



SCHOOL OF ENGINEERING
VANDERBILT UNIVERSITY

2012

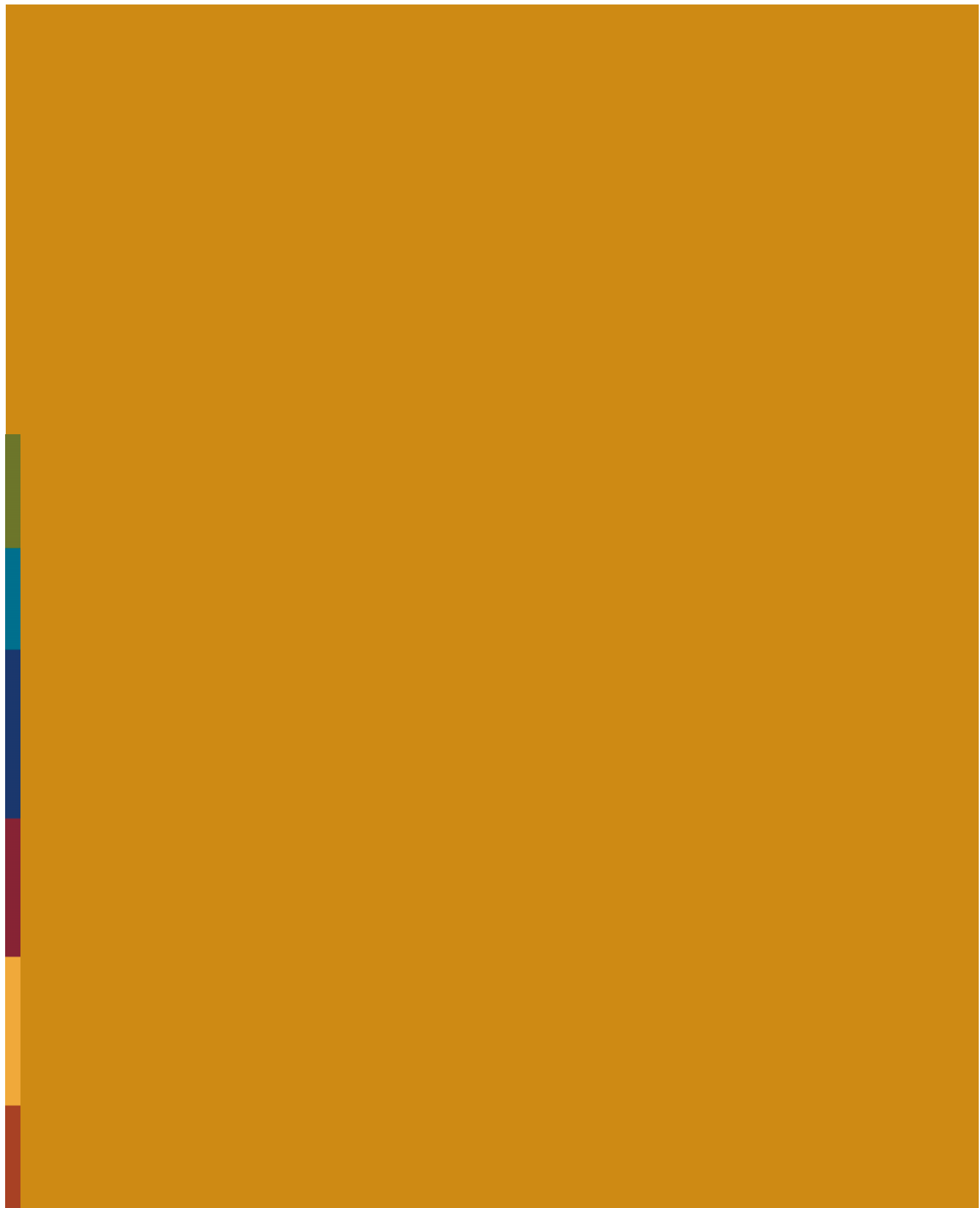
SENIOR DESIGN PROJECTS

APRIL 19, 2012

3-5 P.M.

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PREFACE

Senior design courses provide students with experience working on real-world projects that involve design constraints, budgets, reviews and deadlines. Students learn about the principles of design, professionalism, licensing, how ethics affect engineering decisions, entrepreneurship and the day-to-day implications of intellectual property. This course is a culmination of their undergraduate education and provides them with the opportunity to apply and develop their design, analytical, project management, interpersonal and communication skills through a team-based project.

