD measurements are used to analyze and assess the degree of bone strength. Current techniques to quantify BMD involve non-space-compatible devices. Imaging modalities such as ultrasound are preferred because of their portability and low energy consumption. However, current ultrasound applications to quantify BMD are hindered by signal discrepancies from backscattering. Due to the dense nature of bone tissue, the return signal is reflected back to the transducer and produces unusable data. Thus, under direction of researchers at NASA, we are working to develop a computational model intended to predict the behavior of ultrasonic waves in the lumbar region. To accomplish this, a MATLAB plug-in called Field II will be used. This ultrasound simulation program is capable of displaying the acoustic behavior of waves through different regions of the body. This will eventually aid NASA researchers in the development of a compact, in-space-compatible ultrasound transducer that quantifies BMD.

Hacking Syringe into Micropipette Using a 3D Printer
Oluwafemi Aboloye, Pedro Hurtado, Rafael Romero, Vivian Sandoval

Advisor: David Eddington, PhD, UIC Dept. Of Bioengineering

The overall goal of Team Hack-A-Lab is to create relatively inexpensive lab equipment by using simple everyday materials (i.e. syringe, nut, bolt) as well as a 3D printer for parts. Team Hack-A-Lab has developed a syringe hack or syringe modification which can essentially convert any syringe into a micropipette of a specific volume. The casing consists of acrylonitrile butadiene styrene (ABS) and was printed using a RepRap 3D printer to encapsulate an existing syringe. In order to reduce cost of production, the 3D printed parts (the pipette casing, calibration piece, and luer taper adapter) were designed using Blender™, an open source CAD software. This syringe-based micropipette is great for use in underdeveloped countries, resource limited middle schools and high schools, and for those who desire simple, inexpensive micropipettes. One benefit of this open source micropipette is that if the pipette breaks, one can simply print out and assemble another micropipette without having to buy a new one.
**10.BIOE.49**

**Industrial Water Antimicrobial Purification System**

Shidrukh Ali, Helen Ashaye, Nadine Halabi, Sandy Munoz, Marzia Yasmin

**Advisor:** Dr. Gregory Jursich, PhD; Dr. Christos G. Takoudis, PhD, UIC Dept. of Bioengineering

Water, an inevitably important component of human life, has the potential for harboring harmful bacteria and viruses; thus, the purification of water is crucial. To ensure pathogen elimination in drinking water, the Environmental Protection Agency has regulations to protect people from outbreaks. However, the use of water is not limited to drinking; it is also essential for industrial applications such as food packaging, water fountains, and in swimming pools. One of the most harmful bacteria present in untreated water is E.coli. For industrial water, besides pathogenic concerns, issues like mineral scale deposits need to be addressed. Current water treatments used for industrial applications include the use of harmful chemicals, like chlorine, UV light, or ozone, which are associated with high risk of health and environmental issues. Our design proposes a filtration system using antimicrobial polymers, made of polypropylene with copper based additives. According to the Copper Development Association, copper can continuously kill more than 99.9% of the bacteria within two hours of contact. Using the antimicrobial polymers will reduce chemical loading. Furthermore, these polymers are sustainable, recyclable and economical; they will not wear out nor cause leaching and they can be manufactured in various shapes and sizes. A significant amount of industrial process water is associated with cooling towers for a variety of applications; hence, our product is being made mainly focusing on industries utilizing cooling towers. The proposed designed will ensure elimination of E.coli from industrial water, with a reduced risk of health and environmental issues.

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**1.BIOE.68**

**Mimicking Light Transmission in Eye: Photochromic Contact Lens**

Andrew Chen, Genesis Contreras, David Szlachta

**Advisor:** Michael Cho, PhD, UIC Dept. of Bioengineering. Farah Shareef, MD/PhD student, UIC Dept. of Bioengineering

The human iris, commonly known as the colored part of the eye, determines the amount of light that reaches the retina. People with iris defects such as iris coloboma and aniridia suffer from glare, increased light sensitivity, and reduced field of vision. Current treatments are insufficient in attenuating excessive light in both indoor and outdoor environments that over time can lead to permanent loss of vision. For example, replacing the damaged iris with a fixed diameter artificial iris is effective in restoring eye symmetry but is very costly and can result in surgical complications. UV blocking contact lenses and sunglasses are noninvasive treatment options that are affordable but do not block damaging high intensity visible light. Alternatively, the combination of a photo-responsive pigment imbedded within a contact lens allows for a novel artificial iris that alleviates the symptoms of patients with iris damage at a relatively low price. Our goal is to adjust the visible light intensity entering the patient's eye to a comfortable level to allow for good visual acuity and color judgment. DEA (N,N-diethyl-4-(4-nitrophenylazo)aniline) was chosen as the photo-responsive pigment for its commercial availability, fast photo-reactive response, and activation from transparent to opaque form by visible light. Our artificial iris combines DEA and one of two different types of clear plastics: PMMA and PDMS. Cell toxicity and optical properties will be tested to ensure our artificial iris is a quality product for patients suffering from iris defects.
10.BIOE.51
Mobile Health Android App and Low-Cost Health Kit
Rania Alkhazaleh, Nikhil Bommakanti, Brian Havel, Emil Joseph, Mariah Sciacero

Advisor: Janet Lin, MD, MPH, UIC Center for Global Health

Individuals in the developing world lack access to basic health monitoring services; a 2013 report by the World Health Organization and the World Bank estimated that there is less than 50% coverage in both Sub-Saharan Africa and South Asia, and a CDC estimate notes 6.5% of individuals in the United States failed to obtain medical care due to cost. Monitoring basic vital signs, including heart rate (HR), blood pressure (BP), respiration, and temperature allows for early identification of problems, including respiratory diseases by assessing lung sounds for rales, stridor, wheezing, etc., and tracking heart rate and blood pressure as risk factors for cardiovascular diseases, hypertension, and stroke. Therefore, preventive care, medical care cost reduction, and improved health outcomes can be achieved by simply monitoring vitals frequently. A 2012 PricewaterhouseCoopers report concluded that in areas of the world with lack of access to health care, mobile technology is the only affordable tool available to expand access. As such, we have built a low cost health-monitoring kit that comprises a stethoscope, blood pressure cuff, and thermometer, which interface with a free mobile application and can be used by patients and healthcare providers who have access to a smartphone. The cost of the kit is less than $100 and the app is written for the Android operating system, as Android accounts for 71% of the global 1.4 billion smartphone market.

10.BIOE.53
Mouth Guard and Oral Airway Device
Nancy Rios, Juan Rodriguez, Catherine Santis, Johnny Villaseñor, Melissa Wardlow

Advisor: Trevor Wesolowski

Each year there is an estimated 25 million people in the US that require endotracheal intubation. A major component of invasive surgery and emergency care is proper airway passage for the intended patient. To achieve proper airway, medical personnel utilize intubation technologies such as, the standard laryngoscope, glidescope and fiberoptic laryngoscope. Of these technologies, the most commonly used is the laryngoscope with a Macintosh blade. Complications that arise during the intubation procedure include; tracheal and esophageal perforation as well as teeth chipping and aspiration as a result of the rigidity of the blade. The primary objective of this project is to create a cost efficient, multi-component device that will minimize the aforementioned complications while also providing lip protection and preserving the standard technique of the use of a laryngoscope. In addition, our device is aimed to be disposable to prevent infection and cross contamination, as well as customizable in size.
RK Inventions Hand Strengthen
Denisse Espino Barros, Cyril George, Kyle Kempke, Masood Qader, Katrina Weber

Advisor: Ryan Kole, RK Inventions LLC.

More than ten million hand injuries occur every year in the United States. They occur in the workplace, as well as during sporting activities. Cases in which surgery is needed, a rehabilitation period is necessary. As a result, there are countless products, both in the public market and private healthcare industry, dedicated to assisting patients and doctors with the recuperating process. While most of these devices provide a level of assistance, they lack diversity in functionality desired with the treatment of the hand. The hand constitutes countless bones as degrees of movement, thus a one-dimensional functional device would limit finger movement. Therefore, the goal of our project was to design a device that could provide multiple levels of movement for the human fingers and thumb, all the while strengthening them through different exercise sets. Resistive bands would be incorporated into the design, providing increased pressure by turn of a dial. This eliminates the need for bands of different set resistances, with a device that could be utilized the entire duration of the rehabilitation period. Such a design followed the requirement of portability and ease of use. Resistance measurements were done using basic tension principles and a tensile tester provided by the University of Illinois at Chicago. Adhering to the established design requirements facilitated the creation of a device that strengthens fingers by varying the resistance internally in addition to allowing multiple dimensions of freedom.

Smart Bandage
Sarah A. Glenn, Shabbir Safri, Shivam Thakkar, Rostik Tikhobov

Advisor: Terry Layton, PhD, UIC Dept. of Bioengineering

Wound healing is a natural restorative response to tissue injury. The human adult wound healing process occurs through a cascade of events that include inflammation, neovascularization, collagen synthesis, granulation tissue formation, epithelialization, and wound remodeling. Non-healing wounds affect about 3 to 6 million people in the United States, with those 65 years and older accounting for 85% of these events. Effective wound healing integrates the need of protecting the wound from infectious particles, keeping the wound moist, and relieving the mechanical stress of the wound. The Smart Bandages integrate advanced biomedical sciences concepts to enhance the body’s natural wound healing process. The side ends of the bandage are coated with a temperature responsive polymer, laboratory-synthesized polyurethane-based shape-memory polymer (SMPU), which causes the bandage to shrink due to the heat released by the wound. The shrinkage of the bandage for normal body temperature (~37 °C) is calculated to be 30%. The SMPUs are tailored with transition temperatures in the range of 30-60 °C, which accommodates the average body temperature range (36.8 °C). Shrinking helps in controlling the mechanical environment of the wound and helps relieve load of the wound, for efficient healing. The center of the interior side of the bandage is coated with a layer of hydro-gel with anti-bacterial agents, which keeps the wound moist and protected. The Smart Bandages aim to improve healing of open wounds, where releasing the stress on the wound has shown improved healing.
1.BIOE.67
Smart Running Shoe
Nicholas Anderson, Nicholas Marjanovic, Virile Medina, Dan O’Neil, Shrikant Pandya

Advisor: Craig Niederberger, MD, UIC Dept. of Urology

Running is one of the world’s most popular activities. However, injuries due to improper form are very prevalent. Improper running technique can lead to difficulty maintaining pace, or result in injury. Supination and overpronation of the foot increases the runner’s susceptibility for injuries by not properly distributing force experienced by the body. The primary goal for this project is to create a device to inform the user about their running form. The runner may then correct his form by utilizing a microcontroller to which force sensors are connected and strategically placed in the sole of a shoe. The sensors take real time data, which the microcontroller processes, and then transmits via Bluetooth to be viewed using an app running on an iOS or android device. In addition, the device is shock and water-resistant to protect the internal hardware. Our design was beta tested by experienced runners that provided extensive user input, which was incorporated into the design. The final product is a lightweight, user-friendly device for runners from all walks of life.

