

## UIC COLLEGE OF ENGINEERING



Dear Students, Alumni, Families and Friends:

Welcome to Engineering EXPO 2007! You will be able to visit a wide array of design projects that draw on fundamental engineering skills of our seniors and that display their immense creativity and ability to solve tough engineering problems.

Our program today is made possible through the exceptional generosity of **Continental Automotive Systems, the Principal Corporate Sponsor of Senior Design EXPO 2007**. The College of Engineering gratefully recognizes and extends its thanks to Continental Automotive Systems for its sponsorship and for underwriting four \$400 category awards to be presented to the first place teams in User Interface and Education; Specialty Electronics and Signal Processing; Remote Control; and System Monitoring. Please visit their booth in the Illinois Room.

The College extends its deep thanks to other members of our College of Engineering family who have also underwritten prizes.

Raymond and Jeanine Jasica are providing multiple awards in the Assistive Technology category. Their gift honors grandson Jimmy Mercola.

Arlene Norsym, Vice President of the University of Illinois Alumni Association and Associate Chancellor for Alumni Relations, again provides a prize recognizing the one project voted most popular by the EXPO participants.

Three generous alumni, Gabriel Alexander Duran, Michael W. Gonzalez, Executive Vice President, Primera Engineers, Ltd., and Brian Stinton are underwriting prizes to be presented to three first place teams.

Our alumni at Continental Automotive Systems facilitated the sponsorship of EXPO 2007. With them, the extended Jasica family, Arlene Norsym, and alumni Gabriel Duran, Michael Gonzalez, and Brian Stinton, are making the College of Engineering Senior Design EXPO 2007 a truly memorable capstone event in the lives of our seniors.

Today, seventy alumni, friends and faculty members join us to judge the projects. Our thanks go out to each and every one of you! I hope that you enjoy EXPO 2007.

Prith Banerjee  
UIC Distinguished Professor and Dean  
College of Engineering  
University of Illinois at Chicago

## EXPO 2007 SCHEDULE

7:00 a.m.	<b>Student registration opens</b> EXPO groups start project setups
8:30 a.m.	<b>Students: Briefing in Illinois Room/stage</b> <b>Judges: Sign-in and briefing</b>
9:00 a.m.	<b>EXPO opens for general public</b>
9:30-11:30 a.m.	<b>Project Judging</b>
11:30 – Noon	<b>Collection of voting ballots</b> Attendee/Participant voting ends at noon! Be sure to vote for your favorite project!
12:00 Noon	<b>Robotics Demonstration</b> by the Engineering Design Team (5 robots will be demonstrated – 1st Place winners at the 2006 Jerry Sanders Competition)
12:00-2:00 p.m.	<b>Voting Tabulation</b>
2:00-3:00 p.m.	<b>Awards (Illinois Room)</b>

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## EXPO ORGANIZATION

**General Chair:** Chris Kuypers, Undergraduate Administration, COE  
**Technical Chair:** Vladimir Goncharoff, Ph.D.,  
Department of Electrical and Computer Engineering

**Award Tabulation:** Jim Muench, Undergraduate Administration, COE  
**Judge Coordinator:** Nancy Cohen, Interim Asst. Dean of Advancement, COE  
**Catering:** Mary Larsen, Undergraduate Administration, COE

## ENGINEERING COUNCIL

**Student Co-Chairs:** Katie Owens, Tim Murmann  
**Student Volunteers:** Chris Peoples  
**Prizes & Printing:** Dustin Fell, Charles Frangos

## EXPO FACULTY ADVISORY COMMITTEE

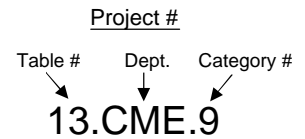
**David Schneeweis, Ph.D.** Department of Bioengineering  
**Donald Lemke, Ph.D.** Department of Civil and Materials Engineering  
**Ted Funk, Ph.D.** Department of Chemical Engineering  
**Vladimir Goncharoff, Ph.D.** Department of Electrical and Computer Engineering  
**Michael Scott, Ph.D.** Department of Industrial and Mechanical Engineering

# THANK YOU!

## JUDGES of SENIOR DESIGN EXPO 2007

Richard C. Adamczewski	Loyola Medical Center	Rick Lasko	Caterpillar Inc.
Keith Alsberg	Square 1 Product Development	Terry Layton	tlayton71@aol.com
Chinue Bailey	GE	Rosanna Lee	David Mason & Associates
George Balaban	C. E. Niehoff & Co.	Yvonne Liebelt	Verizon Wireless
Biljana Barbir	Caterpillar Inc.	Andy Lipman	Next Generation Lighting
Mirko Barbir	Caterpillar Inc.	Joseph Liu	Continental Automotive Systems
Ann Bhatia	Illinois Environmental Protection Agency	Jose Lujano Jr.	Caterpillar Inc.
Peter Biancalana	Motorola Inc.	Ravi Malkani	FedEx
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Sabri Cetinkunt, Ph.D	University of Illinois at Chicago	Allen Micu	Continental Automotive Systems
Louis Chrzasc	Collins Engineers Inc	Moaz Mirza	Accenture
Gabriel Alexander Duran	Caterpillar Inc.	Tom Moher, Ph.D	University of Illinois at Chicago
Christian Fischer	Fischer AG Telecom Engineering	John C. Molburg, Ph.D.	Argonne National Laboratory
John Fudacz	University of Illinois at Chicago	King Moy	Herbst LaZar Bell
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Michael W. Gonzalez	Primera Engineers	John Olenczuk	Continental Automotive Systems
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Jason Hagerdorn	Caterpillar Inc.	Robert Paluch	Mackie Consultants
Robert Hildebranski	Harbour Engineering, Inc.	Raj Patel	Underwriters Laboratories
Debbra Hill		Ed Paulson	The Paulson Group
Tanya Huang	Jasica Family	William S. Pietrzak	Biomet, Inc.
William J. Hurst	Baxter International	Roland Priemer	University of Illinois at Chicago
William S. Hurst	Caterpillar Inc.	Nancy Rocha	BP America
Jeanine M. Jasica	Jasica Family	Richard Schmidt	Midwest Generation EME, LLC
Raymond Jasica	Jasica Family	Michael J. Scott, Ph.D	University of Illinois at Chicago
Julie Jasica-Mercola	Jasica Family	Brian Stinton	Motorola Inc. (Retired)
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Ronald Kirschner	Heartland Angels	Roger Vanoer	US Army Coprs of Engineers
William Kohn	BCC	Jesse Vazquez	US Food and Drug Administration
Richard Landuyt	RF IDEas, Inc.	Jerzy Wielgus	Motorola Inc.
Karen Daulton Lange	Kennedy Home Builders	John A. Wilkinson	Engineering Systems Inc.
Steven Larson	Continental Automotive Systems	Dan Wiseheart	V3 Companies

# PROJECTS BY CATEGORY



## #1 *Medical Devices and Instrumentation*

	The Analysis of Forces and Displacement Acting on a Realistic Human Brain During Locomotion
41.BIOE.1	
40.BIOE.1	Device to Measure Perineal Pressures During Bicycling
38.BIOE.1	Microdrive for the Placement of Carbon Fiber Electrodes in Mice
39.ECE.1	Heart Murmur Detector

## #2 *Cellular and Molecular*

34.BIOE.2	Extended Release of Cisplatin from a Polyacrylic Acid Hydrogel for the Treatment of Ovarian Cancer
35.BIOE.2	Applications of Nanotechnology for the Detection of Cancer
37.BIOE.2	Early Detection of Alzheimer's Disease Through Nanotechnology
36.BIOE.2	The Role of Mechanical and Chemical Stimuli in the Differentiation of Stem Cells

## #3 *Environmental, Health and Safety*

29.ChE.3	Removal of Benzene and other Aromatics from Wastewater
28.ChE.3	CLA: Fat That's Good For Your Heart
27.ChE.3	Nuclear Hydrogen
25.CME.3	Sidestream Elevated Pool Aeration Station on the Chicago River
26.CME.3	City of the Future: Recycling Chicago's Water in 2106

## #4 *Assistive Technology*

11.BIOE.4	Fun For All Game Table
8.ECE.4	Refreshable Braille Display
9.ECE.4	Wheelchair Innovation
10.ECE.4	Building/Obstacle Detector for the Visually Impaired
12.MIE.4	Communication Device Service Cart

## #5 *Process Design*

33.ChE.5	BioButanol - Ethanol's Overlooked Cousin
32.ChE.5	Producing the Conducting Polymer Polyactylene
31.ChE.5	Lucrative Styrene Production
30.ChE.5	Production of Synthetic Diesel from Waste Plastics

## #6 *Structure/Site Design*

15.CME.6	Pine Lake Residential/Commercial Subdivision Development
16.CME.6	Bridge Collision Prevention System
14.CME.6	Athletic Residence Halls for the 2016 Summer Olympics
13.CME.6	Olympic Aquatic Center

## #7 *Infrastructure Design*

23.CME.7	Bus Rapid Transit System Implementation in Chicago
20.CME.7	Design and Implementation of a Monorail System Within the City of Chicago
19.CME.7	Renovation of Weber Road at Interstate 55
24.CME.7	Stormwater Treatment Design for a Commercial Development
22.MIE.7	Try-Generation

## #8 *Materials Design*

18.CME.8	Evaluation of the Structural Behavior of Lightweight High Strength Reinforced Concrete Beams
17.CME.8	Development of High Strength/High Performance Lightweight Concrete

### **#9 User Interface and Education**

- 51.ECE.9 TypeMouse: Fully Functional Keyboard and Mouse in a Single-Handed Device
- 50.ECE.9 DIGITS: Digital Interface Glove Including Tactile Sensitivity
- 52.ECE.9 FM Subcarriers and Software Defined Radio using GNU Radio and the USRP
- 53.ECE.9 Laboratory Radio

### **#10 Specialty Electronic and Signal Processing**

- 47.ECE.10 Software-Based Song Recognition System
- 46.ECE.10 SecondSight: Gun-Mounted Wireless Video Camera System
- 48.ECE.10 Medication Reminder
- 49.ECE.10 Giant Marquee

### **#11 Remote Control**

- 4.ECE.11 System to Allow Easy Access to a Household
- 5.ECE.11 LCD Remote Control for Ipod Docking Station
- 6.ECE.11 Wireless Electronic Shelf Tag Display

### **#12 Mechanism and Device Design**

- 45.MIE.12 Radio Controlled Lawn Mower
- 43.MIE.12 Automated Spin Art Machine
- 42.MIE.12 Easter Seals Bike Project – Interdisciplinary Project Development
- 44.MIE.12 Increasing The Temperature Differential In A Vortex Tube

### **#13 System Monitoring**

- 70.CME.13 Travel Time Estimation Using Automatic Vehicle Location System Equipped Buses as Probes
- 67.ECE.13 Posture Monitoring Device
- 68.ECE.13 Intelligent Home Monitor
- 69.ECE.13 RFID Temperature System
- 66.ECE.13 RFID Based Inventory System

### **#14 Sports Equipment**

- 56.BIOE.14 Determination of Optimal Vibration Frequencies for Sports Equipment
- 55.MIE.14 Portable Nordic Walking Exercise Device

### **#15 Preliminary Design Reports (non-judged exhibit)**

- ECE22 Peltier Cooled and Heated Motorcycle Helmet
- ECE23 Eclipse Window Clock
- ECE24 TabScriber
- ECE25 VirtualStudyBuddy.com
- ECE26 Parts Warehouse Navigation System
- ECE27 Customer Service Response System
- ECE28 MicroStamp11 Automated Tester
- ECE29 Test Tube Heater System Utilizing Micro Hot Plates
- ECE30 Motion Sensing RC Controller
- ECE31 Animal Research Collar