Projects are completed as part of capstone design courses in each department. Students are encouraged to work in an interdisciplinary manner, with an integrated design seminar facilitating the exchange of ideas and talent from multiple disciplines. This exposes students to the kind of multidisciplinary teamwork they are likely to encounter in industry.

As their projects take form, student teams keep in touch with their industry and faculty advisers, hold meetings, write formal documentation and present their work. By the end of the academic year, the teams produce a prototype or virtual demonstration of their design. Students know their design must solve a real-world problem and work hard to achieve a high quality outcome.

As you read through this catalog and learn of the benefits of industry sponsorship, please consider becoming a senior design sponsor. The School recognizes the value of senior projects sponsored by industry and invites project sponsors — industry representatives and entrepreneurs as well as research and clinical faculty — to submit project proposals. This provides meaningful projects of value to the sponsor, and it instills a professional orientation in the student team. If you or your colleagues are interested in sponsoring a project or to learn more, please contact:



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Kenneth A. Debelak, Associate Professor, Chemical and Biomolecular Engineering

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Sanjiv Gokhale, Professor of the Practice of Civil Engineering

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FACULTY ADVISER:

A.B. Bonds, Professor of Electrical Engineering, Emeritus; Professor of Computer Engineering, Emeritus

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FACULTY ADVISER:

John A. Bers, Associate Professor of the Practice of Engineering Management

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On-Chip Bacterial Detection and Diagnosis with Integrated Mechanical Micropump for Low-Resource Settings

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PROJECT ADVISERS:

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Ron Reiserer
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Dr. John Bers
Dr. Matthew Walker III

CLIENT:

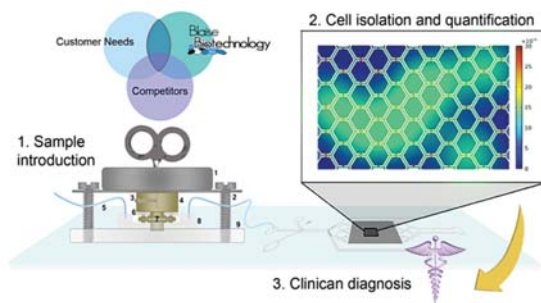
Vanderbilt University
Systems Biology and
Bioengineering Undergraduate
Research Experience

PROJECT DESCRIPTION

Tuberculosis (TB) is a global epidemic for which there exists no current point-of-care (POC) diagnostic device suitable for rapid detection in low-resource settings. Delayed diagnosis leads to irreversible prognosis of the disease and fuels the epidemic by directly abetting onward transmission. Here, we provide a potential solution to the lack of POC diagnostic device for resource-limited settings.

Our objective is to develop a low-cost/low-power microfluidic diagnostic system capable of rapid clinical diagnosis of bacterial infections such as TB. Our platform introduces a novel precise fluid pumping mechanism via solely mechanical actuation, extricating this technology from any power demands. This self-sustaining system is coupled with isolation chambers that can selectively trap labeled bacteria by exploitation of flow properties. Using a time-resolved fluorescence (TRF) reader, we can achieve the sensitivity and time to initiation of treatment that surpass current POC technologies.

In conjunction with the design of our diagnostic system, we intend to create a commercialization strategy, including exploration of registration processes with the FDA for quantification accuracy, a market analysis, and a business plan for taking our device to market. Therefore, if our tool does prove to be profitable, we will have laid the groundwork for presenting to venture capital firms.



A Low-Cost, One Lead Electrocardiogram Device

TEAM MEMBERS:

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Stephen Hollabaugh
Catherine Majors
Corey Peak

PROJECT ADVISERS:

Dr. Michael Bestros
Dr. Matthew Walker III

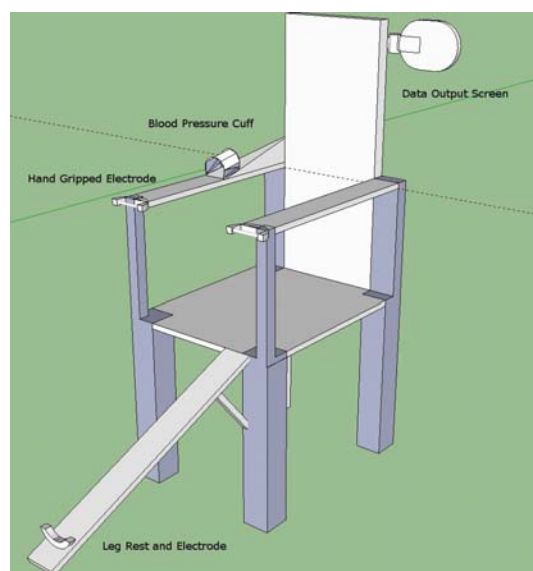
CLIENT:

Rice 360°

PROJECT DESCRIPTION

As the burden of infectious diseases in resource-limited settings has declined in recent history, the burden of non-communicable diseases has grown at an alarming rate. Cardiovascular disease is already the deadliest disease for Africans over 45 years of age and it is growing. In order to mobilize the medical community to allocate appropriate treatment interventions, the true magnitude of cardiovascular diseases must be determined.

We are proposing an electrocardiogram chair designed to screen for the most frequently encountered cardiomyopathies. Amongst many considerations, our design will be low-cost, easily used by minimally-trained practitioners, and is designed to fit congruently into the clinical flow of limited-resource settings. In our design, we have reduced the complex and data-intensive 10-electrode ECG to an intuitive electrocardiogram chair with an electrode on each armrest.



Breast Image Guided Intraoperative Tumor Resection

TEAM MEMBERS:

Travis Meyer
Rachel Harvey
Kristen Miller

PROJECT ADVISER:

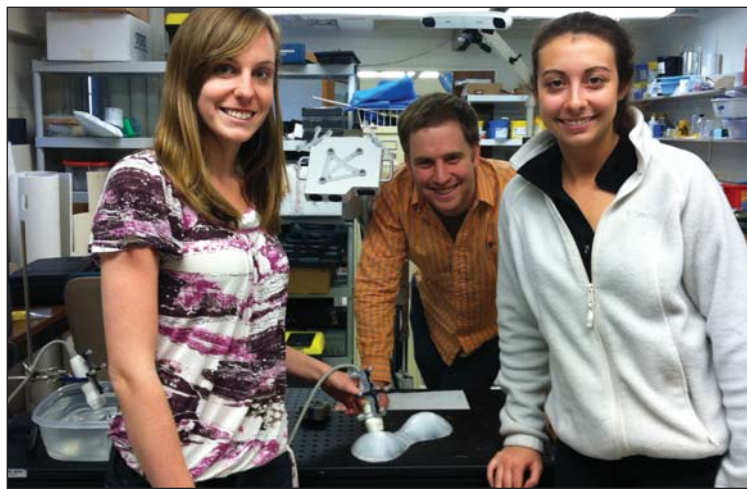
Dr. Michael I. Miga

CLIENT:

Dr. Michael I. Miga

PROJECT DESCRIPTION

We are seeking to create a novel method of breast cancer tumor intraoperative visualization that will aid in accurate tumor margin identification. Downfalls of current resection methods include excessive loss of healthy tissue and high rates of recurrence due to incomplete tumor removal. Better visualization of tumor margins during surgery using ultrasound will provide a relatively inexpensive way to improve upon current surgical techniques. We are developing a toolkit that will examine the minimum negative tumor margins that can be achieved using our tracked ultrasound system, with the hope of providing the foundation for future systems that will contain a full 3D visualization system within the operating room.



From left, Kristen Miller, Travis Meyer and Rachel Harvey with the breast cancer tumor intraoperative visualization tool kit the team designed.

Autonomic Health Monitor Harness and Position Sensor

TEAM MEMBERS:

Mmekom Ekon
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Christina Stanfield

PROJECT ADVISERS:

Andre M. Diedrich MD, Ph.D.
Franz J. Baudenbacher, Ph.D.

CLIENT:

Vanderbilt Institute for
Integrative Biosystems Research
and Education

PROJECT DESCRIPTION

Autonomic Dysfunction Disease patients suffer from failure at some stage of their autonomic nervous system ranging from blood pressure to heart rate to breathing issues. The initial ideal target market for our medical device would be elderly patients with Autonomic Dysfunction Disease whose impairments can cause them to faint or fall down. Our device will provide heart condition monitoring with a small, comfortable, long-term wear ECG. The device also contains an accelerometer in order to detect the body position of the patient wearing the device. The position and ECG data collected can then be sent by Bluetooth to an Android Phone application – thus, allowing the optimal mobile usage and monitoring for the patient. The overall goal would be that patients would wear this device as a medical diagnostic tool, initiate emergency alerts, store data on a database for physicians and also allow patient initiated recordings.