10.BIOE.52
Vascular Impedance Monitoring of the Internal Carotid Artery
Johnwesly A. Kanagaraj, Karan Kerwell, Melissa Manktelow, Sebastian Mestril, Sebastian Pernal, Ayden Zarkhah

Advisor: Andrew K. Johnson, MD, Dept. of Neurosurgery, Rush University

Following a cerebral aneurysm rupture and the resulting subarachnoid hemorrhaging, a subsequent complication within a two-week period lurks which can cause equally debilitating problems from neurological deficits to death. Cerebral vasospasms, the involuntary contractions of intracranial blood vessels that can lead to cerebral ischemia and necrosis, are difficult to assess and even harder to predict. Therefore, a novel medical device is proposed which will monitor the clinically significant vascular impedance of the internal carotid artery(ICA) by way of two biosensors monitoring both blood flow and pressure of the ICA. The vasospasm’s effects on both pressure and flow within the cerebrum will cause variations in the vascular impedance of the ICA. Through a computational analysis with the use of the Water-Hammer Equation and the feedback of the biosensors, the vascular impedance of the ICA is calculated. Computational modeling of cerebral dynamics with the Water-Hammer equation has supported the theory that the changes in pressure and flow will cause a detectable and quantifiable change in vascular impedance. Individual validations of the biosensors on a simple vasculature model have indicated the potential accuracy and sensitivity required to measure the small variances in pressure and flow. With the proposed device, medical staff will be notified of sudden changes to vascular impedance allowing appropriate time for intervention before vasospasms induce fatal complications. The medical device will provide a clear, continuous, and acceptable vascular impedance value to medical personnel, which hopefully will allow an increased survival rate following cerebral aneurysm rupture.
DEPARTMENT OF CHEMICAL ENGINEERING

Senior Design Instructor: Jeff Perl, PhD

8.ChE.42
Combined Heat and Power for Corn Wet Milling
Kunal Desai, Roberto Gomez, Mike Kramer, Paulina Mlynarska

Advisor: Dave Bahr, Jacobs Consultancy

This plant allows for the recovery and purification of corn-based food and chemical products. The demand for these products is high as they can be used in a variety of ways including food, feedstock, and fuel. The heat and power requirements for the facility are electricity and steam. Hydrogen, cooling water, and instrument quality compressed air will also be provided. The combined cycle power plant combusts natural gas generating electricity as the gas is expanded through a gas turbine. The exhaust out of the gas turbine contains a lot of energy allowing it to be used to generate high-pressure process utility steam. Conventional power plants lose this heat energy, but here the “waste” steam is expanded through a steam turbine generating additional electricity and meeting the heat demands. This combined heat and power block helps avoid a negative net present value, as it utilizes waste heat. Bi-directional grid connectivity will allow excess electricity to be sold at a profit to further optimize value through a balanced use of natural gas and electricity as these commodity prices change. Steam methane reforming provides a cost effective solution for satisfying the hydrogen demand. Methane and steam react in the steam methane reformer yielding carbon monoxide and hydrogen. In a water shift reaction, carbon monoxide is reacted with water to form carbon dioxide and additional hydrogen that is separated out through a pressure swing adsorption. Water is cooled by evaporation into air in a cooling tower providing cooling water.

2.ChE.55
Corn Germ Utilization: Refining, and Biodiesel Production via Supercritical Transesterification
Jack Blachut, Kunal Gulati, Monika Jonuskeviciute, Paul Schoeneck

Advisor: Dan Rusinak, PE, Middough Inc.

The rapid growth of fuel ethanol has increased the agricultural development of corn, thereby increasing the supply of byproduct corn oil from the germ portion of the corn kernel. With a surplus of corn oil and a diminishing fossil fuel oil supply, support for alternative fuel sources is rising. Correspondingly, a Federal mandate has pushed for higher non-petroleum blends in fuel; this has opened a vast market for biodiesel. Biodiesel is becoming the most practical alternative fuel source due to its compatibility with existing diesel engines and environmentally friendly emissions profile. Perhaps the biggest benefit of biodiesel is the capability of domestic production from non-petroleum and renewable resources. Although biodiesel production from vegetable oil is well established, the catalyzed processes commonly used today present a series of limitations and drawbacks due to high energy costs required for long reaction times and complicated biodiesel purifications. The biodiesel manufacturing in this design utilizes a supercritical non-catalyzed transesterification – a new and potentially lucrative method of biodiesel production – which leads to quicker and higher yields of biodiesel with a simple post-purification process. The design goal of this process is to economically and efficiently extract, refine and produce biodiesel from corn germ, with minimal negative impact on the environment. The production of biodiesel through the extraction and refinement of the crude corn oil is virtually a waste free process as all of its byproducts hold economic value from the food industry to the pharmaceutical industry. With the use of the non-conventional process of supercritical transesterification, a shorter reaction time as well as a higher yield is achieved. This process provides an interesting alternative to a cleaner, more efficient and versatile method of biodiesel production, resulting in optimization of industrial biodiesel production.
3. ChE. 60  
**Corn Receiving and Steeping Process**  
Patrick Coan, Andre Colorina, Alan Reusnow, Jana Rush, Molly Sompolski  

**Advisor:** John Micheli, PE, Middough Associates Inc.  

Recent advances in corn production have allowed for essentially complete conversion of corn into valuable products, including oils, low weight polyols, and low-weight alcohols. Before these products can be made, however, shelled corn must first go through a wet milling process. The wet milling process is designed to separate corn into its components of starch, germ, gluten, and fiber, each of which can then be converted to sellable products. Consequently, there is a continuing need for an initial steeping process to soften the corn and begin the separation process. Before steeping, corn is cleaned to remove foreign materials. Molten sulfur is burned and the resulting sulfur dioxide is absorbed into water to produce a dilute sulfurous acid solution that controls microbial growth. The steeping process consists primarily of soaking the corn in the dilute sulfurous acid for 36 hours using a batch-continuous method. The process is capable of steeping 100,000 bushels of corn per day. Steeped corn is then sent to a germ separation process. The steeping liquor containing dissolved and suspended solids is concentrated into heavy steep water and added downstream into the fiber or gluten dryer feeds as a nutrient component of animal feed products. Our goal is to design a process that maximizes the potential for downstream separation, while minimizing costs. Although the Corn Receiving and Steeping Process will not produce any finished products, it is designed to be the first part of a larger Integrated Corn Production Complex, and is essential to the Complex’s overall success.

2. ChE. 57  
**Corn to Chemicals – Polyols Separation**  
Amber May, Steven Priest, Daniel Sobieski, Garrett Youngblood  

**Advisor:** Jeffery Perl, UIC Dept. of Chemical Engineering. Dennis O’Brien, PE, Jacobs Consultancy

In an effort to reduce the consumption of fossil fuel, many manufacturers are seeking ways to increase the renewable content of their products. Glycols are among these products. Two of the main glycol commodities are propylene glycol (1,2-propanediol; C\textsubscript{3}H\textsubscript{6}O\textsubscript{2}) and ethylene glycol (C\textsubscript{2}H\textsubscript{6}O\textsubscript{2}). These are used in anti-freezes, pharmaceuticals, personal care products, and foods. Both are widely used as intermediates for the synthesis of other chemicals such as polyesters and polyurethanes. Through the hydrocracking of sorbitol (sugar alcohol produced from a corn feedstock), a biobased polyol mixture of over 50 compounds and isomers is created. Separation of propylene glycol and ethylene glycol from this complex polyol mixture is challenging due to the proximity of the polyol components’ boiling points and solvency. Currently, many methods and patents have been developed for the hydrocracking process. These have not been developed on a commercial scale because the processes for separating the resultant compounds produced are complex and expensive. The goal of this team is to design a process that separates propylene glycol, ethylene glycol, and alcohols from a complex polyol stream. The process incorporates ordinary distillation, extractive distillation, membranes, and other technology to find the lowest cost methods to purify the desired propylene glycol and ethylene glycol products to a technical or USP quality grade equivalent to petrochemical-based glycols.
3.ChE.63
Corn Wet Milling – Concentration on Centrifugal Separation of Gluten and Starch
Osman Braimah, Michael Nguyen, Ishai Strauss, James Walsh

Advisor: Jerry Palmer, Ambitech Engineering

Corn Wet Milling is a corn refining process in which corn is separated into its various components, namely starch, oil, gluten, and fiber. This process yields numerous products and byproducts, which are used in a variety of applications from pharmaceuticals to food processing to animal feeds. On an industrial scale, the process of Corn Wet Milling becomes complex, costly, and energy intensive. For our project, we were given a portion of the Corn Wet Milling process, specifically starch and gluten separation and drying. The task was to use our engineering knowledge to design a reasonable, efficient process for separating and drying starch and gluten generated from 100,000 bushels per day of corn, which would then be used by subsequent groups to produce animal feed, pharmaceutical feedstock, and other profitable products. Requirements that were taken into consideration were the ability to justify our reasoning for particular process equipment, following EPA regulations, and producing enough starch to meet the design specification for conversion into dextrose and sorbitol. Throughout the process of this project, a detailed mass and energy balance was maintained as well as researching various competing processes and potential products that could be produced to maximize profit.

3.ChE.61
Corn Wet Milling Germ Separation
Will Abbott, Justin Barak, Meghan Lapeta, Jong Shin, Sandy Younan

Advisor: Shannon Brown, Ambitech Engineering

Corn wet milling has been around for a long time, over 150 years in fact, yet it can still be quite inefficient. Corn wet milling is the most energy intensive of all food industries and consumes fifteen percent of all energy usage in the entire food industry. In the corn wet mill, the germ separation and drying unit accounts for seven percent of the energy used. Since a single corn wet mill can spend upwards of $30 million per year on energy costs, energy efficiency is paramount in allowing continued competitiveness. With these motivations in mind, we designed a germ separation process unit, which is a necessary component of a corn wet mill, to be as energy efficient as possible. We accomplished this through effectively using so-called waste heat to preheat streams as possible and squeeze the most amount of energy out of process streams while minimizing unrecovered heat and heat losses. Furthermore we take all environmental concerns into consideration to ensure adherence to federal and state regulations. At this stage of design, the project was designed through a stage gate one analysis including payback period and ROI with our recommendation to build the plant.
3.ChE.62
Corn Wet Milling Second Grind and Fiber Drying
Anwar Beker, Leidy Nallely Jimenez, Katarzyna Orbik, Collin Pearsall, Elizabeth Wanic

Advisor: Jerry Palmer, Ambitech Engineering

In order to facilitate sustainable growth, the chemical industry needs to shift from productions based upon fossil fuels to more sustainable material sources. This project seeks to shift material sourcing from traditional oil to corn in the production of biodiesel from corn oil. Utilizing corn in this process will require wet milling to separate the grain into high value starch, protein, fiber, and other products. Specifically this project, on a 100,000 bushel of corn a day basis, will design by simulation and industry consultation, an economical and environmentally sound process for extracting a slurry of starch and gluten protein from corn. This part of the processing plant, known as the second grind, will employ milling and grinding, screening and washing, and dewatering and drying to ensure corn kernel cracking and processing. The slurry production will maximize the separation of fiber from the starch and gluten protein while maintaining system profitability. In addition to corn processing, the second grind facility will produce pelletized animal feed. Animal feed will be manufactured from the waste product corn fiber, steep-water liquor, de-oiled germ, and other plant byproducts, producing an additional profit source.