## PROJECTS BY DEPARTMENT

### **BIOENGINEERING**

40.BIOE.1	Device to Measure Perineal Pressures During Bicycling
38.BIOE.1	Microdrive for the Placement of Carbon Fiber Electrodes in Mice
41.BIOE.1	The Analysis of Forces and Displacement Acting on a Realistic Human Brain During Locomotion
35.BIOE.2	Applications of Nanotechnology for the Detection of Cancer
37.BIOE.2	Early Detection of Alzheimer's Disease Through Nanotechnology
34.BIOE.2	Extended Release of Cisplatin from a Polyacrylic Acid Hydrogel for the Treatment of Ovarian Cancer
36.BIOE.2	The Role of Mechanical and Chemical Stimuli in the Differentiation of Stem Cells
11.BIOE.4	Fun For All Game Table
56.BIOE.14	Determination of Optimal Vibration Frequencies for Sports Equipment

### **CHEMICAL ENGINEERING**

29.ChE.3	Removal of Benzene and other Aromatics from Wastewater
28.ChE.3	CLA: Fat That's Good For Your Heart
27.ChE.3	Nuclear Hydrogen
33.ChE.5	BioButanol - Ethanol's Overlooked Cousin
32.ChE.5	Producing the Conducting Polymer Polyactylene
31.ChE.5	Lucrative Styrene Production
30.ChE.5	Production of Synthetic Diesel from Waste Plastics

### **CIVIL AND MATERIALS ENGINEERING**

25.CME.3	Sidestream Elevated Pool Aeration Station on the Chicago River
26.CME.3	City of the Future: Recycling Chicago's Water in 2106
16.CME.6	Bridge Collision Prevention System
14.CME.6	Athletic Residence Halls for the 2016 Summer Olympics
13.CME.6	Olympic Aquatic Center
15.CME.6	Pine Lake Residential/Commercial Subdivision Development
19.CME.7	Renovation of Weber Road at Interstate 55
24.CME.7	Stormwater Treatment Design for a Commercial Development
23.CME.7	Bus Rapid Transit System Implementation in Chicago
20.CME.7	Design and Implementation of a Monorail System Within the City of Chicago
17.CME.8	Development of High Strength/High Performance Lightweight Concrete
18.CME.8	Evaluation of the Structural Behavior of Lightweight High Strength Reinforced Concrete Beams
70.CME.13	Travel Time Estimation Using Automatic Vehicle Location System Equipped Buses as Probes

## ***ELECTRICAL AND COMPUTER ENGINEERING***

39.ECE.1	Heart Murmur Detector
10.ECE.4	Building/Obstacle Detector for the Visually Impaired
8.ECE.4	Refreshable Braille Display
9.ECE.4	Wheelchair Innovation
51.ECE.9	TypeMouse: Fully Functional Keyboard and Mouse in a Single-Handed Device
50.ECE.9	DIGITS: Digital Interface Glove Including Tactile Sensitivity
53.ECE.9	Laboratory Radio FM Subcarriers and Software Defined Radio using GNU Radio and the USRP
52.ECE.9	
46.ECE.10	SecondSight: Gun-Mounted Wireless Video Camera System
48.ECE.10	Medication Reminder
49.ECE.10	Giant Marquee
47.ECE.10	Software-Based Song Recognition System
6.ECE.11	Wireless Electronic Shelf Tag Display
4.ECE.11	System to Allow Easy Access to a Household
5.ECE.11	LCD Remote Control for Ipad Docking Station
67.ECE.13	Posture Monitoring Device
68.ECE.13	Intelligent Home Monitor
69.ECE.13	RFID Temperature System
66.ECE.13	RFID Based Inventory System

## ***PRELIMINARY DESIGN REPORTS:***

ECE22	Peltier Cooled and Heated Motorcycle Helmet
ECE23	Eclipse Window Clock
ECE24	TabScriber
ECE25	VirtualStudyBuddy.com
ECE26	Parts Warehouse Navigation System
ECE27	Customer Service Response System
ECE28	MicroStamp11 Automated Tester
ECE29	Test Tube Heater System Utilizing Micro Hot Plates
ECE30	Motion Sensing RC Controller
ECE31	Animal Research Collar

## ***MECHANICAL AND INDUSTRIAL ENGINEERING***

12.MIE.4	Communication Device Service Cart
22.MIE.7	Try-Generation
45.MIE.12	Radio Controlled Lawn Mower
43.MIE.12	Automated Spin Art Machine
42.MIE.12	Easter Seals Bike Project - Interdisciplinary Project Development
44.MIE.12	Increasing The Temperature Differential In A Vortex Tube
55.MIE.14	Portable Nordic Walking Exercise Device

# Engineering EXPO 2007 Project Abstracts

## BIOENGINEERING

### 41.BIOE.1

#### The Analysis of Forces and Displacement Acting on a Realistic Human Brain Model During Locomotion

Cheryl Bettinardi, Zenith Jameria, Victor Sapozhnikov

Advisor: Patrick Rousche, Ph.D.  
Department of Bioengineering

Cortical neuroprosthetic devices have the potential to restore sensory perceptions in millions of blind, deaf, and paralyzed patients. These devices provide a multi-channel electronic interface with targeted brain cells that would allow direct communication with the brain from external devices. Although animal experiments have yielded promising results in short-term implants, implant biocompatibility over long-term implants results in a variable electrode-tissue interface. The viewed principle mechanism for failure is the micromotion of implanted electrodes relative to brain tissue. The source of micromotion can be caused by locomotion at various velocities. To generate design specifications for an electrode system that can compensate for the micromotion, a quantitative analysis of mechanical forces acting on the electrode-tissue interface in the brain is necessary. Since direct assessment of these forces on a live human brain is not feasible, a need exists for a physical, benchtop system which can mimic physiologically relevant mechanical properties of the brain. The system to be developed should be able to simulate the natural environment of the brain and allow for the determination of forces acting on an implanted electrode during different physical perturbations. By subjecting the prototype construction interlinked with a single motor to a diverse pattern of locomotion stemming from walking and running, the resulting forces and displacements acting on the agar-gel brain model will be quantified. The results of this study will be applied toward the development of an electrode that will be more accommodating to the brain micromotion.

### 40.BIOE.1

#### A Device to Measure Perineal Pressures During Cycling

Ali Husain, Ershad Forghani-Arani, Ryan Devon

Sponsor: Craig Niederberger, M.D.  
Department of Urology

Recent publications in a journal of sex medicine claim a link between cycling and erectile dysfunction. Goldstein et. al claimed in their article that prolonged pressure on the perineal region causes arterial damage resulting in erectile dysfunction in men. Based on the article and suggestions made by Goldstein et. al, various bicycle seat designs emerged claiming to reduce the pressure applied on the perineal region. However, the basis of these designs lack scientific testing relating the pressure applied to the perineal arteries and the design of the seat. The objective of this project is to design a device to measure the pressures applied on the perineum while bicycling under normal conditions, and stores the data for later retrieval and analysis.

The project will help determine the critical pressure at which occlusion of perineal arteries occurs and over the period of a bike ride if this pressure is reached and sustained. By employing this device a more accurate relation between pressures on the perineal region during cycling and erectile dysfunction can be formulated, promoting more people to partake in the comprehensive cardio-vascular exercise of cycling.

### 34.BIOE.2

#### Extended Release of Cisplatin from a Polyacrylic Acid Hydrogel for the Treatment of Ovarian Cancer

Martha Kidd, David Sarcu, Stephen Soong

Advisor: Richard Gemeinhart, Ph.D.  
Biopharmaceutical Sciences Department

Ovarian cancer is the fifth most prevalent form of cancer found among women. Only 44% of diagnosed patients survive beyond five years, which makes it the deadliest of the reproductive cancers. Current treatment methods start with cytoreductive surgery followed by administration of intravenous chemotherapeutics to destroy any cancerous cells that could not be surgically excised.

Chemotherapeutics are introduced via an IV circulate in the bloodstream at high concentrations. This often creates a high level of toxicity in the body's healthy tissues, because the drugs are deadly to both somatic and cancerous cells. Patients are usually placed on multiple cycles of chemotherapy followed by weeks of rest in order for their bodies to recuperate from the toxic side effects. The relatively short circulation time due to clearance of the drug limits the effectiveness of the initial dosage on cancer cells.

Research has shown that a longer drug presence at a steady concentration has a greater potency towards cancer cells and reduced somatic cytotoxicity than IV infusion. Polyacrylic acid hydrogels were made with various ratios between monomer and crosslinker to investigate the extended release of complexed cisplatin. Toxicity studies were performed on both a cell line that models normal intestinal cell behavior and on ovarian cancer cells. This was followed by a toxicity study using the microparticles on ovarian cancer cells.

### 35.BIOE.2

#### Applications of Nanotechnology for the Detection of Cancer

Alvin Colón, Moises Lopez

Advisor: G. Ali Mansoori, Ph.D.  
Bioengineering and Chemical Engineering

Cancer is the second leading cause of death in the United States, killing about 200,000 people annually. Until recently, before physicians had means of treatment, having cancer almost certainly meant death from the disease. Since then it has been found that earlier diagnosis improves the treatability and superability of the disease, thereby dra-

matically increasing the chances of survival. In addition, earlier diagnosis could reduce the number of standard chemotherapy and radiation therapy sessions required by a patient possibly resulting in: lower hospital bills, lower insurance premiums, greater health care affordability, greater health care access, and an overall higher standard of living and life expectancy. This project seeks ways to aid in diagnosis which might someday make testing for cancer a routine part of medical care so as to catch cancer in the earlier developing stages. The detection of cancer biomarkers is the basis for providing this aid in earlier diagnosis. Solutions incorporating nanotechnology, material structures rivaling biomarkers in size, are explored in hopes of designing detectors capable of monitoring the presence of cancer biomarkers, molecules which if present at all or at inordinate concentrations are probable indicators of the presence of cancer. An inexpensive device capable of screening a small amount of bodily fluid for various markers with good specificity, selectivity, and accuracy in little time is the ultimate goal of this project. Immediate goals for this project include identifying appropriate means of detection for such a device, and identifying an appropriate means of modeling.

### 56.BIOE.14

#### Determination of Optimal Vibration Frequencies for Sports Equipment

Alan Bautista, Nancy Rios, Ashley Selner

Sponsor: Daniel R. Hernandez  
Wilson Sporting Goods

When an athlete uses sporting equipment that collides with a ball or puck, vibrations from the equipment transfer to the hand and arm of the player. Experienced athletes are able to feel whether their hit was centered, or off-centered from the vibration feedback, and consequently play accordingly. Tuning the vibration of the racquet to a frequency at which the athlete is most sensitive to detecting could enhance their performance. There is evidence to believe that a perception vibration threshold exists which an individual is most sensitive to. Previous research has shown that mechanoreceptors in the fingertip have the greatest sensitivity to vibration stimulus at certain frequencies. However, these experiments were conducted with a small population of subjects without considering age or gender. The objective of this study was to confirm and extend results of previous publications by studying perception thresholds while stimulus was applied to the entire hand by holding a racquet. We hypothesized that subjects would have an optimal frequency they are most sensitive to, showing a dependence on frequency that may vary with age and gender. This optimal vibration frequency was the frequency at which the subject could detect the smallest change in amplitude of vibrations while gripping a handle. A device for applying a range of vibration stimuli at various amplitudes and frequencies to a racquet, along with an experimental procedure that tests the

sensitivity of the vibration applied was designed and performed. The frequency(s) obtained could then be implemented into the customized design of sporting racquets.