Bioresorbable IVC Filter

TEAM MEMBERS:

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PROJECT ADVISERS:

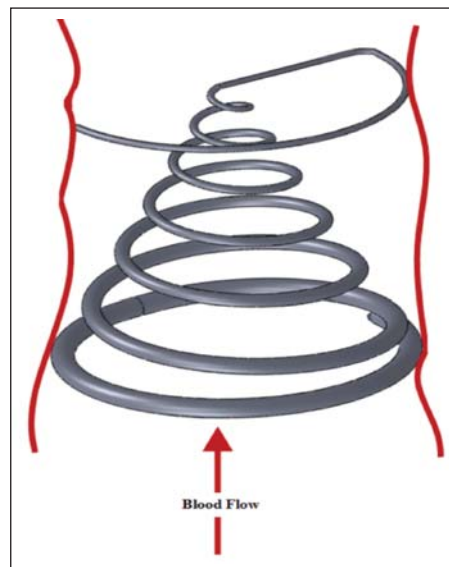
Dr. Matthew Walker, III
Dr. John Rundback, M.D.

CLIENT:

Dr. John Rundback, M.D.,
Interventional & Vascular
Radiology,
Teaneck, N.J.

PROJECT DESCRIPTION

A pulmonary embolism occurs when a blood clot, or thrombus, dislodges from a vessel wall in the venous circulation, free floats through the bloodstream through the heart and into the lungs, reattaches to the pulmonary vasculature, and occludes blood flow. As of January 2011, pulmonary embolisms are the number one cause of inpatient deaths in United States hospitals. Present technologies to combat this medical dilemma include permanent and temporary inferior vena cava (IVC) filters, but physicians widely regard these as inadequate because of the potential for repeat surgeries, adverse immune responses, and further injury and complication. We propose a resorbable IVC filter that, upon the entrapment of floating thrombi, will initiate a controlled radial degradation process that avoids bulk segmentation and further thrombogenicity. The filter is designed in the shape of an Archimidean Screw with specific intrastructural distances to capture targeted blood clots while offering minimal impedance to blood flow. Stabilization rings are present at both ends of the filter to prevent tilt, migration, and fracture of the filter. We would like to thank our course instructor Dr. Matthew Walker and adviser Dr. John Rundback for their assistance with this project.



Peripheral Nerve Repair

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PROJECT ADVISERS:

Dr. Wesley Thayer
Dr. Kevin Sexton

CLIENT:

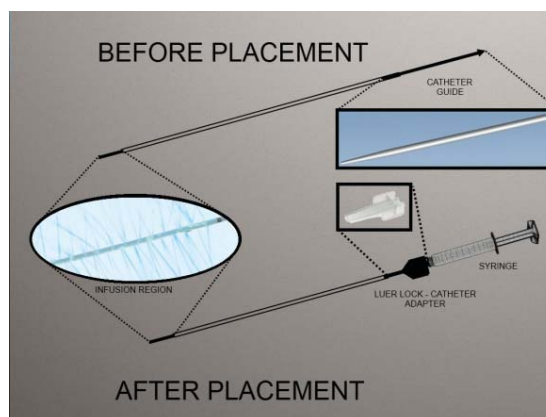
Vanderbilt University Medical
Center Department of Surgery

PROJECT DESCRIPTION

Advancements in modern body armor have evolved to very effectively protect the torso, increasing the number of soldiers with survivable injuries to the extremities. These injuries can often lead to limb paralysis as there are few widely accepted methods to repair severed peripheral nerves. Recently, multiple groups have been able to improve nerve fusion by using hydrophilic polymers. Hydrophilic polymers administered shortly after injury to the nerve have shown to greatly improve clinical outcomes.

Although this technique has shown promise, hydrophilic polymers can be administered only in a single bolus into the open wound at the time of surgery. A re-administration or continuous administration of hydrophilic polymers over a number of days may further improve clinical outcomes and is the focus of our design.

We accomplished a sustained release of hydrophilic polymers by designing a catheter that can be placed at the time of surgery and removed some days after the procedure. This catheter contains an infusion region that evenly distributes hydrophilic polymers to the injury site. The infusion region is an area of the catheter that contains outlets that open in response to an increase in fluid pressure within the catheter. In addition, our design includes a custom mechanism that a surgeon can use to feed the catheter through the skin at a location some distance from the open wound.



CallDoc: A Cell Phone to Haptic Sensor Tethering Device

TEAM MEMBERS:

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Gayathri Prabhakar
André Stevenson

PROJECT ADVISER:

Dr. Andre Churchwell, M.D.