2.ChE.58
Reactor Design for Polyols Production
Nathan Liebmann, Andrew McNamara, Elmar Reyes, Ryan Rock

Mentor: Bill Keesom, Jacobs Consultancy

Glycols are one of the most widely sold chemical merchant products in the world. Millions of metric tons per year of propylene glycol are sold worldwide to manufacture antifreezes, food additives, pharmaceuticals and various other chemicals used in industry. The current mode of manufacture is from the byproducts of petroleum refinement. However, as petroleum resources begin to dwindle the environmentally friendly production of glycols from renewable materials will become more and more competitive. As a result, there is a great opportunity for companies in the U.S. to utilize corn as a raw material to produce glycols – and by extension remain a global leader in the chemical marketplace. The process that we have explored here does exactly this. Sorbitol made from corn is used as a feedstock to generate propylene and ethylene glycols as well as several other byproducts that can be sold on the market. In order to make these products the choice of catalyst and the design of both the reactor and the ancillary equipment all had to be taken into careful consideration. The end result of this work is an eco-friendly glycols production process that will play a vital role in keeping the U.S. ahead in the chemical manufacturing industry for years to come.
Sorbitol and Dextrose Production from Corn Starch
Taras Dykun, Ricardo Plascencia, Patty Rottinghaus, Sarah Wiersema

Advisor: Tom Stephan, Jeffery Perl, PhD

The corn wet milling process is used to separate corn into its four main components: starch, oil, gluten, and fiber. The largest component, starch, can be converted into a variety of products, one of which is dextrose. In this process, the conversion of starch to dextrose is performed by treating diluted starch with enzymes such as α-Amylase, Gluco-Amylase, and Pullulanase. The dextrose will then be converted into sorbitol via hydrogenation. Our primary goal is to maximize profit and minimize losses in a plant such as this where 100,000 MTY of sorbitol is to be produced; we also aim to comply with environmental, safety, and occupational health regulations. Our process consists of four main steps: gelatinization, liquefaction, saccharification, and hydrogenation. Gelatinization is the process of breaking down the intermolecular bonds of the starch molecules in the presence of water and heat. Liquefaction occurs when alpha amylase enzymes are added to break down the gelatinized starch. Saccharification occurs when glucoamylase and pullulanase enzymes are added to break down the solution further, creating a dextrose solution. The dextrose solution will then be purified and sent to the hydrogenation process where a powdered Nickel catalyst will be added to the solution. The mixture will then be sent to a continuous stirred tank reactor in order to produce sorbitol. To minimize waste, the nickel catalyst and excess hydrogen are removed from the sorbitol product stream and reused. Therefore, this design allows for the production of sorbitol with maximum purity and minimum waste.

Water Treatment Facility in Corn Wet Mill Plant
Mark Hartman, David Hu, Christopher Rebolloso, Ethan Rendlen

Advisor: Patrick Shannon, PE, Senior Staff Engineer, Middough Inc.

Sorbitol production from a corn wet milling complex is an emerging market in the country and is useful in several industries. The use of corn in the production of sorbitol has been a controversial issue due to its energy and water consumption. With rigorous environmental regulation, lack of water availability, and economic benefits of water reuse, this facility will aim to be a zero liquid discharge (ZLD) facility. ZLD eliminates wastewater effluent into waterways which can negatively impact the nearby ecosystem. The ZLD treats the blowdown from cooling tower and boiler and essentially other waste streams with a significant brine concentration. As well as reducing the amount of intake water to the facility and in some cases recovering valuable by-products. Utilizing modern anaerobic water treatment technology the facility will produce biogas, which used as fuel, will reduce the net energy requirements of the entire process. The anaerobic treatment will significantly reduce the amount of organic contaminants and in combination with ultrafiltration, softening and demineralization processes produce clean reusable water for the complex. The source water to be used for this process is Lake Decatur in Decatur, Illinois. The plant will be capable of implementation of additional waste to energy sources such as surrounding sanitary and farm waste if desired. Some solid waste can be reused as fertilizer, increasing the symbiotic relationship of the process with the surrounding rural area. Overall, this water treatment facility will substantially reduce the environmental concerns revolving water usage in a corn wet mill plant, while providing the plant with clean, reliable, and reusable water.
7.CME.36
City of North Chicago: Water Distribution Phase I
Paul Guardi, Keith Schell, Nadia Simek

Advisor: Amid Khodadoust, PhD, UIC Dept. of Civil and Materials Engineering. Arun Heer, PE, CFM, United States Army Corps of Engineers

The city of North Chicago (Illinois, USA) is located on Lake Michigan and has a municipal water treatment plant (WTP) with a 15 million gallon per day (MGD) capacity. This facility, however, currently produces only 4-6 MGD. Meanwhile, some communities directly west of the city are facing water shortages in the near future. Selling water to these communities would provide needed revenue to North Chicago, and would ensure the supply of this precious resource in areas where it is needed. In addition, North Chicago-based pharmaceutical company Abbott/Abbvie currently buys 60% of the plant’s water. If Abbott were to relocate or stop needing the water, it would be a large loss of revenue for the city. This project is a Phase I study on the feasibility of expanding the North Chicago WTP and its network. It will determine the necessary upgrades for the plant to treat enough water for distribution to those communities that need it. These include expansion of the plant’s facilities and a distribution pipeline. This study will establish the water demand for the distribution area and the permitting for land acquisition and water allocation. Our goal is to design the improvements required to bring the plant closer to its operating capacity, and to do so in the most economic, efficient, and sustainable manner possible.

7.CME.31
Design of Geothermal Pavement for Runway 16/34 at Chicago Executive Airport in Wheeling, IL
Oscar Gomez, Zachary Jaydos, Maciej Konczewski

Advisor: David R. McDonald Jr., PE, PhD, PTOE, Chief Roadway Engineer, Hanson Professional Services Inc.

Every year travelers continually experience flight delays due to inclement winter weather. As flight cancellations compound by the minute, airport operational costs exponentially increase with each grounded flight. The traditional methods of mechanical snow removal and chemical implementation are costly, unable to keep pace with clearing runways for actions (takeoffs/landings), and can have environmental consequences. The primary goal of this project installs a geothermal heated-pavement system to raise the runway temperature and prevent the formation of ice on the surface at a representative airport. In doing so, this will directly minimize flight delays, operational costs, and chemical use. Specific requirements include the development of a closed loop, glycol-based pipe system directly underneath the runway surface, allowing for controllable temperatures and a sustained ambient temperature range during the winter months. The heating system allows for reduced use of harmful anti-icing chemicals, which discharge directly into rainwater runoff basins. Our team worked in conjunction with the Executive Director at Chicago Executive Airport in Wheeling, IL to implement the design and integrate the system into the current facility maintenance program. The system was tailored to the airport’s main runway, 16/34, which is responsible for nearly 90% the 80,000 actions each year. A benefit cost analysis was conducted for the project, showing significant benefit for the airport property. The geothermal pavement design for runway 16/34 was estimated to successfully decrease the facility maintenance budget and prevent future runway closures due to adverse winter weather.
7.CME.32
Drainage Improvement on Bunning Drive, Downers Grove
Abdolreza Alemzadeh, Tom Benneke, Carlos Bravo, Antonio Tijerina, Yuriy Yatsyshyn

Advisor: Joseph W. Schulenberg, PhD, UIC Dept. of Civil and Materials Engineering. Tom J. Topor, PE

Flooding is one of the most undesirable problems that can affect urban roadways and cause damage to thousands of residential properties. It results in shutting down of the roads and is costing homeowners thousands of dollars in repairs to their properties. A section of the roadway that had experienced similar degrees of indentation is located along Bunning Drive in Downers Grove, IL. During frequent storm events the street and the parkway becomes impassable to surrounding residents and emergency vehicles. Implementation of engineering design is necessary to prevent future flooding issues. In order to reduce the risk of flooding in the specified area, two major alternatives that are allowed by the local, county and federal agencies will be considered. The first alternative will include an evaluation of the existing storm sewer system and resizing of the pipes to the maximum allowed before downstream drainage is impacted. The second alternative will consist of the design of an underground detention basin, able to intercept and retain the stormwater runoff before it is discharged to the storm sewer system. Water quality improvements will be addressed through an exploration of porous pavement before the stormwater is transferred to the detention basin. Existing rainfall data, DuPage County 2-foot contour maps, underground utility information and field topographic data will be used to determine watershed area and the existing hydraulic characteristic of the region. Rational method will be used to determine the peak discharge. The design alternatives will be drafted and presented with a use of AutoCAD software.