### 37.BIOE.2

#### Early Detection of Alzheimer's Disease Through Nanotechnology

Benjamin Bick, Jason Ip, Theresa Lo, Lucy Trevino

Advisor: G. Ali Mansoori, Ph.D.  
Bioengineering and Chemical Engineering

Alzheimer's disease (AD) is a neurodegenerative disorder characterized by irreversible and progressive loss of memory. In AD, nerve cells in the brain are lost, preventing the proper transmission of brain signals, thus causing dementia and other neurological disorders. Although presently there is no known cure for AD, there are some medicines and treatments that can slow its progression. These treatments are most successful the earlier they are given to a patient with AD. Currently, however, AD can only be diagnosed with at most 80% accuracy, but only after symptoms are visible in its later stages. A 100% detection rate can only be accomplished through a post-mortem histological examination. Therefore, the best treatment method is to incorporate the early detection of AD onset. Other pre-mortem detection methods are unreliable and inconclusive, and they are not capable of detecting the early onset of AD. Most of these methods also require cerebral spinal fluid to be extracted through a lumbar puncture, an invasive procedure that can offset serious complications in addition to being highly expensive. Our goal is to develop a sensitive, non-invasive and cost-efficient method of accurately and quickly detecting AD in its early stages, via present biomarkers and incorporating nanotechnology detection. We have found that the early detection of AD onset is possible, and the next phase of our project should allow for the easy integration of this method for humans.

### 36.BIOE.2

#### The Role of Mechanical and Chemical Stimuli in the Differentiation of Stem Cells

Parvaneh Salehi, Lindsay Kotouch, Jake Prettyman

Advisor: Michael Cho, Ph.D.  
Department of Bioengineering

Stem cells are showing increasing promise as a cell type that will be very useful for tissue engineering applications. Human mesenchymal stem cells (hMSCs) are one type of stem cell found in the bone marrow of adults. In order for

the full potential of stem cells to be harnessed an understanding of how these cells can be coaxed into more specific cell types is needed. Already, some protocols exist for inducing certain specific cell lineages (ex. osteoblasts, adipocytes...) with the use of chemical stimuli. Other factors such as mechanical forces seem to also have an effect on the lineage fate of a stem cell. Previous studies have shown that varying the substrate stiffness on which the cells are cultured will direct the differentiation of the stem cells down different lineages. The focus of our project is to design experiments to determine the individual as well as the combined effects of mechanical and chemical stimuli on the differentiation of hMSCs. In our study we looked at two possible cell lineages the hMSCs could attain: osteogenic and neuronal. The hMSCs were induced to osteogenic and neuronal cell types with the use of chemical stimuli. The hMSCs were also cultured on soft collagen gels which act as a mechanical stimulus of neuronal cell lineage. Finally, the hMSCs were cultured on the collagen gels with neuronal chemical stimuli as one condition and osteogenic chemical stimuli as another condition.

### 38.BIOE.1

#### Microdrive for the Placement of Carbon Fiber Electrodes in Mice

Joanna Borla, Jyoti Shenai, Joel Thomas

Sponsor: Chris Fall, Ph.D.  
Department of Anatomy and Cell Biology

Advisors: Michael Ragozzino, Ph.D.  
Department of Psychology

Mitchell Roitman, Ph.D.  
Department of Psychology

Carbon fiber microelectrodes have been demonstrated to provide a reliable, sensitive means of detecting the release of oxidizable neurotransmitters (Armstrong-James et al., 1979; Wightman & Cahill, 1995). Carbon fibers are aspirated into glass tubes of approximately 0.65mm outer diameter. Then the tubes are heated and extruded, to form fine tips with the glass tightly mated to the fiber and acting as an insulator. Studies concerned with the release of said neuro-transmitters have been done until now using rats as the animal model. But in light of the better understanding of the genetics of mice and of their use as a model for human disease, as gained in recent years, it is now favorable to use carbon fiber microelectrodes in the study of neurotransmitter release in mice. A mechanism is needed for their secure and precise positioning in the brain tissue of an awake, active mouse. "Screw-type" microdrives and cannulae have been used to achieve this positioning in rats. We have proposed a microdrive and associated cannula appropriately scaled to the size of lab mice, designed and composed of selected materials, with considerations to-

wards the effective machining and use of the microdrive. CAD drawings were used in the design process, which required correspondence between both machinists and electrophysiologists. The prototype microdrive has been demonstrated to securely hold the electrodes. Spatial resolution of approximately 0.2mm was achieved, with nominal cost of machining. Changes to the design to aid the ease of use are discussed, considering the experience gained from the design process.

## 11.BIOE.4

### Fun For All Game Table

Hussam Mostafa

Sponsor: Judy Gardner, M.A.  
Easter Seals of Dupage

Advisor: David Schneeweis, Ph.D.  
Department of Bioengineering

Cerebral palsy affects a person's body movements and muscle coordination. This special type of person experiences a difficult task when he/she may try to grasp or hold certain devices. There is also a tendency for the person to lose total concentration in any activity, and they often tend to put their head in a downward position. The objective of this project is to develop an easel table top with adjustable heights and angles; there will be several game devices that will be beneficial for a person that experiences cerebral palsy. The different heights and angles of the game table will contribute to the desired head level position of the person. The height and body of the individual will determine which operating position the player will have: the lay-position, the sit-position, or the stand-position. The devices featured in the game table will be very simple to operate, and they will provide a brilliant interactive environment for the game table player. The Blue Light Rope is featured in the game table. It displays several light patterns that the player will enjoy to watch, and he/she will want to feel the blue rope. The Atom Massager is also included in the game table; it vibrates and lights up when activated. Ultimately, the game table will serve as a beneficial tool for a person with cerebral palsy because the interaction and the motor functionality of the person increases substantially due to the elaborate design and the strategically chosen entertainment devices.

## CHEMICAL ENGINEERING

### 33.CHE.5

#### BioButanol - Ethanol's Overlooked Cousin

Dan Heideman, Kristine Heideman, Heather Mayes

Advisor: Edward Funk, Ph.D.  
Department of Chemical Engineering

A somewhat overlooked alternate fuel is biobutanol, or butanol made from biomass. While ethanol has been making headlines, there are several advantages of butanol over ethanol. For example, butanol is safer because it is less volatile, engine modifications are not needed, and butanol can be transported by pipelines currently used for gasoline while ethanol cannot.

Our project details the production of butanol from biomass by fermentation. This process has been known since the 1860's, but has been plagued by high costs of feedstock and low conversion. However, the rising price of petroleum-based fuel and more efficient strains of bacteria have made the process worth revisiting. Our project outlines the pre-treatment of feed stocks, a combined fermentation and liquid-liquid extraction unit, and separation processes for product purification. A key innovation in this process is the combination of the fermentation and extraction units. The original process was severely product-inhibited, resulting in low product concentration and associated high costs in separation and recovery. By continuously removing the butanol from the fermentation broth, we obtain higher yields and lower costs. With these improvements, biobutanol can be produced in an economically viable process yielding a fuel superior to ethanol. Biobutanol production represents the next step in the effort to reduce our dependence on fossil fuels.

### 32.CHE.5

#### Producing the Conducting Polymer Polyacetylene

Gerald Begaj, John Jackson, Oluwagoke Ajayi

Advisor: Edward Funk, Ph.D.  
Department of Chemical Engineering

Conducting polymers were discovered around twenty years ago in a Japanese laboratory. With a little luck and insight acetylene was polymerized and turned into a shiny metal. With this discovery scientist look to use it by doping it with I2 so it could become conductive. In our project we are using the same ideas but we are producing acetylene from

scratch, and then convert it into polyacetylene. We are also completing a complete financial analysis of the project. This is a fantastic find because polyacetylene is almost as conductive as copper, and can be used in aircraft and in battery circuits to replace copper.

### 29.CHE.3

#### Removal of Benzene and other Aromatics from Wastewater

Jeff Grunschel, Craig McComas, Travis Pyrzynski

Advisor: Edward Funk, Ph.D.  
Department of Chemical Engineering

In refineries, roughly one barrel of water is used for every barrel of crude oil that is distilled. With increasing treatment costs, more stringent regulations, and scarce water sources in some areas, the need to increase onsite treatment will become more important in upcoming years. In this project we base our initial flowsheet on methods already available to recycle refinery wastewater. The use of air flotation, surface skimming and sand filtration will be used as an initial unit to help with removal of large particles. These initial units will be ideal to help keep costs of the process down. The use of activated carbon will be used to help with removal of aromatics and will be placed towards the end of the flowsheet to also help keep costs down. Also biological and chemical methods will be used to help further purify the wastewater. The hope is to recycle the wastewater from plants to avoid the need of fresh water from public sources. Economics of the process will be presented to show whether or not complete recycling of refinery water is cost effective.

### 31.CHE.5

#### Lucrative Styrene Production

Pongpak Yongsatirachot, Monika Ceglarska

Advisor: Edward Funk, Ph.D.  
Department of Chemical Engineering

The production of Styrene is a billion dollar industry. There are several ways to produce Styrene. The conventional way is from Ethylene and Benzene. However, the cost of Ethylene is not only high but also relatively volatile. The idea for this project is to use cheaper raw material, namely Ethane instead of Ethylene. The new process will allow us to convert Ethane to Ethylene. The new route to produce Styrene monomer from Ethane and Benzene is expected to enable significant cost savings.

Ethane, along with Ethylbenzene from the alkylation unit, is fed to a dehydrogenation reactor, with a catalyst capable of simultaneously producing Styrene and Ethylene. The catalyst suitable for this type of reaction is composed of gallium, platinum and potassium on alumina modified with silica. Necessary data on chemistry for this project is based on Dow Chemical Company and Snamprogetti's patents.

We are going to design the best route and other factors, such as the sizes and types of reactors used in this process, and the amounts of feeds to the reactors to make this process most profitable. Despite the fact that we do not know the exact prices for all of the equipment, approximations will be made by the help of computer software such as ChemCad. Finally, we are going to evaluate the economic potential for this new process to prove that it is economically feasible.

### 28.CHE.3

#### CLA: Fat That's Good For Your Heart

Sansarn Riewchotisakul, Yevgenny Strashnov,  
Jesus Trujillo

Advisor: Edward Funk, Ph.D.  
Department of Chemical Engineering

Researchers have shown that one of the major causes of heart disease, the number one killer in United States, lies in the unhealthy diet consumed by the mass population. As such, a tremendous amount of attention and funding have been invested the research and production of essential fatty acids, which contain health benefits such as lowering cholesterol in human blood. Conjugated Linoleic Acid (CLA) is a family of essential fatty acids that studies have shown to potentially lower blood sugar and prevent cancerous tumor growth, and is therefore a topic of growing research interest.

Current CLA production, however, requires expensive seed oil with high CLA content and needs to be performed at high temperature, resulting in unwanted side reactions. The primary goal of our project is to design a CLA batch production and separation system using cheap soybean oil that works at low temperature. Our design was based on current research of CLA conversion from non-conjugated linoleic acid using UV radiation, and low-temperature separation using Urea. Specific requirements include the design of a radiation reactor unit and its integration with the low-temperature separation unit, as well as their economic analysis. Analyses show that our unit would greatly reduce the production costs of CLA and the use of production chemicals, giving an economical and environmental advantage.