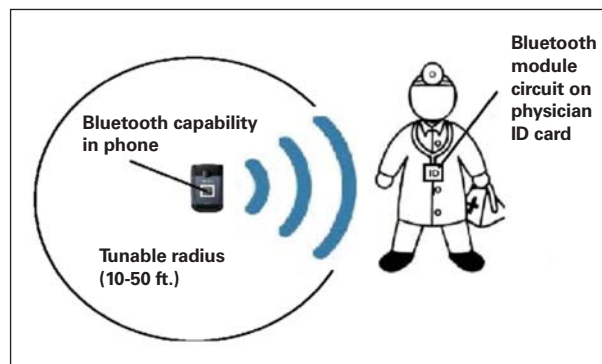
CLIENT:

Dr. Andre Churchwell, M.D.

PROJECT DESCRIPTION

An important need for health care institutions is to promptly and appropriately alert a physician when a patient is in need of care. The cellular phone has become an important device for this use. However, physicians have become constantly frustrated by displaced cell phones, especially when traveling from room-to-room caring for patients. There exists a need to identify, invent and implement a

device design strategy to alert the physician when he or she has unknowingly left his or her cell phone, thus allowing for the continual success of treating patients. No product on the market meets the specified design needs. The goal of this project is to make a device that will alert a physician when his or her phone is out of range. The device will operate via Bluetooth and, by employing haptic technology, will make a device on the physician's name tag vibrate. Our success is multifaceted. The first achievement will come when we are able to create a prototype that successfully performs the desired function. Ultimate success would be if the product goes to market, allowing physicians – as well as other clients – to find this device useful for misplaced phones.



Prosthetic Suspensions Systems Design

TEAM MEMBERS:

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PROJECT ADVISER:

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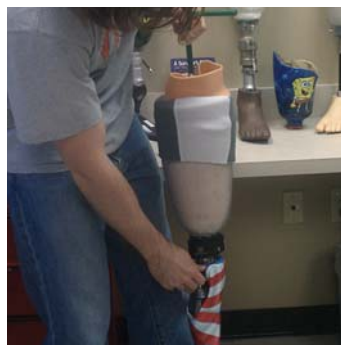
CLIENT:

The Surgical Clinic, PLLC



PROJECT DESCRIPTION

The aim of this design project is to achieve a reliable method for monitoring circulation in the residual limb of prosthetic patients while their prosthetic devices are in use. Currently, physicians measure circulation once the prosthetic device has been removed to determine the device's effect on circulation. This method does not provide accurate feedback. Our project monitors residual limb circulation in real time during prosthetic use. A transcutaneous oxygen monitoring (TcOM) system was chosen because it provides reliable feedback of oxygen levels, which are representative of circulation in the local tissue. The sensors for the TcOM machine are costly, bulky and extremely sensitive to pressure. Because of this, designing a transtibial gel liner that can incorporate and protect these sensors is the main focus of the project. A liner company will be collaborating to make a custom molded liner containing cavities for the sensors to help relieve pressure. Furthermore, our team and adviser will be manufacturing the socket, which encases the liner, to also contain small cavities. Once complete, the design will be tested on several patients to quantitatively measure circulation while patients are wearing their prosthetics. This design has the potential to be marketed to physicians for diagnostic purposes. Ultimately, as TcOM sensors get smaller, cheaper and more rugged, this design could be marketed directly to patients for continuous circulation monitoring in everyday life.



Analysis of Wound Dressing Material Response in Negative Pressure Wound Therapy

TEAM MEMBERS:

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Eric Millisor, **ChBE**
Karl Schroeder

PROJECT ADVISER:

Josh Smith

CLIENT:

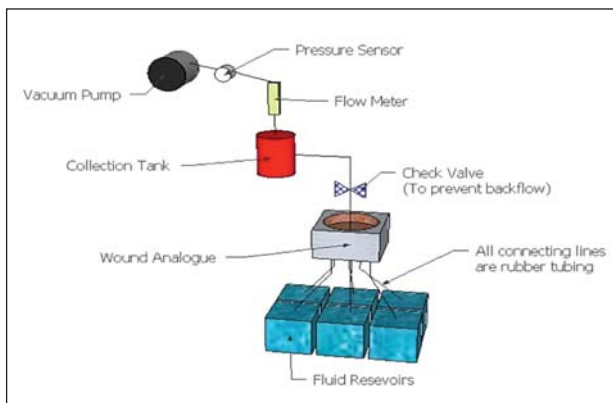
Integrated Healing Technologies

PROJECT DESCRIPTION

Negative Pressure Wound Therapy (or NPWT) is a therapeutic method to treat and heal serious wounds by using a vacuum to apply sub-atmospheric pressure, increasing flow in the wounded area.