8.CME.38
Edgebrook Metra Station Upgrade Utilizing LEED Construction
Charles Boutros, Razvan Calin, Ben Ilciuc, Deven Nandamuri

Advisor: Mustafa Mahamid, PhD, UIC Dept. of Civil and Materials Engineering

In the forever-adapting working class, more and more commuters have looked to alternative modes of transportation to commute to and from work. Reasons such as frustrating traffic congestion, environmental consciousness, and expensive fuel process are a few of the reasons for this mode shift. This, however, has not been an easy transition due to the aging and outdated rail infrastructure. In the Chicagoland area, Metra operates commuter rail service from the surrounding suburbs to downtown Chicago. The Edgebrook Metra Station, on the Milwaukee District North Line, is in dire need of rehabilitation, as it currently stands as a small, open structure that provides little to no cover from the elements as passengers wait for their train in Chicago’s extremes weather conditions. Lacking patron accommodations is likely one of the causes of declining ridership. This project scope focuses on developing a structural design of a modern rail station house and shelter that fulfills the demands of the surrounding area while following Metra guidelines associated with new station construction. This will comprise of erecting new structures, incorporating steel and glass, on both the inbound and outbound tracks with amenities including, but not limited to: an automated ticketing system, bathrooms, warming stations, and WiFi accessibility to better serve, as well as draw in more passengers. As the City of Chicago aspires to transform into a world leader in environmental consciousness, this project will incorporate LEED design standards with a modern station design that will significantly benefit the community, both economically and environmentally, for future years.
Flood Control in Residential Neighborhoods of Greater Chicago
Advisor: Sybil Derrible, PhD, UIC Dept. of Civil and Materials Engineering

Every year, many neighborhoods in the Greater Chicago area incur flood damages costing millions of dollars. There are several different ways in which flooding occurs, such as the capacity of the local storm sewer system is exceeded and sewage backup. The development of Chicago and its surrounding areas resulted in an increase of impervious surfaces, which caused an increase in the amount of stormwater runoff draining to the existing drainage systems which are many times inadequate. On April 18, 2013, five to eight inches of rainfall was observed by the National Oceanic and Atmospheric Administration (NOAA), which resulted in widespread flooding and caused severe damage which lead to evacuation of residences. A study performed by the Center for Neighborhood Technology (CNT) analyzed urban flooding across Cook County ZIP codes from 2007 to 2011. CNT found that one in six residences made a flood damage claim with a private insurance group over the five-year period amounting to $660 million. In order to derive the rise in water elevation, historical and design storm events were analyzed. Current practices and experimental methods were looked at to find the most efficient way to mitigate flooding in residential areas. Technologies utilized specifically to monitor stormwater levels are implemented to make the stormwater management system more efficient over time. These technologies most specifically consist of a network of sensors used to detect water levels that are connected to local storm water management agencies. The agencies therefore can also notify residents living downstream of the runoff.

Geothermal Application for Overpass De-Icing
Adam Casati, Glen Duffy, Sher Khan, Scott Paloian
Advisor: Craig D. Foster, PhD, Dept. Of Civil and Materials Engineering

At very low temperatures salt nearly becomes ineffective at melting ice and snow on roadways. While combinations of other chemicals may alleviate this issue, there still lies a concern about the environmental impact from runoff of melted snow. The usage of salt can also be attributed to large amounts of corrosion of steel on bridges and the breakdown of concrete bridge decks. The primary goal of the project is to design a geothermal heat system that will effectively melt ice and snow on the bridge deck of an overpass. The Harlem Avenue Bridge at Interstate-55 was chosen as a basis for design due to the location and its high average annual daily traffic (AADT). While expensive, geothermal energy is a renewable resource that relies primarily on the constant temperature of the earth. By circulating liquid through an integrated piping system using harvested geothermal energy, it will be able to maintain an operating temperature that is consistently above freezing. While the implementation of geothermal technology on bridges is relatively new, we hope that our work will further promote the use of geothermal energy and serve as a stepping-stone for future projects regarding sustainable highway design.
7.CME.33
Heated Re-Pavement System for Bridge Decks
Christian Elia, Gabriel Flores, Matthew Rasmussen, Jesse Storm
Advisor: Michael J. McNallan PhD, UIC Dept. Civil and Materials Engineering

Every year in the United States, traffic accidents are one of the leading causes of death. Road conditions can be a major factor that contributes to this phenomenon. During the winter, bridges are one of the most dangerous forms of infrastructure because they tend to develop ice at a faster rate than roadways. For years now, deicing chemicals have been used to melt the black ice on bridge surfaces; these chemicals damage the surface and bridge material which ultimately decreases the service life of a bridge. There are several bridges in the U.S. that have built in heating pipes to combat this problem. These systems pass heated water through the pipes and allow the bridge to be deiced without the use of chemicals. However, these systems are costly to build and maintain. We will design a pavement heating system that can be installed in conjunction with the routine milling and replacement of the top layer of concrete. While the concrete is being replaced, heating elements encased in steel will be installed below the surface of the bridge deck. The heating elements work using joule heating rather than radiant water heating. In addition to the top layer of concrete being replaced, an access trough along the edge of the pavement will be installed to allow simple access to the heating elements. The overall goal of this heated re-pavement system is to reduce the danger of winter conditions, increase the service life of the bridge, deice the bridge and provide simple maintenance.

8.CME.37
Nutrient Removal Using a Constructed Wetland
Caleb Carr, Paul Jacobs, Diana Mejorado
Advisor: Karl Rockne, PhD, UIC Dept. of Civil and Materials Engineering; Jill Kostel, PhD, The Wetlands Initiative

Nitrogen and phosphorous are essential nutrients for sustaining plant life, however, excessive amounts in waterways can cause eutrophication and hypoxic conditions, which can put aquatic life at serious risk. Agriculture is the primary source of these nutrients to the Mississippi River. Pollutant loads that leave agricultural fields can be difficult to manage once they enter a stream system. Constructed wetlands sited to intercept tile drainage flow in locations where nutrients originate have the potential to significantly reduce nutrient levels. A site in the Big Bureau Creek watershed has been identified to serve as the demonstration of this non-conventional conservation practice. The primary goal is to develop an engineering design for this site. The main requirement is that the design meets the Illinois Natural Resource Conservation Service’s practice criteria and standards so the landowner can receive financial assistance through federal/state conservation programs. Sizing the wetland began with calculating design flows through hydrologic and hydraulic models followed by the modeling of nutrient loading to determine influent Nitrogen concentrations and reduction potential. Geotechnical data and physical land characteristics were analyzed to design the impoundment structure. Permitting issues were investigated and a cost/benefit analysis was performed. A template of the hydrology and engineering parameters was developed with key design elements facilitating and accelerating the design of future wetland sites which implement an underutilized but highly effective nutrient reduction practice within the context of a state nutrient reduction strategy or trading program.
12.CME.2
A Resource for Commuters and a Building for UIC
Marian Agamy, Slawomir Domagala, John Kando, Alexandra Laskero

Advisor: Mustafa Mahamid, PhD, SE, PE, LEED AP, UIC Dept. of Civil and Materials Engineering

The University of Illinois at Chicago (UIC) campus has the largest student commuter population in Illinois with approximately 85% of the 27,500 students commuting. The University has tried to accommodate these students by providing the Commuter Student Resource Center (CSRC), however, originally planned in 2009 for the maximum of 200 total students at a single time. Due to the current layout, there are many problems with the CSRC, which include: space restrictions, the inconvenient location and layout, operating hours, student outreach capabilities and the lack of amenities provided. Considering these problems many students could benefit greatly from a relocation and redesign of the CSRC. Thus, to better accommodate students, a new building dedicated to the CSRC is proposed. This proposed facility would significantly improve the lives of students, based on its location in the heart of the eastside campus, the ample space and the services that will be provided. Students will benefit from amenities such as: a kitchen to store and heat up food brought from home, abundant locker space, shower rooms, a lounge area, a computer lab with printing center, and private study rooms. The building will be LEED certified under the new construction and major renovations section following the green building. Green building technologies to be utilized include: a renewable energy source, green roofing, greywater recycling systems, rain barrels, and more. In short, building a new CSRC UIC will show its commitment to the commuters. Which will make UIC more diverse and expand the perspectives at the school and that will continue to make UIC one of the forefront universities in the country.

12.CME.3
Stormwater Repurposing System for Lecture Center E, UIC Campus
Khaled Abunijmeh, Bryan Gehrling, Saulius Imsha, Laura Nainggolan

Advisor: Thomas Burke, PhD, UIC Dept. of Civil and Materials Engineering

The City of Chicago experiences upwards of 37 inches of rainfall every year that gets sent to treatment when it could be potentially reused and treated as a commodity that is not wasted. UIC’s Lecture Center E (LCE) would be an optimal location of initial inquiry to measure the environmental implications and results. In other more arid regions, such practices would be even more lucrative due to higher water costs and limited supply. The repurposing plan for LCE would begin with minor alterations to the gutter and drainage system which would allow the stormwater (rainfall and snowmelt) to be collected and conveyed towards a reservoir for minor settling treatment that would be either within or just outside the building. After filtering, the gray water can be easily pumped towards the building’s restroom use. During seasons of low precipitation, the facility would have to rely on City tap water. The lower amount of stormwater entering the city’s combined sewers as a result of this proposed repurposing system decreases water treatment volumes to Metropolitan Water Reclamation District (MWRD) of Greater Chicago. The benefits of implementing this environmentally friendly system includes reusing a valuable commodity as well as lowering the flow into the already limited capacity of the City’s combined sewer system as well as leading to an overall higher efficiency level of energy usage for the City of Chicago.
**8.CME.39**

**Sustainable Design of Signalized Intersections**  
Mark Kachanthong, Rana Kalo, John Salihoglu

**Advisor:** Dr. Sybil Derrible, PhD, UIC Dept. of Civil and Materials Engineering

Energy consumption continually increases in the United States, and with rising consumption comes rising costs of energy. Moreover, the production of this energy has several adversarial impacts on the environment, and engineers must consider sustainability as a more important part of their work. Aspects of road design that constantly uses electricity are traffic signal design, roadway luminaires, and loop detectors. LED traffic signals in Chicago use about 600 watts, whereas incandescent signal heads use 3 times as much. By implementing a new design for street intersections with sustainable traffic signals, not only can our society lower our impact on the environment, we can also spend the resources saved on other important matters. The use of energy gathering concept in civil engineering design is becoming more prominent. One such concept involves reusing energy from traffic through intersections. This design concept is called the Traffic Powered Renewable Energy System (TPRES). This concept is implemented by installing an array of pneumatic pistons in the surface of the road that passing vehicles would depress, therefore sending compressed air into a nearby turbine and generator that can create power for use in traffic signals directly. The purpose of this concept is to generate enough energy from the daily flow of traffic to meet the electricity requirement for the traffic signal cabinet and other needs. For this project, we plan to conduct a feasibility study for the real-life application of this concept at a large scale. This feasibility study includes energy, life cycle, and cost-feasibility assessments.