### 27.CHE.3

#### Nuclear Hydrogen

Syed Ahmed, Adam Nichols, Nirav Patel

Advisor: Ludwig Nitsche, Ph.D.  
Department of Chemical Engineering

President Bush allocated \$1.2 billion during the 2003 State of the Union Address for the development of reliable hydrogen fuel and technologies to reduce America's growing dependence on foreign oil. Along with providing energy independence, hydrogen fuel produces no pollution and no greenhouse gases during production or utilization. The primary goal of this project is to devise a method for commercial-scale production of hydrogen via a thermochemical process using copper chloride. Excess heat available at nuclear power plants will be used to provide the energy for the process. The proposed process requires reactors to run at temperatures not exceeding 550 deg C, which allows the process to be compatible with discharge heat from current nuclear reactors. Next-generation nuclear reactors will operate at much higher temperatures, allowing us to further optimize the process by exploiting the higher temperatures available in the future. The project will also address the transition of our society to a hydrogen-based economy. New methods need to be developed for safe storage and transportation of hydrogen. Safe storage tanks need to be utilized in cars to prevent failure during collisions. Fuel cells need to be made available to utilize the new fuel source. Estimates of the time required and a full economic analysis will be developed for the transition of the American economy to hydrogen fuel.

### 30.CHE.5

#### Production of Synthetic Diesel from Waste Plastics

Mindy Truong, Barbara Augustynek, Sevasti Pyrovolikou

Advisor: Randall Meyer, Ph.D.  
Department of Chemical Engineering

In today's society it is difficult to find an area where plastics have not made a contribution. However, once these products lose their function, only a fraction is recoverable through recycling. Plastics in the form of polyethylene, polypropylene and polystyrene make up the majority of this volume and are central to the focus of waste reduction. Among the differences between plastics and liquid fuels are the molecular weights and varying lengths of the molecular chains. Liquid fuels tend to have smaller chains compared to the long polymer links found in plastics. It is logical to

assume that if the long bonds of the polymers were able to be broken under the correct conditions that a synthetic liquid fuel could be obtained. The goal of this project is to carry out this idea and design a process for the conversion of waste plastics into a cheaper fuel source. Pyrolytic gases from plastic wastes can be refined into a diesel grade fuel. The solid char that is produced as a byproduct can be partially combusted to form carbon monoxide, which is subsequently used in a Fischer-Tropsch synthesis to produce a mixture of hydrocarbons in the diesel range. While it is necessary for the pyrolysis reactor to be carried out in a semi-batch manner, the remaining components of the process require continuous operational parameters. An economic analysis will show whether or not the process is beneficial in producing a cheaper fuel source.

## CIVIL AND MATERIALS ENGINEERING

### 25.CME.3

#### Sidestream Elevated Pool Aeration Station on the Chicago River

Kendra Berg, Jon Ebers, Drew Gazis,  
Andrew Grzesnikowski

Advisor: Christophe Darnault, Ph.D.  
Department of Civil and Materials Engineering

The purpose of Sidestream Elevated Pool Aeration (SEPA) Stations is to raise the dissolved oxygen (DO) in a river. Currently there are five SEPA stations along the Calumet River, which have successfully raised the DO levels in the area and for up to four miles downstream. This improvement to the waterway has many benefits both environmentally and aesthetically. The reversal of the effects of pollution would be increased by the installation of a SEPA station. Marine life would start to increase, bringing birds back to the area and increasing public enjoyment of the area. The visual appeal of the area would also be increased by the waterfalls (weirs) of the SEPA station. Currently the Chicago River has two diffused aeration stations on Devon Ave and Webster St. The diffused aeration stations experience operational and cost problems, which is why that design was abandoned and replaced with the side stream design.

The design of the SEPA station on the Chicago River will include: collection of existing or interpolated dissolved oxygen levels to insure the proper location of the SEPA station, design of the electrical and mechanical systems (as required to maintain proper water flow), weir design in or-

der to increase DO levels, design the pool to supply water to the weir system, and the building to house electrical/mechanical components and piping.

### 19.CME.7

#### Renovation of Weber Road at Interstate 55

Louie Cudia, Dave Novotny, Sean OBrien,  
Adrienne Parsons

Advisor: Kouros Mohammadian, Ph.D.  
Department of Civil and Materials Engineering

Chicago is notorious for traffic jams. The Weber Road exit from Interstate 55 is no exception. Our project sets out to fix the mile long back-ups onto I-55 during rush hours. Our design proposes the addition of a cloverleaf to eliminate the signalized intersection after exiting the interstate. Doing so will provide less back-up, and ultimately a faster commute time. This project requires major renovation to add in cloverleaves and merge lanes to eradicate the signalized ramps off of the interstate. In order to draw plans of our design, surveying of the current land conditions was completed. CAD drawings were created for the existing roadway and proposed designs. Our design is the original solution to the problem. The only feasible next step would be to gain funding and begin construction to implement our design.

### 16.CME.6

#### Bridge Collision Prevention System

Eric Campos, Tony Gura, Ashok Kumar, Davood Karimi,  
Erik Alvarez

Advisor: Ming Wang, Ph.D.  
Department of Civil and Materials Engineering

The Bridge Collision Prevention System (BCPS) will alert a heavy vehicle operator of insufficient clearance under an upcoming structure or bridge. The system will be designed to provide an attention-grabbing warning signal, as well as ample SSD to allow the high vehicles to stop in time. This system will make it possible to minimize loss of life, property, time, and money which occurs every time a truck collides with a highway bridge. The BCPS will prevent bridge collisions in a cost-effective way that is minimally intrusive to vehicles for which bridge clearance is not an issue. The proposed project involves researching past bridge collisions in the State of Illinois, finding the main problem areas, and designing an economical solution to prevent such collisions in the future. A cost estimate analysis will also be per-

formed, with the cost of a BCPS weighed against the cost of recurring bridge repairs.

After researching problematic bridges in the Chicagoland area, our group has decided to work on the bridge located at Harlem Avenue, spanning over the I-55 (Stevenson) Expressway. Our research indicates that this bridge is periodically hit on the south-bound lanes by trucks with insufficient clearance. We have gathered data regarding this bridge, including topographic information, traffic volumes, and other relevant information regarding this problem site. Through the use of pavement loop detectors, an inexpensive laser, warning lights and proper traffic signage we have designed a system to prevent this type of an incident from occurring.

### 14.CME.6

#### Athletic Residence Halls for the 2016 Summer Olympics

Sean Pfeiffer, Steven Jeske, John Saraceno,  
Emily Druckrey

Advisor: Robert H. Bryant, Ph.D.  
Department of Civil and Materials Engineering

If Chicago has the honor of hosting the 2016 Summer Olympics, residence halls will have to be constructed that can hold 16,000 athletes. There is not an easy solution to this problem, seeing that Chicago is a very congested place and finding a lot big enough to house 16,000 athletes could become quite a challenge. The lot being proposed for the construction of these residence halls is the truck parking lot that McCormick Place uses to hold numerous trucks when big conventions come to Chicago. Land rights were not given to designers, but instead air rights were awarded; this means the buildings must be built on "stilts" so as to allow trucks to continue their use of the parking lot. A single structure will be designed from the knowledge that we gained throughout our college careers. From this structure, we will use a "cookie-cutter" approach to fill out the entire lot with replicas of the first building so as to make sure our quota of athletes is reached. The engineering calculations will consist of a steel design for all 17 stories, with the help of structural computer programs. This will include selecting members and calculating connections with loads found in the Chicago Building Code. A slab, as well as foundation design will be completed, given soil boring logs at the specified construction site. There were many changes to this project during the duration of this semester, but the final product will be the best choice architecturally as well as structurally.

### 26.CME.3

#### City of the Future Design Competition: Recycling Chicago's Water in 2106

Arun Heer, Janet Shackelford, Zaki Ali, Samantha Ebright

Advisor: Karl Rockne, Ph.D.  
Department of Civil and Materials Engineering

In the year 2106 freshwater will be considered to be the new oil. Currently, Chicago drains approximately 1 billion gallons of water a day from the Great Lakes for industrial and residential uses, yet less than 1% of this water is renewed back into the lakes. According to the United Nations two out of every three people in the world will be facing water shortages, and it is predicted by scientists that by the year 2106 water will be even scarcer due to global warming effects. The primary goal of our project is to engineer a design concept, proposed by an architectural firm called Urban Lab for the City of the Future Competition, to recycle 100% of the water within Chicago back into Lake Michigan. In Urban Lab's design, they have proposed to incorporate "eco-boulevards" which will expand Chicago's existing parks and waterways and treat all of Chicago's waste and storm water biologically. This treated water will then be sent back to the lake for public and private use. In our engineering proposal we have constructed 100 "eco-boulevards" running from the eastern and western limits of the city that biologically treat waste and storm water through the use of algae, aeration, nitrification, and sedimentation. The storm and waste water will be conveyed to the boulevards by an expanded TARP system in conjunction with new sanitary and storm lines. The result of this design, with the assistance of water conserving infrastructure, will be to significantly reduce water consumption and increase greenspace throughout Chicago.

### 70.CME.13

#### Travel Time Estimation Using Automatic Vehicle Location System Equipped Buses as Probes

Petro Kravets, Kai Yeung Lam, Stephen Veleff,  
Xuanwei Bi

Advisor: Jie Lin, Ph.D.  
Department of Civil and Materials Engineering

The Chicago Transit Authority (CTA) collects information about the location of busses and passenger traffic volumes from Automatic Vehicle Location (AVL) and Automatic Passenger Counting system (APC) equipped busses. This information includes the location of specific stops, time that

the bus spent on a particular stop, the number of passengers boarding or departing the bus, etc. The primary goal of this project is to estimate the travel time of commuter vehicles on the section of Madison street between Racine and Morgan using the data provided by the AVL and APC systems. In order to accomplish this goal, our group recreated the actual section of the street in the Visual Simulation (VISSIM) program using the data collected in the field. VISSIM is a microscopic, time step and behavior based simulation model developed to model urban traffic and public transit operations which can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc., thus making it a useful tool for the evaluation of various alternatives based on transportation engineering and planning measures of effectiveness. The second step in this project was to simulate the traffic flow on the street with the assistance of VISSIM and study the data produced in the simulation. While referencing that data our group determined the relationship between movement of both commuter vehicles and busses and the passenger flow, which would allow us to estimate travel times of either vehicles given the information provided by the CTA's APC.

### 13.CME.6

#### Olympic Aquatic Center

Akash Surani, Ingrid Oberle, Ryan White, Sokol Lluri

Advisor: Subrata Chakrabarti, Ph.D.  
Department of Civil and Materials Engineering

On July 26th, 2006, the United States Olympic Committee narrowed the field of competing cities for a 2016 Summer Olympic bid to Chicago and Los Angeles. Under the direction of Mayor Daley, Chicago has been looking to put itself on the map as a world-class city, and hosting an Olympics would showcase the city on a global stage. While Chicago's best assets would be its lakefront atmosphere and relative proximity of events, it still is without major venues including the Olympic Stadium and Aquatic Center, while competitor Los Angeles has many structures in place from its previous 1984 Summer Olympics. The scope of this project is to design the main components of this Aquatic Center, including the steel roof truss, columns, connections, and foundation. Main references include the Chicago Building Code, as well as the AISC steel construction manual. In its final product, the structure would house an Olympic-size swimming pool, diving pool, and be capable of seating approximately 10,000 spectators. In addition, steps will be taken to make the building as aesthetically pleasing as possible, while still fulfilling its functional requirements. Having such a facility in place would not only help Chicago secure an Olympic bid, but it would also serve its surrounding community for decades thereafter.