**7.CME.35**

**Sustainable Storm Water Management for Harlem Irving Plaza**  
Matt Boladz, Steven Childers, Jana Knoppe, Caitlin Lahey

**Advisor:** Thomas Burke, PhD, Christopher B. Burke Engineering, Ltd.

Extreme cases of flooding around the Chicago area due to rains are becoming a growing issue. The sewer systems in Chicago are combined sewer systems and are not adequate to handle the volume of runoff during these severe events. The combined sewer system receives runoff from commercial buildings and residential areas. The rainstorm causes the pipes to exceed their capacity, resulting in raw sewage directed back into residential homes and into Lake Michigan where all of Chicago’s drinking water is from. The combined sewer system can only hold up to 2 inches of rain while we are experiencing storm events with up to 8 inches of rain. Our plan is to separate a combined sewer system into a separate storm sewer and waste sewer system. The area we selected to analyze this concept was Harlem-Irving Park Plaza and the surrounding neighborhood in Norridge, IL. This area has experienced devastating flooding multiple times in the past decade. Analysis will be run using HEC-HMS to get a volume of storage for green infrastructure and the new storm sewer system. The new storm sewer systems will be constructed along with permeable concrete and a new retention pond to detain runoff. We will size the retention pond based off previous storm events. Our goal is to mitigate the storm water issue and be a sustainable solution. We hope this area can serve as an example for the rest of Chicago to follow.
Within our lifetime, population is expected to greatly increase in the Chicagoland area, putting strain on our limited natural resources. In order to combat such an issue, one must consider building structures that are liberated from relying solely on the consumption of nonrenewable resources. In conjunction with the population increase, the University of Illinois at Chicago (UIC) plans to accommodate an anticipated increase in students by revamping the current commuter campus and creating a more stationary hub capable of housing a larger volume of residents. Parking lot number 5, located off of Morgan Street, is a relatively unused space that would benefit from a rejuvenation. In order to appeal to potential residents, the UIC campus must consider the inadequately used public grounds and redesign them with the community and environment in mind. In the new multi-disciplinary design, the existing impervious lot will be replaced with open green space, a dual-purpose water retention basin, and a new student dormitory that would incorporate LEED certification, thus providing a more appealing atmosphere and a release from dependence on nonrenewable resources. Key features include water conservation, renewable energy and energy-efficient design, economical structural design, and a functional yet appealing landscape. With the redesign, the university will foster a unique urban campus that encourages growth and advancement in education as well as decreasing the global footprint generated by UIC.
12.CME.6
UIC's Sky Garden: A Green Escape

Salvador Carvajal, Alejandro Flores, Mario Martinez, Victor Patino

Advisor: Sybil Derrible, PhD, UIC Dept. Civil and Materials Engineering

Student Center East (SCE) is one of the largest buildings on UIC’s campus and serves thousands of students and staff each day. It is a multipurpose building that requires a substantial amount of resources in order for it to function properly. The size of the building also contributes to a large amount of surface water runoff in the area. At times the surrounding structures and landscapes are overwhelmed which results in large pools of standing water collecting in locations which students travel along. Our plan to improve storm water collection in the area is to install a green roof on top of the SCE building. The plants and multilayer roof will reduce runoff and effectively use rainwater in maintaining aesthetically pleasing plants. A green roof has important properties that allow it to effectively manage stormwater runoff. In addition, the green roof will aid in reducing energy costs for the building. The vegetation will reduce cooling costs in the building since they will absorb a large portion of heat which would normally be absorbed into the building. The roof will also be accessible to students and serve as a fifth floor to the building. It will be aesthetically pleasing and serve as an additional recreational space. The vegetation will also help improve air quality in the area which will attract students.
5.ECE.28
Access Control and Environment Monitoring System
Aissar Alanasweh, Michael Gray, Akeem Olaoesbikan, Karl Swanson

Advisor: Milos Zefran, PhD, UIC Dept. of Electrical and Computer Engineering

In this day and age, the ability to monitor the environment and access to a specific space, or group of spaces, is extremely important. Various establishments like schools, businesses, hospitals, and homes all contain what many would consider “precious cargo”. For the sake of keeping this cargo safe, environmental and access control systems are purchased. Although, environmental monitoring systems and access control systems exist, these products tend to be implemented separately. Our device combines these systems into one unit that can serve at both capacities. Not only does this allow for a reduction in cost but through our device, things like monitoring the temperature of mechanical and electrical equipment or allowing designated users into secured areas become very simple. Our design uses sensors for environmental readings. A card reader, relay and electrical strike plate powered by a few 9V batteries are used for access control. Data from the entire system is then sent to a small controller which then relays the information to a web server. The web application displays the data in a very user friendly manner making it easy for anyone to learn and use. The potential growth of this product is great, mainly due to the ability to implement more features and the never-ending progression of technology.

6.ECE.19
Analog Dub Delay Pedal
Adam Balfour, Quan Huynh, Douglas Wood

Advisor: Dr. Vahe Caliskan, PhD, UIC Dept. of Electrical and Computer Engineering

Within the music world analog delay effects are commonly used, especially amongst guitar players. Analog delay pedals produce a more vibrant and richer audio tone compared to digital delay pedals while only offering few options. Traditionally analog delay pedals offer one type of delay (waveform) and surface mount knobs to make adjustments to the signal. The idea for the Dub Delay Pedal is to integrate analog audio with features that digital pedals boast while not losing the warm pure tone. The Dub Delay Pedal gives the user the option of manual adjustment with surface knobs or hands free adjustment, via on board expression pedal. The second design idea is adding a waveform generator that can produce more than just the traditional analog sine wave. Our solution is to design an analog delay circuit that expands upon the available modern technology. The goal is to keep the pedal’s form factor similar to what is currently available today. Utilizing the familiar multi-effects board design, the dub delay pedal will be completely self-contained and easy to cascade with other effect pedals or instruments. Improving the features and capability of the analog delay pedal while keeping the warm audio tone is what we set out to achieve.
5.ECE.29  
Automotive Microcomputer Control Unit (AMCU)  
Mark Blustein, Billy Wu, Mohammad Zeni  

Advisor: Mitchell D. Theys, PhD, UIC Dept. of Computer Science  

Car enthusiasts that wish to be able to customize their car currently have no option but to dish out thousands of dollars. In most cases, a person only has the option to add features to their car when they are purchasing the vehicle at the dealer and an enthusiast may want to add gauges with price ranges in between $100 to $300 dollars. This is where our AMCU comes into play. We wish to design a product that can read numerous sensors (in the future, add the ability to add on multimedia features) and display them all on a fully customizable interface. This provides a far cheaper alternative to what is available in the market currently and would allow a user to customize the display to their preference. It will also remove the need of buying each physical component separately as it will all be contained and managed on one device. Implementation of this project was done with the Beaglebone Black (BBB) and ADC convertors. The data is interpreted via a user friendly GUI, allowing for a customizable interface. We have developed circuitry that will protect the BBB and to ensure proper operation and our testing proves that the data is retrieved efficiently and reliably. As we opt for a fully customizable product and user interface, we have accomplished our short term goals and we can pursue venture opportunities to introduce this project into the public market.

6.ECE.20  
Bicycle Turn Signal  
Aswin Gonzales, Eunkook Kwak, Nathan Piland, Jacob Ruggiero  

Advisor: Vladimir Goncharoff, PhD, UIC Dept. of Electrical and Computer Engineering  

Bicycle safety is an extremely prominent problem in the United States, especially in large cities such as Chicago. The main problem for bicyclists today is visibility, i.e. their ability to be seen. Many accidents involving bicyclists are due to the fact that motorists simply cannot see them. One way to fix this is to install turn signals and brake lights on bicycles, much like those that you see on motor vehicles. This will greatly increase bicyclists’ visibility and motorists will be more likely to recognize them as a vehicle on the road. Our product is a system of lights and sensors that will be installed on the bicycle: two led turn signals on the front of the bicycle, a proximity sensor at the rear of the bicycle to show when a car is near to the bicyclist, and two rear turn signals and brake light. The bicyclist will control the turn signals by flipping a switch located on the handlebars either up or down, depending on which direction the bicyclist wishes to signal. The brake light will be operated by simply pulling either the front and/or rear brake. Wireless communication devices will be utilized for data transmission between the front and rear light systems to reduce the amount of wires necessary for the product and to improve aesthetics. With this product, a bicyclist can be more confident that he/she will be more visible when riding on the road and should reduce the number of accidents between motorists and bicyclists.
6.ECE.24

Body Effective Sensing Temperature Vest (BEST Vest)

Syed Mehfooz, Krunal Patel, Andrew Dwinal, Mohammad Hossain

Advisor: Vladimir Goncharoff PhD, UIC Dept. of Electrical and Computer Engineering

Safety is the most quintessential factor that every business regards in today’s world. Whether it is the safety of consumer products or employees, business managers cannot afford to overlook this crucial factor in running successful companies. Testing the effects of temperature of numerous environment on a human using temperature body vest would provide many applications. With a properly positioned life-size body wearing BEST Vest instead of thermocouples, in a car for example, can provide real-life scenario simulation and data collection for increasing safety. Our BEST Vest would take into account air flow and heating element to simulate certain conditions that affects body. The demand for this vest could be reach into most testing environments. By adding pressure and acceleration sensor; areas of application for BEST Vest can further be enhanced to water and space vehicles, environment where atmospheric pressure differs, and firefighting. The temperature sensors can be calibrated and would hold up to US Code of Federal Regulations. Power supply to the BEST Vest can be adjusted as its application demands. By using microcontroller and temperature sensors, the calculation of the temperatures and data transmission will occur via either serial or wireless connection. The applications of this device are continuously growing as we believe there are many more areas where our product would be relevant. Many industrial test engineers would save time by using BEST Vest.

5.ECE.27

Electromagnetic Communication Band of Tomorrow

David Macedo, James Redondo, Dan Sellers, Qing Zhang

Advisor: Robert Becker, MS, UIC Dept. of Electrical and Computer Engineering

Most of us carry keys, credit cards, identification cards, and numerous other valuable possessions with us every day. With engineers constantly creating smaller more powerful devices and RFID technology becoming more commonplace, we believe being able to store our personal information and items onto an RFID enabled device will be an attractive solution for many different people. Our goal is to take those common items we carry with us every day and replace them with a wristband with integrated RFID technology. As a result, users will have one comfortable wristband that can ultimately replace their keys, I.D. cards, and credit cards. Our design will consist of three main components. These are the RFID wristband, an RFID transmitter, and a server system for security/protection purposes. A microcontroller will be used to communicate between the server and RFID system. Upon reading a tag, the tag’s information will be transmitted to the server and verified that it is correct and valid. Then the corresponding action will take place such as unlocking a door or completing a transaction. Additionally, tags will be able to be shut off in the case of a lost or stolen wristband. The reassurance of having your information secured, easily accessible, and portable is a stepping-stone to the communication band of tomorrow.
5. ECE.25
Emergency Vehicles Detector
Alan Chan, Hong Lee, Henry Moy, Jedidiah Oyeyemi

Advisor: Ning Jing, PhD, UIC Dept. of Electrical and Computer Engineering

The goal of the EVD is to alert drivers of incoming EV (Emergency Vehicles) by indicating the direction. The EVD can reduce traffic problems and accidents in addition to alerting the hearing impaired and distracted/aging drivers. In order to not distract drivers, a simple user interface display that is easy to use would be a specific requirement. The display will contain four arrows where one of the arrows will light up and point at the direction of the incoming EV. In addition to the display’s LED lighting up, there will be a sound effect to alert drivers. An Arduino microcontroller will be used to sample the sound and process it into the display. Four microphones will be placed in the north, south, east, and west directions because the EVD samples short segments of sounds in its surrounding. Arduino will verify the sampled sound frequency with the EV’s sound frequency stored in the database. By taking the Fourier Transform of the signal and analyzing the signal strength at those frequencies, the EVD will be able to estimate the direction in which the EV is moving. The next phase of this product will include how far the EV is from the vehicle. Overall, drivers can seamlessly integrate the EVD into their car due to the simplicity of the user interface, and it will provide drivers an extra ear for EV.