## 24.CME.7

### Stormwater Treatment Design for a Commercial Development

Andrew Wojcik, Jaroslaw Szelewa, Jaime Stewart

Advisors: Christophe Darnault, Ph.D.  
Department of Civil and Materials Engineering  
Amid Khodadoust, Ph.D.  
Department of Civil and Materials Engineering

With the increase in environmental awareness, municipalities are challenged to address the relatively new concept of storm water treatment. Our senior design group has taken on the task of looking into and researching various Best Management Practices which have multiple advantages and disadvantages. Our design group will then design a commercial subdivision which utilizes these Best Management Practices. The design of the commercial subdivision will focus primarily on drainage, storage, and treatment of storm water runoff. The design of the commercial subdivision will either comply or exceed many of the requirements for storm water quality that are likely to be enforced by municipalities over the next decade. The design will not be for an exact location but will be more of a criteria design assuming northeastern Illinois rainfall conditions. The primary goal of the design group is to establish a criteria set of plans for small to medium size commercial developments that implement the most cost-effective Best Management Practices for increased storm water quality. Increased storm water quality is of utmost importance in areas where storm water is not combined with sanitary discharge and is either discharged into a lake or river.

## 17.CME.8

### Development of High Strength / High Performance Lightweight Concrete

Dorin Bogdan, Cotor Marian, Gentry-Fernandez Elliot, Atanasiu Romulus, Krzysztof Piszczek

Advisor: Mohsen Issa, Ph.D.  
Department of Civil and Materials Engineering

Structural lightweight concrete (LWC) is a concrete where lightweight coarse aggregate (expanded soil, slate, or shale) is used instead of the regular normal weight coarse aggregate, while the normal weight fine aggregate remains the same. This practice results in low density for the LWC (115 to 125 pcf) compared to 150 pcf for normal weight concrete. The high percentage of voids inside the LWCA makes a limit on the maximum strength of LWC that can be

obtained. Within the available literature, there is a lake of information about LWC mixtures with compressive strengths exceed 8000 psi that is essential to effectively utilize LWC in bridge structures. This experimental study was conducted with a major objective of developing high strength/high performance LWC mixtures. Other objectives include learning standard test procedures for casting and testing concrete and learning how to prepare a professional report. A total of 12 LWC mixtures were designed, mixed, and cast. From each mixture a large number of specimens were prepared for the strength tests. The tests were conducted for each mixture at 1, 7, and 28 days. Based on this study, it was able to develop LWC mixtures with a compressive strength exceeding 5500 psi at 1 day, and exceeding 10000 psi at 28 days. Relations between the compressive, flexural, and splitting tensile strengths were explored. Economical issues were also considered. The findings of this study will serve as a foundation for other research studies were high strength LWC mixtures will be utilized.

## 23.CME.7

### Bus Rapid Transit System Implementation in Chicago

Felimaaur Flauta, Elora Ibay, Jose Montesinos

Advisor: Jie Lin, Ph.D.  
Department of Civil and Materials Engineering

The Chicago Transit Authority (CTA) currently operates the second largest public transportation system in the United States. About 1.6 million riders use the CTA, with a little over 1 million using buses and the rest using rapid transit cars, resulting in a high demand for improved bus transit. Bus Rapid Transit (BRT) is a system that provides a higher and more efficient quality of service, similar to the service quality of rail lines. The development of BRTs throughout the world have greatly enhanced the levels of service for customers and therefore improved ridership by providing exclusive bus lanes, signal priorities, transit pay stations, or other ideas. However, with Chicago's busy transit network, these ideas have their disadvantages. The primary goal of our project is to examine several BRT developments with similar demographics to Chicago and implement a similar system for the city. We researched several BRT case studies and used their different features in order to provide a conceptual design. Current bus ridership data and existing road and transit configurations have aided us in implementing our design using Visual Simulation software. Our design provides an innovative look to the possibilities for a successful bus rapid transit system for the city of Chicago.

## 18.CME.8

### Evaluation of the Structural Behavior of Lightweight High Strength Reinforced Concrete Beams

Yogesh Patel, Nayankumar Patel, Deian Ivanov, Lukasz Pocięcha, Daniel Tomicevic, Marcin Krok

Advisor: Mohsen Issa, Ph.D.  
Department of Civil and Materials Engineering

Lightweight concrete (LWC) has a density of 115 to 125 pcf, which is about 20% lower than the density of normal weight concrete. LWC is achieved by using lightweight coarse aggregate, expanded clay, shale, or slate, instead of normal weight coarse aggregate. Due to its reduced density, LWC has many advantages for engineering applications, especially for structures that require high strength, but must maintain low dead loads. The principal goal of this project is to study the structural behavior associated with high strength LWC beams. Overall, twelve full-scale high strength LWC beams, 12 ft long and having a cross section of 8in by 12in, were fully designed and fabricated for this study. The specimens were divided into three groups, each consisting of four beams. Each group consisted of two specimens that were designed for flexural analysis, and two to study shear behavior. Group I, II, and III beams were made of LWC with a designed compressive strength of 6,000, 8,000, and 10,000 psi respectively, and then tested and analyzed. This study encompassed an extensive experimental program. In addition, the flexural and shear test results were used to compare with the provided equations in the ACI and AASHTO standard specifications. Execution of this project has facilitated the understanding of the structural behavior of LWC beams, and their potential use and benefits for structural applications. The outcomes of the study will be beneficial for researchers and industry since limited research and information about the subject of this study are available.

## 15.CME.6

### Pine Lake Residential / Commercial Subdivision Development

Rosanna Lee, John Lynk, Kevin Klein, Vi Nguyen

Advisor: Jie Lin, Ph.D.  
Department of Civil and Materials Engineering

As the population of the Chicago metropolitan area grows, so too does the need for responsible urban planning with respect to both the environment and the quality of neighborhood design. There currently are a number of de-

velopments in the Chicago area that provide highly desirable neighborhood settings, but do so at the expense of environmental health. Ways in which existing subdivisions detract from the welfare of the environment include poor access to mass transit systems, substandard water and wastewater infrastructures, failure to mix land uses appropriately, and failure to conserve resources where practical, among others. Our goal is to develop a subdivision that addresses the environmental health of the site while still providing a neighborhood that is attractive to its residents. We intend to deliver a set of plans, as would be submitted to a land developer, that complies with the Leadership in Energy and Environmental Design – Neighborhood Development (LEED-ND) guidelines provided by the US Green Building Council. Furthermore, the plans will comply with Hanover Park, IL building codes, which is where the site is located. Specific plans to be submitted include site layout, topography, grading and drainage, road layout, and utility plans. A compilation of LEED-ND submittals will also be included, as well as necessary submittals for the Village of Hanover Park, IL. An intended extension of this project is to submit the plans to the US Green Building Council in order to see if they meet all of the prerequisites and intended credits for a LEED-ND subdivision.

## 20.CME.7

### Design and Implementation of a Monorail System Within the City of Chicago

Dipak Patel, Marat Goldenberg, Michael Marczyk, Dave Miller, Dina Muller, Korinne Krych

Advisor: Kouros Mohammadian, Ph.D.  
Department of Civil and Materials Engineering

Recent headlines have proposed the 2016 Olympics to be held in the city of Chicago. Based on this notion, we have decided to focus our senior design project on the transportation aspect of this event. The predicted extreme increase in tourism will introduce the necessity to alleviate the heavy congestion that would take place for the duration of the Olympics. Our proposed design consists of interconnecting the inbound transit system into Chicago with that of the existing Chicago Mass Transit system. For aesthetic and environmental purposes, we have decided on a monorail for the city of Chicago. The route would connect with the major Metra stations and also connect to the major CTA stops. The monorail will continue by making a loop around the city towards the lake front where it is assumed that the Metra electric will be expanded northward; hence, the monorail would conveniently connect to its line. The goal of this project is not only to alleviate the congestion of Chicago during the Olympics, but also to make the daily lives of its citizens more convenient outside of the event. Furthermore, this aesthetically pleasing design will add to the culture of Chicago and act as a symbol of the future for the city.

## ELECTRICAL AND COMPUTER ENGINEERING

### 51.ECE.9

#### TypeMouse: Fully Functional Keyboard and Mouse in a Single-Handed Device

Jeremy Kahsen, Robert Hanrahan, Benjamin Stef,  
Wojciech Przeczkowski

Advisors: David Schneeweis, Ph.D.  
Department of Bioengineering  
Vladimir Goncharoff, Ph.D.  
Dept. of Electrical and Computer Engineering

Simple and rapid input from both a keyboard and mouse has become an essential and important part of data and command entry into the computer. Every day, millions of users use a keyboard and mouse as two separate devices to input commands into a computer. Often times, it may become difficult to alternate between the two devices when working on a project that requires simultaneous input of both the keyboard and mouse for quick and easy manipulations. Our project will implement a fully functional keyboard, contained and arranged in only forty-five buttons, and a fully functional mouse, implemented by sliding the upper base of the device on a stationary lower base, in one single-handed device. Specific requirements of our project include five nine-position switches located on the exterior shell of the device, and a moveable upper base supported on a stationary lower base. Different combinations of switch inputs will produce preset and configurable keystrokes, no different than the keystrokes that a computer interprets from a conventional keyboard. Sliding the upper base on the lower base will move the mouse pointer on the screen, just like a conventional mouse. The device will be connected to a personal computer through a standard USB connection. The exterior shell will be ergonomically shaped to provide comfort and stability for a user's hand. All in all, with proper training and practice, our device will combine, revolutionize, and simplify simultaneous keyboard and mouse inputs into a computer.

### 50.ECE.9

#### DIGITS (Digital Interface Glove Including Tactile Sensitivity)

Jeff Kantarek , Emil Remolana, Christopher Kaczor

Advisor: Dennis Vaccaro, Ph.D.  
Dept. of Electrical and Computer Engineering

DIGITS will be a multimedia wireless glove mouse. The product's intention is to use hand motions to interface a user to a computer. The product will have all the functions of a typical mouse, but will be worn on the hand. The mouse pointer on the computer screen will be controlled by hand movements made by the user. The direction, speed, and acceleration of the pointer will be controlled by the user's hand. The user will interact (click) with on-screen windows (objects) by bending each finger and having them come in contact with the thumb. The glove will be wireless and will have a max distance use of no less than two meters from the receiver.

The glove with both a microprocessor and sensors on board (gyroscope, accelerometer and click detection). Each sensor would be connected to the microprocessor. The microprocessor would be able to process the data and provide real-time translation onto a two-dimensional plane. The error could be reduced by including more planes in the calculations. Transforms relating not only to change in the x-y, y-z, or x-z planes but also combinations therein of 30, 45, 60 degree offset planes could be tested.

### 46.ECE.10

#### SecondSight: Gun-Mounted Wireless Video Camera System

Maciej Janiszewski, Kent Nelson, Mariam Pauls

Advisor: Vitali Metlushko, Ph.D.  
Dept. of Electrical and Computer Engineering

In the news there have been several incidents where a major municipality's police department officers were prosecuted for discharging their weapons in self-defense. The question of how necessary such lethal force was has arisen time and time again. This not only applies to police officers, but also citizens at home. If an officer of the law is questioned as to whether it was necessary to use deadly force, it is even more questionable for the average person. Our project aims to resolve ambiguity by providing a "silent witness" to this sort of event – a video camera that is mounted on a gun to

record exactly what happened from the point of view of the shooter.

The user purchases the kit, and needs only the weapon itself and a VCR. When the weapon is removed from the box, the unit will transmit video to the AV receiver unit attached to VCR along with an IR 'record' signal to begin recording. Once the gun is placed back in the box, a 'stop' command will be sent to automatically stop the recording. The unit can transmit an analog video signal on a 2.4 GHz carrier wave up to about 300 feet from the box, providing the freedom to capture video anywhere throughout the house. It transmits full color video and audio from the camera.

## 6.ECE.11

### Wireless Electronic Shelf Tag Display

Bryan Strysik, Sean Richards, Justin Jones

Advisor: Roland Priemer, Ph.D.  
Dept. of Electrical and Computer Engineering

Retailers have long wrestled with the problem of efficiently changing prices on the many stocked items in their stores. Paper shelf tags or labels must be manually placed by store personnel on every shelf stowing an item for sale, as well as for implementing price changes. This leads to problems with accuracy as well as speed in pricing, which may discourage store management from changing prices on items in stock on their shelves. Clearly the scope of the task of price administration can be quite cumbersome. Our solution is to create a wireless electronic shelf labeling system using the low-complexity and low-power ZigBee wireless protocol. This protocol can instantaneously update prices on all electronic shelf label nodes via a central computer database. We were successful in creating a prototype shelf label node and a simple-interface database program to change the pricing of the nodes. Ultimately, we found that in order to be a commercially viable product, the price of a node must be only a couple dollars. The current prices today are too high; however, ZigBee is still new and we expect the cost of nodes to gradually drop over time making this product commercially viable in the future.

## 48.ECE.10

### Medication Reminder

Edward Ojode, Cesar Aguilos, Samir Desai

Advisor: Zhichun Zhu, Ph.D.  
Dept. of Electrical and Computer Engineering

With an increasing elderly population and complex medication regimens, the problem of patients skipping doses of medication continues to grow. The Medication Reminder is a product that will alleviate this problem. This device consists of a storage unit for organizing medication and a portable unit that sounds an alarm whenever medication is due. This device is targeted mainly toward elderly and disabled patients who have complex medication regimens. The device will automate the process of taking medication by sounding an alarm whenever it is time for medication. It will also display the required dosage of medication required on the Storage Unit. The current design allows for up to 8 different types of medication to be stored in the compartments. The device will also keep a record of the amount of medication taken from any particular compartment. Our design implemented the User Interface of both the Storage Unit and the Portable Reminder. The design was implemented using very basic components. This was done with the expressed purpose of reducing the cost of the implementation. We extended the functionality of the basic PIC16F917 microcontroller and used a number of low cost electronic parts to implement the design. The final design includes prototypes of both the Storage Unit user interface and the Portable Reminder user interface. The final design is an implementation of a low cost prototype, with functions to set the time and alarm and the dosage of the medication.

## 49.ECE.10

### Giant Marquee

Eric Gesell, Konstantin Khrustov, Steven Mockus

Advisor: Dennis Vaccaro, Ph.D.  
Dept. of Electrical and Computer Engineering

Conveying a desired message to the right public is a very important part of publicity and advertisement for many sectors today, whether a corporation with product solicitation or a college or university with its news updates. This project's goal is to create a giant dot-matrix display of any size (starting as small as two by two dots and going up to almost any size). Each dot on the matrix would be a wireless module that flashes on and off with certain delay as programmed by a central unit. The messages (signs, letters,

words, sentences, etc.) that are displayed would be scrolling through the matrix with adjustable speed.

We envision this product to be used as a giant marquee that is displayed in the windows of a building at night. Each unit at a window location would be considered one pixel in a matrix. The units would contain a microcontroller, a light source, a battery, and wireless communication circuits. Each unit is small and compact as to not disturb the view from the window. The unit would have a light sensor so that it can turn itself on automatically every night. Its light source will be adequate to be viewed at a distance. The battery will hold enough power for at least one week or more. The units will communicate wirelessly to stay in sync with a pre-programmed message display sent from a portable computer. The units most likely would be at a building location for a temporary amount of time, and should be easy to install, remove and program. The unit installation at each building site will most likely be unique, so the design must be flexible to allow different ways to attach the unit to a window location (i.e. magnets to a metal window frame, suction cups, two-way stick tape, etc.).

#### 10.ECE.4

### **Building / Obstacle Detector for the Visually Impaired (Walking Cane)**

Iniobong Essien, LaTToya Harris, Robin William

Advisor: Roland Priemer, Ph.D.  
Dept. of Electrical and Computer Engineering

Currently in the market today, there are several walking canes in existence for legally blind individuals; these canes are meant to assist these individuals in their daily activities. In most cases, visually impaired individuals still have difficulties locating entrances to buildings, detecting an obstacle in front of them, and detecting the presence of low overpasses at eye level (the cane only helps them detect obstacles near the ground). The objective of this project is to design a sensory cane that will assist legally blind people with the above-mentioned tasks.

A single battery will power the cane, as well as a controlling microprocessor, cell phone vibrators, receiver amongst other components. Transmitters placed above the door to a building will signal a receiver in the cane that an entrance is near. Ultrasonic proximity sensors to detect obstacles at close range and two vibrator alerts will also be integrated within the walking cane. A smaller prototype will be constructed that will demonstrate the features of our design.

This design integrates many different aspects of the electrical engineering field. This project serves as an excellent example of how a useful system can be constructed using

knowledge of sensory systems, controls, wireless communication and software programming.

#### 53.ECE.9

### **Laboratory Radio**

Maher Eseed, Salam Jmari, Samir Abuzagheh

Advisor: Yingwei Yao, Ph.D.  
Dept. of Electrical and Computer Engineering

Our goal is to design an improved demonstration circuit for the laboratory portion of Communication Engineering Course ECE 311. One of the tasks is to accurately demonstrate Quadrature Amplitude Modulation (QAM) using a balanced modulator. QAM has two carriers – each having the same frequency but differing in phase by 90 degrees. Our method combines two amplitude-modulated signals into a single channel, thereby doubling the effective amount of information being transmitted over the same bandwidth. Because the orthogonal carriers occupy the same frequency band and differ by a 90 degree phase shift, each can be modulated independently, then transmitted over the same frequency band. We also demonstrate Frequency Modulation by driving a voltage-controlled oscillator.

#### 39.ECE.1

### **Heart Murmur Detector**

Arnold Lee, Jovani Ibarra, Tenille Madeline

Advisor: Vladimir Goncharoff, Ph.D.  
Dept. of Electrical and Computer Engineering

Heart Failure is the number one cause of death. The primary goal of this project is to develop a product that will make it easier for physicians and medical technicians detect heart murmurs in patients. Our device will hopefully aid in future diagnosis, and in the long run create a means of early detection of heart murmurs. The main functions of this device include accepting an analog input from a microphone or stethoscope. These audio data are collected, stored and recorded for at least four cycles of real-time heartbeats. We are able to filter out any noise caused by the sensors. Finally, the product will present results in a format that can make it easy for a user to visualize and analyze them. A GUI will also be developed to download signals into a PC and perform further analysis. The product will be tested to detect heart murmurs from a sample database of normal and abnormal heart sounds.

## 67.ECE.13

### Posture Monitoring Device

George Tunaru, Stephen Grasser, Uzoma Onyenweama

Advisor: Vladimir Goncharoff, Ph.D.  
Dept. of Electrical and Computer Engineering

Over 80 percent of people suffer back pain in their lives, and the only way to alleviate back pain and prevent back injuries is to maintain a proper posture. The device we have created is intended to detect an improper posture and give the user feedback on how to correct it. We have interfaced flex and mercury switch sensors to an Oopic-R microcontroller. A flex sensor is a long, flat, and bendable resistor that changes in value when bent. The mercury switch sensors detect changes in angle relative to the gravitational field, and provide a binary output. All of these sensors are mounted on a shirt so that they can monitor posture. The flex sensors are mounted parallel to the spinal cord to monitor excess spinal bending. The mercury switch sensors are mounted on the shoulders at angles so that when the shoulders slouch the sensors turn off. Only when the shoulders are in proper position will the mercury switches be on. We have also interfaced a serial LCD with the Oopic-R microcontroller board. When the Oopic-R alerts the user that he/she is exhibiting an improper posture, the LCD displays information as to where the posture defect is located at. For this device to be used on a large scale, it would have to be built to user-friendly specifications. Currently the wiring is very fragile and the parts are relatively expensive.

## 4.ECE.11

### System to Allow Easy Access to a Household

Adam Williams, Hafiz Tahiru, Boadkye Yiadom

Sponsor: Judy Gardner, M.A.  
Easter Seals of Dupage

Our client Amy is confined to a wheelchair, and has very limited use in all of her limbs. She has been entirely unable to either enter or exit her house without the aid of another person. We were approached by the Easter Seals of Dupage County to come up with a solution to Amy's problem. So, our group set out to design a means by which Amy can enter and exit her house entirely on her own. We have set up a system that, with a push of a button, automatically opens the garage door and two inner doors in order for her to gain access into her house. The pushbutton switch is attached directly onto her wheelchair for easy use, and the doors automatically close after one minute. We have attached two motorized door openers on the two inner doors

and linked them together with the garage door opener that was already in place. Then each motorized device was programmed to activate with one remote switch. The only requirement set before us was to find a way to get all the doors to open automatically, have them all be linked together so one switch can open each of them, and have that switch mounted on her wheelchair for easy access. All of these parameters have been reached.

## 8.ECE.4

### Refreshable Braille Display

Vincent Arguelles, Fernando Garcia, Matthew Chan

Sponsors: Greg Ritchey  
Magnet-Schultz of America, Inc.  
Vegetable Fresh, Inc.

Advisor: Roland Priemer, Ph.D.  
Dept. of Electrical and Computer Engineering

As society progresses through the Era of Technology, the visually disabled are left behind. Many visually impaired individuals have jobs, but they are limited in what they can accomplish. An example of this is a blind person's limitation of using a computer. We have developed a refreshable Braille display that can display text in a file in Braille format. There are existing products for refreshable Braille displays, however they are very expensive. Our goal is to make a design that achieves the same task, but at a much lower price. The two main components of our design consists of six solenoids and a stepper motor. When a solenoid is fired, it strikes a retractable switch which raises a single dot on the Braille board. Six solenoids are used to output one Braille character. A stepper motor moves these six solenoids up and down over the Braille board, eliminating the need for dedicated machinery for each dot in the Braille display.

## 68.ECE.13

### The Intelligent Home Monitor

Hanan Semoon, Omta Ddankha

Advisor: Kaijie Wu, Ph.D.  
Dept. of Electrical and Computer Engineering

There are numerous products on the market that deal with home monitoring. While providing an important service to homeowners, many of these home monitoring products are expensive. Furthermore, they are difficult to install and operate. Our Intelligent Home Sensor is intended to be inexpensive and simple to use. If an intruder appears while

the homeowner is away, the system would text message a specified phone number, the homeowner's cellular phone, and also inform them of the situation via email. Besides that it will enable the owner to remotely check what is happening in the house, to verify who is in the house and where. This information can serve several purposes: monitoring children's location in the house, and detecting the presence of unwanted intruders. Our system is made of two parts: motion sensor and a monitor. There will be one motion sensor in each room of the house to detect a human presence. It will send a signal wirelessly to the monitor as soon as human motion was detected. The monitor is the main unit of the system. It will receive the sensor's signals and compare them to data saved in its memory. If a normal movement was detected, the information will be displayed on the monitor; otherwise, a text message will be sent. We are designing a device that will be appreciated by the public, that will be a simple tool for the majority to use, and it will make life easier and more secure for its users.