6. ECE.21
A Method for Blocking Distracted Driving
Jordon M. Birk

Advisor: David Borth PhD, UIC Dept. of Electrical and Computer Engineering

A growing cause of preventable death in the United States is the use of mobile technologies while driving. The Center for Disease Control and Prevention (cdc.gov) estimates over 9 deaths and 1,060 injuries stemming from distracted driving in the US on a daily basis. Of most interest is driving while texting, due to the level of attention it removes from driving relative to other tasks. 31% of drivers, age 18-64 reported driving while texting within 30 days prior to being surveyed by the CDC. While mobile apps exist that will prevent driving while texting, through use of the GPS velocity, to verify motion unattainable by other modes of transportation, they do not work indiscriminately. Many will simply block text messages from being sent at a certain velocity, which prevents texting outside of the driver's seat and will also block texting while using public transit. Implementing “jamming” technology in vehicles, even if only confined to the driver's seat, would block the driver from sending messages while the car were not moving, which is both undesirable, as many consider the car to be a valuable safety bubble around the environment, and illegal in the United States by FCC regulation. By using a near-field communication emitter with a threshold of arms-length of a driver's seat, alongside GPS velocity tracking, together the criteria should suffice to block only unwanted text messaging. A proof-of-concept using GPS and NFC modules, ANDing each output, was implemented.
Motor Telemetry System
Joe Davis, Brian DeSimone, Zach Quinn

Advisor: Vahe Caliskan, PhD

In today’s world there is an increase in automated manufacturing and motor controlled systems. From large companies to even the garage hobbyist, there is a high demand for a motor monitoring device with intuitive software. Currently, motor telemetry systems are simply too expensive for many small businesses and consumer use. Our Motor Telemetry System (MTS) is affordable, meaning the average person, small business, or large corporation will be able to accurately and reliably monitor any type of motor driven system. MTS is a low cost, highly efficient, and very unique answer to this large demand. MTS is unique for two reasons, first, it is sold “tool only” meaning you buy the standalone system as a separate unit or a barebones kit. The user can then buy the attachments they desire to monitor data such as temperature, speed, or circuit breaker status. While helping to keep the cost down, this method is environmentally friendly and keeps the footprint of the system as small as possible. Secondly, MTS is an open source project, meaning a public API will be written to allow individual expansion of the system and further customization to customer specific needs. MTS uses two powerful microcontroller processors that interface with each other to provide real time status updates of the sensory data collected while displaying them graphically and wirelessly to our handheld LCD. By creating a device that transmits sensory data from our attachments wirelessly, it allows the operator to have mobility as they are interacting with our system.

Occupancy Network with Mobile Tracking
Gary Landisch, Isaac Puckett, Mark Skiba

Advisor: Igor Paprotny, PhD, UIC Dept. of Electrical and Computer Engineering

How often do you wait for a train or a bus and find that it is completely packed? How often are your plans foiled when completing daily errands? Our product is designed to give users the information they need to plan their day more efficiently. We can accomplish this by breaking down an environment into an array of areas that people occupy. For example, this could be seat/standing room on a bus, or equipment at your local gym. We then use sensors to detect human occupancy and aggregate the data onto a local microcontroller. We then broadcast the newly acquired information to a central hub. The hub will update our servers so that our clients may access the data via android application. Consequently, our product will inform our users on the seat availability of each transit route. The companies who use this product will also benefit as well. They can track usage so that they know what products people are using. This will give them insight when they want to increase certain routes or invest in new equipment. This product can be applied to a variety of situations that were not mention above. This could be household security, lecture attendance, restaurant seating, etc. Due to the versatility of this product, the applications are limitless.
6. ECE.23
Placing Made Easy
Hector Acosta, Querida Ellis, Ravi Patel, Konal Shah

Advisor: Vahe Caliskan, PhD, UIC Dept. of Electrical and Computer Engineering

Increasingly, there is a push for greener, more environmentally friendly approaches to food production. With the emphasis on farm-to-table and organic movements in the United States and all over the world, individuals have been seeking ways of becoming smarter consumers. Our gardening device, Placing Made Easy, seeks to provide beginners and the more advanced the option to do just that; those wishing to grow their own fruits, vegetables, herbs, or plants can quickly become proficient gardeners. While there are similar monitoring systems on the market, our approach is different in that it is small, interactive, easy-to-use, and affordable. In addition to monitoring moisture, sunlight, temperature, pH, and soil nutrition, it also grants users access to a database containing optimal gardening conditions for a number of plant species. The device consists of four major parts: sensor circuits (including any necessary amplification components), an analog-to-digital converter, a microcontroller, and an LED display. Each of the sensors passes analog values to the microcontroller’s ADC to be converted to digital values and displayed on the LED screen. In terms of acceptable performance, the device will provide measurements within 5% of actual values and work in environments between 40 and 120 degrees Fahrenheit.

1. ECE.64
Sailing for the Blind
Frank Marotta, Robert Obrochta, Matthew Pristave

Advisor: Robert Becker, MSc, UIC Dept. of Electrical and Computer Engineering

At present, sailors who cannot see must be accompanied by sighted persons whenever they wish to sail. The Judd Goldman Adaptive Sailing Program aims to change that. The scope of the program is quite large, with the end goal being to have the sailor request important sailing data by speaking commands into a headset, and then to have the system return the data requested by playing back verbal responses that the sailor may use to navigate safely. Our contribution to the project is to capture and report the angle of the mainsail and jib of the Sonar boat, relative to its centerline. Our specific requirements are that we capture these angles within a tolerance of 5°, and pass this data along to the system’s main microcomputer (a Raspberry Pi) in a format it may easily interpret and relay to the sailor. Previous work on this project included a compass IC used to capture the heading of the vessel, which then sent this data wirelessly to the Raspberry Pi. Our intention is to incorporate additional compass ICs that we will fix to the jib and the mainsail, and develop an algorithm to compute the relative angles reported by these components, yielding their angles relative to the centerline of the boat and any given time. One constraint we have is that all of the equipment must be easily removed from the boat while the boat is docked. Our approach provides a lightweight solution that will have no trouble meeting this requirement.
University of Illinois at Chicago
Engineering EXPO Abstracts

**4.ECE.11**  
Universal Power Supply and Automated Thrust Testing System  
Bryan Bickel, William Guszczo, Thomas Nixon, Christian Ortega  

**Advisor:** Vahe Caliskan PhD  
**Society:** The American Institute of Aeronautics and Astronautics at UIC

The AIAA chapter at UIC competes in the annual Design Build Fly competition hosted by the national body. Each university team designs and builds their own aircraft for the competition. It is vital that the team has accurate data about the maximum thrust possible in order to design the aerodynamics of the plane. Previously, the motor was tested while powered by batteries and data was recorded by hand. Problems include the introduction of human error in the data and the short life span of the batteries before requiring an hour or more to recharge. A power supply which is capable of delivering 25 amps at voltages between 14 and 36 volts was designed with the capability of being used independent of the automated testing system. The automated testing system is designed to communicate with the power supply and capture thrust force, rotations per minute, and motor current draw. Then the system streams the data to a computer over a serial connection for easy analysis using MATLAB, Python, or Excel. The AIAA chapter at UIC looks forward to using our prototype to streamline testing in the coming years.

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**4.ECE.7**  
Vector Recording Lock-In Amplifier  
Carl Goding, Ashvin Ilangovan, Moath Jaber, Douglas Spitzer  

**Advisor:** Danilo Erricolo, PhD, UIC Dept. of Electrical and Computer Engineering

Our project focuses on the design of a circuit for measurements and verification of theories related to electromagnetic radiation detection. This investigation is motivated by the need for measuring vector quantities such as the magnitude and phase of sinusoidal waveforms for the purpose of comparing them. As instrumentation for scientific data acquisition continues to evolve, improvements focus on optimizing performance characteristics such as selectivity, sensitivity, uncertainty and detection limits. One practical challenge is the extraction of information in the presence of noise, therefore in many fields of science, methods addressing a dynamic strategy for improving the signal-to-noise ratio have strong impact on experiment design, signal sampling and post-processing data characterization. Accordingly, we designed an electronic circuit to recover information embedded in noise or otherwise below the measurement threshold of other less sensitive instrumentation. In the lock-in technique, system functions include detection, modulation, filtering, mixing, amplification, processing and storage, with a phase-locked loop frequency synthesizer removing most external noise. Further differentiating qualities of our design include its comparatively small dimensions, enclosed shielding, portability, cost-effectiveness, low power dissipation and constant connectivity to a personal computer for immediate viewing of results. Investigative explorations featuring our circuit include measuring the intensity of select light and sound waves and--discovering features of weak signals yet to be resolved in actual laboratory research. The next stage of development involves upgrading each component for extremely high-accuracy, high-precision laboratory applications. Thus the ability to represent a signal without distortion leads to new physics and further opportunities for innovation.
5.ECE.30
Vehicle Light Sensor
Saad Bhatti, Hang Huynh, Duoc Nguyen, Zaid Bin Zubair

Advisor: Robert Becker, MSc, UIC Dept. of Electrical and Computer Engineering

Technology continues to grow without bounds but people’s income does not seem to be matching its costs. Looking at today’s cars, specifically, it is easy to observe the vast number of gadgets and safety options that come standard with these dynamic vehicles. Owners of older vehicles, however, do not have the luxury of being offered the same level of protection. Our project is geared towards bring these older cars up to par, in terms of safety, with the rest of the vehicles of today by developing a system that can detect when a car’s brake light and/or back lights have stopped working. Specific requirements include constructing a way to evasively detect current flow to the light bulbs, using transistors and relays, and communicating with the car driver if a light bulb has stopped working. Taking into account that cell phone use, by law, is very limited while driving, for obvious safety reasons we have decided to use a LCD screen that can inform the driver about the condition of the light bulbs. The sensing system will not need to interact with the car and this can allow the owner of the vehicle to save the cost of seeing a professional mechanic as the system is very easy to handle and one system can take care of multiple light bulbs at once, once again saving the owners a little extra money.