#### 9.ECE.4

##### Wheelchair Innovation

Uday Sangar, Jin Bang, Chubin Mei, Jerry Bwanhot, Peter Nicholas, Jan Sagun

Sponsor: Judy Gardner, M.A.  
Easter Seals of Dupage

Advisors: Vladimir Goncharoff, Ph.D.  
Dept. of Electrical and Computer Engineering  
Carmen P. DiGiovine, Ph.D.  
6 Degrees of Freedom LLC, Dept. of BioE

The primary goal of our project is to provide disabled children a measure of independence when utilizing their wheelchairs. Certain physical disabilities, such as quadriplegia or congenital malformations of the upper extremities, present users with difficulty in independently fastening seatbelts on existing wheelchairs. This new, innovative wheelchair allows not only more independence and freedom of mobility, but also enhances safety for the child. In addition, because external help will not be constantly required when fastening seatbelts on wheelchairs, caregivers will have more time to attend to other issues involving the care of their child.

When physical disability prevents children from achieving their full range of independence, any measure of restoring and helping develop this sense of independence is essential. The driving force behind our wheelchair seatbelt project is the desire to help a young child who could not use his arms to fasten his own wheelchair seatbelt, and whose family requested an upgrade of his current wheelchair. While this project wheelchair will not be able to perform any medical miracles in helping regain physical functionality, we are

hoping it will contribute on a daily basis in helping restore some measure of independence to children.

#### 69.ECE.13

##### RFID Temperature System

Ken Fadera, Piotr Jedraszczak, Nate Ruengpinyophun

Advisor: Michael Strocio, Ph.D.  
Dept. of Electrical and Computer Engineering

Radio frequency identification (RFID) is an automatic identification method that stores and remotely retrieves data using RFID tags or transponders. It is used in a variety of ways which include product tracking, inventory systems, automotive systems, and even human implants. The primary goal of our project is to implement an RFID temperature system. Ultimately, we wanted to get a hands-on experience with the technology itself in order to get a better understanding of how RFID works. The specifications of the project include the ability to store multiple temperature readings, the ability to read from multiple tags, user-friendly interface and LCD output, and power conservation. The design process involved establishing and testing communication between the tag(s) and the base station. We experimented with different microcontrollers for the data manipulation and found that the PIC series would be our best investment since it was more efficient and involved simple programming techniques. Once clear communication was established, we integrated the temperature reader and incorporated a working LCD to display the readings. Our design is simple and cost effective, providing a cheap solution for integrating an RFID system that is quick and reliable. Overall, this project gave us a better understanding of RFID technology.

#### 5.ECE.11

##### LCD Remote Control for Ipod Docking Station

Leonid Greyz, Alex Pashnev, Ciprian Pasare

Advisor: Piergiorgio Uslenghi, Ph.D.  
Dept. of Electrical and Computer Engineering

In recent years digital music player sales have grown tremendously. An increase in sales brought new companies to the market and at the same time developed a new market for digital music player accessories. iPod undeniably is the most popular device on the market right now. After investigating the market for iPod accessories, particularly iPod docks with remote controls, our design team found out that the market only has docks with basic remotes that utilize old-technology infrared or RF signal communication links.

The primary goal of our project is to design an iPod docking station with a display remote control that uses ZigBee communication. Specific requirements include the development of a remote with low power consumption, simplicity of use, and aesthetically pleasing design. Also it must have a working battery charger for the remote and the iPod. The remote must have such functions as play/pause, change volume, choose songs and choose playlists. We used gEDA PCB software to draw out our design for the circuit board and etched the board circuit using photo-resist concept.

To minimize our design we used surface-mount components and touch sensors instead of regular buttons. Ultimately, our design was a success and all our specific requirements for the project were satisfied. We think this device has a very bright future due to its convenience of use.

### 47.ECE.10

#### Software-Based Song Recognition System

Elias Zamaria, Chi Man Yu, Sergey Feldman

Advisor: Roland Priemer, Ph.D.  
Dept. of Electrical and Computer Engineering

The idea for our senior design project came about when a friend of one of the group's members asked him: "Is it possible to have something like Google, except you sing into it and it tells you what you sang?" The construction of a database containing every song known to man may be an impossible feat; however, the technology itself is very much within reach. Our product is a software-based song recognition system written in Matlab programming language. The program will accept input hummed or sung into a microphone, then analyze the input signal and determine the closest known song from a database. It can play back the closest match when requested. Alternatively, the user can enter the tune manually. A user-editable song database will be included allowing the user to add new songs. The program uses a simple, yet powerful graphical user interface. Our target market consists of casual music fans who simply hear a song and want to know the title and artist, as well as musicologists, educators and songwriters wishing to determine whether their song was already written. This project can be expanded. One could start a telephone service where the user dials a number, sings or hums the tune, and receives the data from anywhere. The technology from the project could also be built into devices like MP3 players, so that the user can select a song without having to search through a list of artists and song titles.

### 66.ECE.13

#### RFID-Based Inventory Management System

Peter Mazarakos, Paul Kuzich, Antony Paul, Donald Keller

Advisor: Danilo Erricolo, Ph.D.  
Dept. of Electrical and Computer Engineering

Inventory management is vital to the health of any small retail business, but is tedious and prone to error. Computer systems that manage the flow of items in and out of a business are common, but they lack the ability to track items between these events. A system that could provide real-time data about the location of items would increase efficiency and lower costs by removing the need for human inventory management. An ideal solution would incorporate an inexpensive device attached to each item that would constantly communicate with a network of installed sensors. RFID technology is extremely well suited to this type of design. The system consists of a number of fixed antennas that communicate with small tags attached to each item. Antennas are placed under shelves and where inventory transfers occur. The antennas connect to a small base unit and then to a standard computer, which manages the entire system. The development of our system focused on simple setup and an intuitive interface, necessities given that the likely consumer will be a business owner with little technical experience. The design functions well as proof of concept, but requires a more robust RFID system so that multiple tags can be read with a single antenna.

### 52.ECE.9

#### FM Subcarriers and Software Defined Radio using GNU Radio and the USRP

Joe Janik, Ravindrakumar Patel, Ashfaq Syed

Advisor: Yingwei Yao, Ph.D.  
Dept. of Electrical and Computer Engineering

Software-Defined Radio (SDR) is an exciting and rapidly growing field within electrical and computer engineering, with research being conducted at universities all around the world. Software-Defined Radio is only one aspect of the growing trend to convert as much as possible of analog into digital. By replacing analog components of systems with programs running on a digital processor, great innovations are allowed to occur. The digital data can be stored, manipulated, and acted upon by software leading to systems that are more dynamic. For our senior design project we chose to research and develop a better understanding of SDR. We were able to utilize the Free Software Foundation Project, Gnu Radio, along with the Universal Software Radio Peripheral (USRP) to explore FM frequencies ranging

from 87.9 to 107.9 MHz, then analyze the signal to pick up subcarrier channels. Subcarriers of interest were RBDS data channels at 57kHz and audio SCA channels typically at 67 kHz and 92 kHz from the main carrier. Using the GNU Radio Framework processing blocks along with the Python programming language we were able to display and output data obtained by the USRP. For our group, this experience has been a great entry point into the world of software-defined radio.

## MECHANICAL AND INDUSTRIAL ENGINEERING

### 43.MIE.12

#### Automated Spin Art Machine

James Piatek, Nemanja Stefanovic, Marina Dubinskaya,  
Stephen Karamyalil

Advisor: Michael Scott, Ph.D.  
Dept. of Mechanical and Industrial Engineering

The objective of this project is to build a prototype for a spin art machine that can accommodate an array of interfaces to provide a creative outlet for people of limited mental and/or physical abilities. A spin art machine is a mechanical system that allows paint to be ejected onto a canvas or paper via a spinning action. Usually paint is delivered manually via squeeze bottle, however, because of their physical or mental handicaps, some people cannot perform required actions to deliver paint in this fashion. Thus, we intend to develop an interface and complimenting automated mechanical system to allow the user to produce spin art through an assistive system, such as pushing buttons, for various colors of paint to be deposited on their working medium. The system must be easy to use and maintain, allow the user to control the patterns being placed on the medium, and provide unique signals for each selection made by the user. These signals will be in the form of an auditory blurb of some kind. We utilized the internet to get all the details of existing manual spin art machines such as paint, platform functions, and painting mediums and to find information on compressors and valves. This allowed us to design a system that incorporated the basic features of normal spin art machines into our design of an automated paint delivery system.

### 12.MIE.4

#### Communication Device Service Cart

Kevin Carrara, Peter Visser, Adam Lewandowski

Advisor: Judy Gardner, M.A.  
Easter Seals of Dupage

Maggie is a 4' tall, ten year old girl with Down syndrome, a congenital heart defect and a cleft palate. Maggie uses the assistance of a four year old chocolate Labrador retriever named Lacey. Due to Maggie's health conditions she is unable to communicate to others without the use of her speaking device. The device Maggie uses is the PRC Vantage Plus Communicator; however, her physical conditions inhibit her ability to carry and use the device. Initial design ideas entailed a device that would be mounted to the back of the service dog, however after considerations about the safety and mobility of the dog along with the versatility of the device, a stand-alone cart was proposed. Maggie is not the only child that uses a communication device, for this reason our hope and goal for this project is to create a device that could be useful for other people with communication devices or medical devices such as oxygen tanks. If the device is intended to incorporate a service dog as well, using a back-mounted device could cause problems with sizing and mounting if a different service dog is ever commissioned. Through communication with the family and sponsors at Easter Seals, a design was formulated. The stand-alone cart must be lightweight, collapsible, easy to maneuver by both Maggie and Lacey, and adaptable to other uses, children or service dogs.

### 45.MIE.12

#### Radio-Controlled Lawn Mower

Aslan Golant, Dominic Bellino, John Mills,  
Daniel Tomany, David Hall

Sponsors: Hydro-Gear, ADDCO Inc., Kelly Golant

Most people can attest to the fact that mowing one's lawn can be an extremely long and arduous task. By designing a radio-controlled lawn mower, our project focuses on alleviating this problem, while allowing for anyone to have a fun and relaxing time mowing the lawn. We set out to design a radio-controlled lawn mower that implements some of the mechanical properties learned through our mechanical engineering curriculum. The goal of this project was to design a lawn mower that has all of the functions of a manual lawn mower (i.e. forward, reverse, and multi-speed drive,

while incorporating radio control operation and zero-radius turning).

The original design of the lawn mower called for the use of several servo-motors to (1) turn the rear wheels, which were mounted on hinges, and (2) engage the drive mechanism. After performing multiple tests, it was found that the amount of force needed to effectively turn the rear wheels was far more than what the servo-motors could supply. To solve this problem, we turned to the use of hydraulic pumps and motors (generously donated by Hydro-Gear) and linear actuators (generously donated by ADDCO Inc.).

## 42.MIE.12

### Easter Seals Bike Project (Interdisciplinary Project Development)

Chris Steiner, Jason Shiffler, Joe Buchina, Joe Martin

Sponsor: Judy Gardner, M.A.  
Easter Seals of Dupage

Advisor: Michael Brown, Ph.D.  
Dept. of Mechanical and Industrial Engineering

The Technology-Related Assistance for Individuals with Disabilities Act of 1988 defines Assistive Technology as “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain or improve functional capabilities of individuals with disabilities.” Easter Seals is a team of therapists, teachers, and other health professionals that help people overcome obstacles to independence and reach his or her personal goals. The staff of the Easter Seals DuPage Assistive Technology Department and the UIC College of Engineering have been working together to provide opportunities for engineering students to use their skills by assisting with the everyday problems that are faced by people with disabilities. The challenge provided before us was that of a ten year old girl with Down Syndrome by the name of Maggie. Like any ten year old girl, Maggie enjoys summer bike rides with her family. Because of her disability, Maggie is unable to understand the dangers she could face when riding. She has relied upon tag-along style bikes guided by her parents, however, the available options have been either unstable, much too expensive, or simply could not support her weight. The requirements for our customer were to provide a tag-along style bicycle that provides stability and portability, while also providing Maggie with some form of exercise. Utilizing ProEngineer software to provide both aesthetic and mechanical analyses, we were able provide a design that is both ergonomically and functionally pleasing. The project has now reached the prototyping phase and completion of a finished product is of our utmost regard to fulfill the request of a customer, as well as our promise to a young girl.