6.ECE.22
Wallet-Safe
Kirill Goldin, Mladen Milesic, Valeriy Yermolenko

Advisor: Vahe Caliskan, PhD

Wallets are susceptible to theft, loss, and misplacement. This often happens from neglect to keep track of one’s belongings. This issue needs to be solved for the sake of personal convenience and the prevention of identity theft. To help with this issue, we decided to make a system that will pair a person’s wallet with their phone. The intention of this project is to lower the odds of having a person’s wallet stolen, lost, or misplaced. Wallet-safe connects to the user’s smart phone and stays connected throughout the day; if at any point in the day the connection is lost, the smart phone will alert and notify the user. The goal of the Wallet-safe project is to incorporate a pairing system between smart phone and a credit card sized module insert for the wallet. The ambition for this project is to create a simple user interface to easily connect with the Bluetooth chip within Wallet-safe. The platform we chose to start this project with is iOS on the iPhone with possibilities for expansion to other platforms. The application provides a streamlined and easy to use interface, complete with push-notifications and on/off toggle feature for when the user does not require the services of Wallet-safe. Future iterations of our project may feature inductive charging for a completely streamlined experience that lasts for years to come. Ultimately, the end user of this product will have the peace of mind knowing that their wallet is safe when they need it to be safe.
4.ECE.12
Wireless DMX
Ryan Bennett, Tom Jurocepis, Piotr Nowak, Tom Surma

Advisor: Vitali Metlushko, Director of the Nanotechnology Core Facility

There is currently a wide use of DMX protocol based lighting systems. Some examples of DMX systems include: mobile DJs at weddings and parties, concerts, clubs, bars, as well as structural lighting. Some of these applications are not suited for running a physical line. For mobile applications there’s the additional time required of running and setting up lines. The other hazard with mobile operations is damaged cables leading to issues with the rest of the chain. Also, the problem with a daisy chained system is that damaged fixtures can lead to problems with data propagating to the rest of the chain. Our solution for these problems is creating a reliable robust wireless system. The foundation of our wireless system is a basic transmitter to multiple receivers. This reduces the potential hazard created by damaged cables and fixtures. This is because each fixture is no longer responsible for the rest of the chain. Additionally a wireless device for each fixture decreases setup time as there is no longer the need to run lines to every fixture. For mobile operations we can create a battery plugin for the system that would be rechargeable. This allows the users to simply plug in the device and set the light wherever needed without worrying about finding additional outlets or running a line. Although wireless systems already exist, the advantage to our design is the much lower price with similar capabilities. This will hopefully increase the adoption.
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING
Senior Design Instructor: Michael A. Brown, PhD, PE

1.MIE.59
Avery’s Chair
Danny Ball, Bernarda Bay, Patrick Delaney, Victor Truong

Advisor: Michael Scott, PhD, UIC Dept. of Mechanical and Industrial Engineering

Avery Seigel is a 12 year-old boy with Duchenne's muscular dystrophy. He is confined to a wheelchair, and his primary form of entertainment is his computer. His condition is worsening, and soon he won't be able to sit in a normal chair. The goal of our project is to design and build a customized chair/workstation where Avery will be able to use his computer. This will require our design to incorporate an ergonomic computer configuration that will alleviate the stress on his back and neck, allow for adjustability and mobility, and provide seamless transfer of Avery to and from the workstation. To accomplish this we began by building a network of resources including nurses, occupational therapists, doctors, and professors. This allowed us to gain a better understanding of the progression of Avery's condition and the important factors we needed to take into account in our design. At this point we established a few design concepts and selected the best one based upon various criteria. Our ability to obtain and manufacture parts also played an important factor in our selection.

11.MIE.15
CINTAS Inventory Maintenance
Daniel Curyla, Andrew Arellano, Michael Gore

Advisor: Michael A. Brown, PhD, PE

The CINTAS location in Maywood, IL provides sanitation for floor mats, mops, and towels to local businesses. CINTAS delivers clean products to the customer and returns the dirty products which are then cleaned at the facility and prepared for future delivery. The company has expressed their interest in increasing accountability of its customers by monitoring lost towels. Currently the random auditing system of products has proven to be unreliable. If the amount of product lost by the customers can be accounted for then CINTAS will be able to reduce their operating costs by decreasing the amount of new product purchased. The goal of this project was to develop an efficient and ergonomic process that would increase accountability. The random auditing system was changed to a confidence interval system which compares the weight of returned bags to a calculated average. The average was determined by taking numerous samples of the weight of a dirty towel. With the amount of data collected, we determined that the weight of a dirty towel is normally distributed and thus created a confidence interval for the product. Returned product outside of the confidence interval range will manually be counted to get exact towel losses. Furthermore, in order to keep track of which customers lose product each bag returned will have a barcode label with customers’ information to improve accountability. The project was successful in terms of the goals that were set. This process did improve accountability thus reducing costs. The next phase would be to have 100% accountability.
9.MIE.45
Conceptualization and Implementation of a Replacement Heat Exchanger within a Reverse Osmosis Water System
Matt Billo, Kyle Handlen, Esteban Lopez, Victor Cueto

Advisor: Michael A. Brown, PhD, PE

Generating a product with a stable value for the end-consumer, while lowering its production cost, is an engineering and financial feat desired in every industry. The technology, equipment and resources readily available in today’s industry make it possible to attain such ends-goals. Our project achieves this through optimization of present working concepts, which eliminates wasted time and funds to improve energy consumption and profitable gain. Our team designed a new layout, which implements a new heat exchanger operating concurrently with a water filtration system at an Industrial level. The pairing of these systems operates by providing a product that meets FDA/Company specifications, while reducing time to produce it. An analysis was conducted which aided in choosing a heat exchanger with given parameters, that the company is currently operating with. From the obtained results, specifications were concluded in order to properly design/select the optimum heat exchanger. Successively, it operates in accordance with a Reverse Osmosis/UV water filtration system, which was researched to work optimally for the desired process. As a result, our design layout and implementation reduced the time required to effectively heat and cool water in a compounding process by 30% or more. Thus, our analysis and application of concepts provided a profitable and innovative advantage in the production of our company’s product.

9.MIE.48
Flip Seats
Taha Allali, Jainil Chikani, Josiah Haines, Timothy Kong

Sponsor: Freedman Seating Company

In public transportation, a high priority is accessibility to handicapped passengers. As seen today in the many forms of public transportation, seating structure is a factor that contributes to a hassle-free ride for all passengers. In order to accommodate handicapped passengers and objects such as wheel chairs, seats that can flip up into a stowed position are used. Currently, the handicap seats that are used in most transportation units require a latch to be pulled in order to flip the seat up or down. While this creates more space for handicapped passengers, it slows down the boarding and un-boarding processes and is not convenient for all users. For this reason, Freedman Seating Company wanted us to develop a seat that automatically returned to the stowed position after use. The goal was to modify a current Freedman Seating Company seat, while maintaining the same base structure and staying within certain design requirements and constraints. By reverse engineering the seat provided by Freedman Seating Company, the team developed a working prototype on which various tests were performed. 3-D models and 2-D manufacturing drawings were developed, and a Finite Element Analysis was performed. The final design met all the design requirements and constraints that were provided by Freedman Seating Company.
11.MIE.16  
Gourmet Gorilla Efficiency Improvement Project  
Rachel Flores, Lindsey Hermes, Marek Jaromin, Bill McIntyre  

Advisor: Michael A. Brown, PhD, PE

Gourmet Gorilla is a private company that offers lunch catering accommodations for elementary schools. They prepare and distribute local and organic food to over fifteen schools. The company has expanded exponentially in the past few years causing complications in keeping up with many food orders. This has lead to over processing as supplemental orders and shipments have to be made to fix mistakes. Another wasteful practice the facility encounters is a bottleneck at the loading dock door where orders flow though a small door crowded with product to be loaded on trucks. This is where the distribution employees are struggling to organize and move the product for their many distribution routes. If there could be a standard organization to either the labeling of the food or the storage of the food, distribution times could be dramatically reduced. The primary objective of our project is to reduce or eliminate entirely the supplemental distributions. This optimization would also facilitate a better flow through the facility. In order to do this we will perform time studies and production flow analyses to pinpoint the slowest part of production, which can be feasibly optimized. We’ll need to determine the best way to standardize the whole system of labeling, packaging, storing, and delivering. We can increase performance by implementing a standardized system. By fulfilling these objectives, this system will allow all the employees to work more efficiently and effectively in their workstation.

4.MIE.9  
Increasing the Efficiency of a Bus Bar Lamination Process  
Pedro Bahena, Grzegorz Bugaj, Radoslaw Kaczowka, Andres Salgado  

Sponsor: Methode Electronics, Inc.

With demand increasing and technology improving Methode Electronics was faced with a rising problem with their bus bar lamination process. The method of heating, cooling, and lamination used was becoming outdated and needed an update to improve the cycle time, increase the efficiency of the heating and cooling cycle, and possible process automation. This is the challenge our team was faced with. We have developed a design that incorporates state of the art heating and cooling techniques that significantly reduce the cycle time of the lamination process which results in a greater output of product. Also we have included ideas of an automation system to further increase the efficiency and output of the process.
11.MIE.14
Labjacks
Munjal Kamdar, Josue Tejeda, Chris Zborowski

Advisor: Farid Amirouche, PhD, UIC Dept. of Mechanical and Industrial Engineering

The Xtreme-Z-12 lab jack from LabJacks.com provides a reliable platform for sensitive laboratory applications. Current lab jack models do not meet the demanding stability and lift displacement requirements for the extreme tolerances of scientific experiments and industrial processes. Recognizing the need for a more stable laboratory platform, the creators of the Xtreme-Z-12 made a strong, high lift capacity lab jack. This project applies a finite element stress analysis method to the current lab jack design in order to qualify it for full commercial production. The Z-12 was crafted from heuristic intuition which is now validated using the powerful FEA method. Additionally, the Z-12 design is re-scaled to 6” and 18” lift models—thereby expanding the current line of lab jacks to meet a wider variety of applications. These new models are evaluated for their stability, strength, manufacturing constraints, and cost sensibility to ensure an analogous standard of reliability as that of the Z-12. FEA methods are again used to validate the new models and design elements of the Z-12 are re-evaluated to minimize production cost and provide for the manufacturability of the new products.