## 22.MIE.7

### Try-Generation

Jaime Frausto, Borko Andric, Nebojsa Kisic,  
Milos Stefanovic

Sponsor: John Cuttica, M.S.  
UIC Energy Resources Center

Advisors: Clifford Haefke, B.S.  
Michael Chimack, M.S.  
UIC Energy Resources Center

The goal of the team is to design two viable Combined Heat and Power (CHP) systems for three neighboring industrial facilities located in Illinois. Currently, these facilities individually have non-coincidental electrical and thermal demands for their operation. By designing a CHP system for all three facilities the senior design team will determine if the combined electrical and thermal loads will make this a viable application for CHP. The cogeneration designs will satisfy electrical and thermal energy requirements, whole or in part, for the three facilities. The end product of the senior design project will be a report detailing at least two economically viable designs with supporting technical analysis. The report will provide a dollar cost savings, explain the strengths and weakness and recommend the best option based on technical and economic analysis. Our financial and simple payback goals are 5% energy reduction and a simple payback period of less than 15 years.

## 55.MIE.14

### Portable Nordic Walking Exercise Device

Georgios Zissimopoulos, Rolland Less,  
Christopher Naylor, Steven Parnell, Jesus Alvarez

Sponsor: Tom Rutlin  
Exerstrider Products Inc.

Cardiovascular exercise is a great way to keep the body in shape. The best cardiovascular exercises involve working the muscles in the whole body, specifically the large leg muscles. One such exercise is Nordic Walking, which is basically cross country skiing without the skis. However, the exercise requires lots of time and space to execute properly. Tom Rutlin of Exerstrider, a company that specializes in making poles for Nordic Walking, proposed to us to design a portable, compact device which simulates the upper body movement of Nordic Walking. This would allow the user to remain stationary, while still achieving a decent cardiovascular workout. Specifically, Mr. Rutlin desires the product to be compact, portable, adjustable to different us-

ers, and useable in many different environments. After brainstorming ideas and researching existing products, our team devised a solution based upon the idea of the retractable dog leash. The device we designed consists of a coil of rope attached to a power spring which is held in a housing and attached to a handle. The spring provides adjustable resistance while the recoiling rope is compact and easy to transport. By attaching the free end of the rope to a variety of mounts, the user can simulate the upper body exercise of Nordic Walking while standing still. We are currently in the final design and testing phases of our project. Once we acquire a power spring specialized to our product, we can construct a prototype and begin testing it using test subjects.

#### 44.MIE.12

### Increasing the Temperature Differential in a Vortex Tube

Christopher Anagnostopoulos, Stefanie Esposito,  
James Giannakis, Yulian Filler

Sponsor: Puget Sound Naval Shipyard

The U.S. Navy uses vortex tubes when performing maintenance work on the pipes of their vessels. A vortex tube is a product that uses compressed air for heating and refrigeration, and has no moving parts. The technology is non-toxic and reliable: compressed air forced through a vortex generator creates a freezing-cold flow of air from one end of the tube, and this flow is used to freeze water in the pipes to allow maintenance to be performed. The Navy would like to increase the size of the pipe for which they can use the vortex tube. The Puget Sound Naval Shipyard sponsored this project to see if one can optimize the temperature differential of the vortex tube. From a literature search on the operation of the vortex tube we concluded that increasing the velocity of the vortex can provide a bigger temperature differential. One of the most direct ways of increasing the velocity of the vortex is to optimize the vortex generator's nozzles. We created 3D CAD models of the current design and imported them to a Computational Fluid Dynamics (CFD) software package. Here we modeled the current conditions and correlated them with experimental measurements. Given the baseline parameters, we created more solid models that were optimized by the CFD package. Prototypes were created to prove this increase in velocity, and a final report on current and optimized performance, as well as other possible parameters for optimization, was issued.

## PRELIMINARY DESIGN REPORTS (non-judged exhibit)

### ECE22

#### Peltier Cooled and Heated Motorcycle Helmet

Aamer Ahmed, Krzysztof Krzewski, Eric Kolodziejczyk  
Department of Electrical and Computer Engineering

During the summer months many motorcycle riders take the safety risk of not wearing helmets due the discomfort of heat build-up inside of them. This problem is solved by our modified motorcycle helmet, which will be able to cool the rider in the summer and also to provide heat in the winter. We will use a direct application of Peltier plates to the forehead region of the helmet. The system will be a closed loop system with feedback from a temperature sensor. The sensor will be placed on the Peltier plate to read temperature and compare with the desired temperature, set by the rider on an easy-access control dial. A microcontroller will read the actual temperature, compare with the desired temperature, and adjust the duty cycle of the Peltier plates to obtain a motorcycle helmet temperature to within 5 degrees of desired.

### ECE23

#### Eclipse Window Clock

Abdullah Usman, Huda Siddiqui, Alex Mendoza  
Department of Electrical and Computer Engineering

The Eclipse Window Clock is a self-sufficient time device that utilizes solar energy to power both a digital and analog clock display. Important parameters addressed were the capturing efficiency of the solar energy, power conversion efficiency, response to environmental changes, and a minimal product cost. The entire device is to be supported by the attraction of a non-corrosive magnetic ring to a metallic ring inside the home, on either sides of a glass window. The captured solar energy is transferred to a rechargeable power supply, from which it is then converted into an electrical current to be used by a microcontroller device, LCD and analog time display. The ease of readability, even with the sunlit backdrop along the window, gives the product its name – Eclipse. By starting small, in our case with a sleek, contemporary solar-driven design, we hope to manifest a paradigm of environmental consciousness.

## ECE24

### TabScriber

Brittany Badali, Shadi Manasra, Pawel Opalinski  
Department of Electrical and Computer Engineering

The goal of this project is to create a transcription device for guitar players. It is intended to be an alternative to the current transcription methods available. The targeted consumer is the casual guitarist, as we believe that a more serious or professional guitarist would most likely invest in the more expensive equipment for use with their own guitars. What we propose its own instrument – a modified version of an existing guitar. Guitar players will appreciate the ability to feel the strings on the fret and hear what they are playing, as in a normal electric guitar, while transcribing music. The method of note detection relies on signals from vibration sensors placed near the bridge under each string, together with signals from circuits detecting electrical connections between individual strings and frets.

## ECE25

### VirtualStudyBuddy.com

Peter Klimek, Chris Nielson, Matt Woodhead  
Department of Electrical and Computer Engineering

Our project will be an easy-to-use, online database where students may post and easily access course documents posted by other students. These documents will include notes, old exams, homework assignments, and any other items. The website will feature indexing based on criteria such as university, course, term, and instructor to allow for simple searching and an intuitive layout. The website will also allow for a comments section to each of the files posted so users may discuss any errors in the document, with the additional ability to rate each posted document so the highest rated documents in each category filter to the top of the list.

## ECE26

### Parts Warehouse Navigation System

Erik Horwath, Robert Krynski, Kintu Beck  
Department of Electrical and Computer Engineering

This project is to design a programmable, short-range transmitter/receiver system to guide a warehouse worker along the optimal route to the location where a requested inventory item is stored. The system will translate inventory location information into an optimal route map from any starting location in the warehouse. As the worker approaches an aisle intersection, a short-range radio signal transmission from a unit that he carries triggers voice feedback into his headset that guides him to the desired destination. Our low-cost design solution will have simple installation, reconfiguration and maintainability.

## ECE27

### Customer Service Response System

Jason Gerol, Rita Pun, Fitsum Teklemichael  
Department of Electrical and Computer Engineering

We propose to design and fabricate a system that will alert customer service staff in all parts of a building whenever and wherever a customer is in need of assistance. This product is intended to be used in locations such as offices, libraries, or community centers, where a limited number of staff is expected to readily service customers throughout the entire building. The system is composed of two parts – a receiver and a transmitter. Customers push a button on the transmitter to alert staff, who carry small receivers that vibrate and display location information for the customer requiring assistance. This allows the staff to respond immediately from any part of the building. When the call is received, the first staff member who arrives to assist the customer can remotely shut off the transmitter to notify the rest of the staff that the call had been answered.

## ECE28

### MicroStamp11 Automated Tester

Mark Sabatino, Terry Schleyer, Sebastian Rembisz  
Department of Electrical and Computer Engineering

The MicroStamp11 is a Motorola 68HC11 microcontroller development module, built by Technological Arts company in Canada, that is used by ECE students in the laboratory portion of ECE 367 (Microprocessor-Based Design). Students in this course often spend hours writing assembly language code that does not properly function due to a hardware fault. There is currently no simple way to quickly determine if the MicroStamp11 hardware is functioning properly. Our project is to design an easy-to-use automated tester of the MicroStamp11. The tester will upload its own software to test and display functionality of each input/output pin, quickly displaying the functional status of the module.

## ECE29

### Test Tube Heater System Utilizing Micro Hot Plates

Sean Fitzgerald, Raymond Kaminski, Scott Nguyen  
Department of Electrical and Computer Engineering

Our design project is a test tube heater system utilizing several MEMS micro hot plates ( $\mu$ HP) to uniformly heat several test tubes to the desired steady or time-varying temperature. This closed-loop feedback system will maintain specified temperature profile for a preset amount of time and alert the user when this time limit has expired. The design of the  $\mu$ HP will have two serpentine resistors patterned onto a typical silicon substrate. The wafer specifications require that it be of  $\langle 100 \rangle$  orientation to create the multiple low aspect ratio holes. Construction of the  $\mu$ HP will require the use of many micro fabrication techniques including photolithography, metallization, and plasma/KOH etching.

## ECE30

### Motion Sensing RC Controller

Jessica Jones, Rafael Mendoza, Humera Muzaffar,  
Terell Williams

Department of Electrical and Computer Engineering

This product will be a proof of concept for an alternative to using joysticks or buttons as input to a moving mechanism. It will be a tilt motion sensing and orientation sensing (via digital compass) remote control unit. This unit will control a radio-controlled (RC) toy car, one modified to also have a digital compass on board. The orientation of the toy car will be wirelessly transmitted to the remote control unit where it will be compared to the controller's own orientation. Then steering and throttle control signals will be transmitted to the car so that it will head in the direction that the remote control is being tilted, regardless of which direction either the remote control or the RC car is facing.

## ECE31

### Animal Research Collar

Zoran Alempijevic, David Perez, Ignacio Chaidez  
Department of Electrical and Computer Engineering

The Animal Research Collar is a device that will aid researchers, scientists, and even the common pet lover with understanding an animal's behavior patterns. It is essentially a data-logging device that will be attached to the animal under study via a neck collar. The following environmental conditions will be detected and stored along with a time code: temperature, light luminance level, and acceleration in a specific direction. Once the device is retrieved, data stored in it will be uploaded by the researcher to a laptop or PC via wireless local-area network for analysis. The device will be both waterproof and dustproof for safe outdoor use. It will have a power supply that will be rechargeable and have a minimum lifetime of twelve hours. The product will also have enough memory to store twelve hours of data measurements.

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