11.MIE.13
Modeling of Pantograph/Catenary Interaction
Mohil Patel, Edward Randerson, Mike Swift, Brian Tinsley

Advisor: Dr. Ahmed A. Shabana Dynamic Simulation Laboratory. UIC Dept. of Mechanical and Industrial Engineering

The High Speed Ground Transportation Act of 1965 was signed into law by President Lyndon B. Johnson to begin the conceptualization and planning of economically-viable high-speed rail corridors across the United States. Americans have long anticipated the emergence of high-speed rail as a competitive and environmentally-safe alternative to airline and automotive travel. High-speed trains typically reach speeds upwards of 220mph – a technological marvel. A major challenge is the dynamic stability of the electrical supply mechanism that includes the pantograph, which takes current from an overhead wire, called the catenary, to power the train. This paper details a multibody system method to evaluate the effectiveness of a pantograph/catenary system. Using multibody dynamics analysis software, a pantograph/catenary collection system, attached to a railcar, was created to study the contact dynamics between the pantograph and catenary at high speeds. The contact dynamics are of vital significance to the train’s operation because any loss of contact will result in power drops to the train’s engines. The developed rigid-body railcar and pantograph model, coupled with a flexible catenary wire, allowed us to obtain results for the contact interactions at varying speeds. Numerical analysis techniques were used to evaluate and optimize the pantograph mechanism to meet catenary contact regulations. Our presented results discuss the successful implementation of an accurate pantograph/catenary model and the effect of pantograph suspension on the contact and catenary dynamics. Further work will consider the application of the developed model to include curve negotiation scenarios and higher operating speeds.
9.MIE.44
Motorized Venturi Vacuum
Quinn Carlson, Eric Isaacson, James Pena, Yesenia Rios

Advisor: Michael A. Brown, PhD, PE, UIC Dept. of Mechanical and Industrial Engineering

Household vacuum cleaners employ various technologies and principles of fluid mechanics to enhance suction power and reduce noise levels. Suction in a vacuum cleaner is a result of the difference between ambient air pressure and a lower pressure that is usually created by a fan. The motor running such a fan typically generates noise that is unpleasant to the user. This project aims to design a vacuum that uses the venturi effect to create a pressure differential that generates suction power comparable to that of a typical vacuum. A venturi tube can be used to lower the pressure of a fluid flowing through it. When a fluid is forced through a venturi tube a decrease in cross sectional area causes an increase in the fluid’s velocity and reduction of pressure according to Bernoulli’s Principle. The geometry of such a tube can be manipulated to create a desired pressure that is less than that of ambient air. The venturi vacuum has an air inlet positioned at the point of low pressure which will allow dirty air to be sucked in and filtered. Using the venturi effect allows the vacuum’s motor to run more quietly and efficiently giving this design a competitive and marketable advantage. A full assembly of the vacuum centered on the venturi suction system is also designed to be portable, durable, and affordable.

11.MIE.17
PEER into the Future
Thong John Nguyen, Nathan Smrha, Miguel Jacob, Mike McCague

Advisor: Michael A. Brown, PhD, PE

PEER Bearing Company is a dynamic and customer focused bearing manufacturer delivering valued solutions to a global market. In order to be the most reliable supplier to their customers, PEER intends to meet all of their quality and delivery requirements. A quality product provides the critical foundation for the relationship with the customer. PEER expects the same level of cooperation from their suppliers. As a global business, PEER offers a full line of agricultural, radial, mounted unit ball and tapered roller bearings. PEER’s main manufacturing site is located in China, with a Chicagoland area location utilized for distribution and specialty bearing supply. Continuing off of last semester's senior design project, in which the team expressed the need to create automation opportunities, the team will focus on PEER’s in-house assembly line to reduce idle time and increase efficiency. In order to bring PEER bearing manufacturing process into the future, the team will implement mechanical engineering techniques to streamline the efficiency and capacity of the line. PEER bearing has expressed three main concerns with their current process which include manually loading of the bearings into the washer machine, bearing drying time, and grease change over. The idea is to mechanically design an automation process for the washer and greaser station, and in addition suggest new technology to reduce the drying time. The overall goal is to limit manual human interaction within the assembly line while minimizing costs and increasing efficiency.
9.MIE.43
SAE Mini Baja Rear Suspension System
Kevin Delva, Juan Guzman, Peter Ojeda, Matthew Stoch

Advisor: Michael Brown, PhD, UIC Dept. of Mechanical and Industrial Engineering

Each year, the Society of Automotive Engineers organizes an engineering student competition where teams from around the world design and manufacture mini Baja vehicles. During competition, the vehicles are tested in different events such as hill climbing, suspension and traction, rock crawling, and others. The vehicle performance during these events determines the score that a team receives. Performance in off-road vehicles is mainly affected by the suspension system, which filters the noises from the tire excitation produced when hitting an imperfection on the road. Typical suspension systems are double wishbone, as know as an A-arm, and semi-trailing arm. In previous UIC cars, a double wishbone configuration was used on the rear. This kind of configuration did not allow proper change in the toe angle during suspension travel, which caused the car to understeer. Last year, a decision was made to move to the semi-trailing arm. This solved the steering problem since the semi-trailing arm allows the toe angle to change. However, after analyzing the final product, it was determined that the toe as well as camber angles were changing beyond the desired range. Our goal is to redesign and optimize the rear suspension system for the 2014 competition vehicle by modifying the toe and camber angles to be within their desired limits. The design and analysis was performed using 3D CAD modeling, mainly Solidworks. Different prototypes were modeled until a final prototype was chosen. This final prototype was then analyzed and optimized to provide the best performance possible.

11.MIE.18
SAE Shop Layout Optimization
Avi Bromberg, Leah Cuyler, Michael Miszta, Matthew Schubert

Advisor: Dr. Nantaporn Ratisoontorn, PhD, UIC Dept. of Mechanical and Industrial Engineering

Society of Automotive Engineers, SAE, is a student run organization at UIC which focuses on the design, fabrication, and performance of two distinct cars: Baja and Formula. The fabrication of these cars takes place within the SAE student shop located on UIC grounds. While this shop itself caters to the necessary work involved for the fabrication of those cars, its layout performs inadequately on multiple levels. Those areas include unnecessary redundant work actions, lack of immediate resource accessibility that hinders crucial task performance, and more importantly, uncorroborated equipment placement for upholding safety regulations. The purpose of the SAE Shop Layout Optimization project is to enhance the utilization of the shop space to better suit the demands placed on it. The scope of this project encompasses the adaptation of both safety and efficient work in process standards. The optimization of said layout is first constrained by irrefutable safety standards that, in turn, dictate further efficiency applications and preference accommodations. The goal of this optimization project is to 1) ensure compliance to all pertinent safety specifications and 2) enhance utility of shop floor space. Applying concepts derived from operation research, work productivity analysis, ergonomics and engineering design, a shop layout is proposed, and recommended for implementation, that will better fit the constraints and requests placed upon it. This will ultimately gratify and give aid to the students involved in SAE during their fabrication of the Baja and Formula cars.
9. MIE.46
Snack Tray
Boris Golub, William Hartman, Mitesh Shah, Ryan Zei

Advisor: Michael A. Brown, PhD, PE

Over a century ago Freedman Seating Company began with the production of seat cushions for horse-drawn buggies. Since then, Freedman Seating has developed into an industry leader of seating for buses, trains, and commercial vehicles. The manufacturer continues its charge in innovation with the development of a new snack tray that can accommodate for the modern commuter. The new design aims to provide the user with a surface that remains level independent of the reclinable seat to which it may be attached. The tray will maintain traditional functions such as securing a beverage, but will also provide the passenger with a space to comfortably use a laptop or mobile device. The snack tray must provide apt support, a two-position in-use and stowed design, and should be retrofittable so that customers may have the option of post-production installation. It is our goal to see our design reach the manufacturing stage of development, and watch as it joins the rich history of innovation within the Chicago based company.

12. MIE.1
Solar Heating Solutions
Jonathan Alvarez, Batuhan Eisen, Timothy P. Seo, John Strukl

Advisor: William A. Ryan, PhD, UIC Dept. of Mechanical and Industrial Engineering

The majority of the world’s current electricity and heating supply is generated from fossil fuels such as coal, oil, and natural gas. These traditional energy sources currently face a number of challenges including rising prices and environmental concerns associated with power generation using these conventional methods. The fossil fuels used for producing most of the energy for everyday applications is not only producing an abundant amount of greenhouse gas emissions, but is also of finite supply. Our task is to devise a system so that the Student Center East (SCE) building’s current water heating method is either replaced or accompanied using solar thermal panels when weather conditions permit to do so. By utilizing the seemingly endless energy from the sun, we will develop an alternative source of energy to generate hot water by absorbing sunlight and converting it into usable heat. With our design, we will outline the benefits of solar energy production including environmental advantages, flexible locations, cost efficiency, matching peak output with peak demand, modularity and scalability over other conventional energy sources.
9.MIE.47
Spray Nozzle for Spraying Systems
Company
William Knowles, Leslie Cassandra Malaki, Frank Michalak, Ian Pierce

Advisor: Farzad Mashayek, PhD, UIC Dept. of Mechanical and Industrial Engineering

Whether you need to keep dust from becoming airborne or suppress particles that are already airborne, applying water to dust is usually the most efficient, cost-effective, and environmentally friendly solution. We have designed a water atomizing nozzle, able to reduce droplet sizes in the order of 5 microns maximum diameter. The key feature to this design is the converging-diverging nozzle (or a de Laval nozzle), whose role is to produce thrust by efficiently converting the pressure/internal energy of inlet gases into kinetic energy. Initial acceleration of a flow at subsonic speeds occurs in the convergent section and, for sufficiently high-pressure ratios and nozzle area contraction, it is possible to accelerate a flow to sonic conditions at the nozzle throat. The addition of a divergent section downstream of the throat enables further acceleration of the flow through supersonic expansion. The implementation of an adjustable prefilmer is also key feature in enabling various resulting droplet sizes, giving our nozzle product versatility.

4.MIE.10
Two-Stage Slurry Utilizing Venturi Effect
Jon Hawley, Nathan Loll, Beata Oknta, Luis Sandoval

Advisor: Suman Sinha Ray, United States Gypsum

When mixing solids and liquids most processes utilize a mechanical system. The fallback to a mechanical system is that it can incur high maintenance costs. To avoid these costs, a new process is necessary. A design that has been proposed would incorporate driven fluids creating a uniform continuous mixture. Employing the Venturi effect, a subsidiary of Bernoulli’s law is used to entrain a solid by using a gas motive. This can be done by using an eductor specifically made for that purpose. After the solid has been accelerated through the eductor, it will continue until water is introduced. The geometry of this connection has been formed with the help of modeling software to generate optimal flow conditions. After this union, our desired mixture has been accomplished. Due to the nature of this design, it offers the ability to be cleaned rather than replaced when compared to a mechanical system. With this in mind, this setup is a viable alternative to preexisting mixers.
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