Wound filler that has been packaged into the wound removes excess fluid while binding and inactivating harmful pathogens. Additionally, the negative pressure creates a pressure gradient that promotes contraction and, therefore, healing of the wound.

We are currently working with Integrated Healing Technologies who represents a hydrophobic wound filling material called Sorbact®. Our group has been tasked with testing various wound filler materials. We plan to look at Sorbact®, standard surgical gauze (cotton), polyurethane foam (the industry standard), and woven nylon. The two key design features we will monitor are hydrophobicity and experienced pressure drop. Hydrophobic interactions between the material and bacteria facilitate binding and pathogen inactivation. We will more directly be able to gauge the effectiveness of the material by measuring the pressure drop over a given flow, using Bernoulli's Equation. These materials will be tested by using a simulated wound model connected to fluid reservoirs containing blood analogues. Our wound model will be made out of Dragon Skin®, while our blood analogues will include a saline solution, pulpy orange juice, and diluted corn syrup. Six areas of the wound will be connected to separate fluid reservoirs containing our blood analogue. We will be able to see how the pressure is distributed over the wound by comparing the loss of liquid from each reservoir. We will also measure the flow rate of our blood analogues to see how wound filler material affects the flow. These values will help us determine which wound filler material operates most effectively in a wound.



Systems Engineering Approach To Closing The Gap

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Joseph Morse, Jr.

PROJECT ADVISERS:

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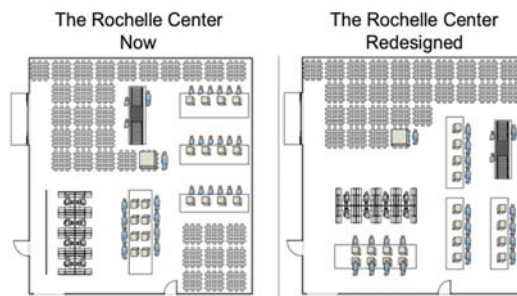
The Rochelle Center



PROJECT DESCRIPTION

Our team is engineering a three-pronged approach to improve the working conditions at the Rochelle Center, a not-for-profit employment agency that specializes in employing people with disabilities. In order to improve the Rochelle Center, they are first redesigning the workplace layout. This modification will improve workplace efficiency while ensuring the safety of the clients. Second, the team is creating a rubric that can be

used to properly allocate the taskforce at the Rochelle Center. This rubric will cater to persons with disabilities by focusing on a task driven evaluation method that matches each client with a job based on their capabilities rather than their inabilities. This rubric can potentially lay the groundwork for a national workplace standard for evaluating persons with disabilities. Team Closing the Gap will also observe current assembly line practices to determine if a device could be implemented to help an individual enter or excel in the work place.



Modeling of Suspected Ventilator-Associated Pneumonia Protocols in the Critical Care Setting

TEAM MEMBER:

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PROJECT ADVISER:

Erik Boczek

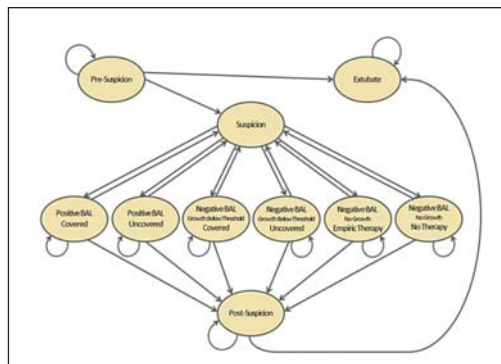
CLIENT:

Vanderbilt University
Department of Biomedical
Informatics

PROJECT DESCRIPTION

Empiric broad-spectrum therapy for suspected ventilator-associated pneumonia (VAP) results in significant unnecessary antibiotic exposure, leaving the patient at risk for subsequent infection and infection with resistant pathogens. The primary aim of this project is to characterize and model this unnecessary exposure, identifying flaws in the current standard of care that could be rectified using tools for rapid VAP identification.

A Markov Chain process was used to model VAP therapy in the intensive care setting. A Markov Chain model is composed of a series of mutually exclusive states, each of which has certain allowable transitions in a given unit of time to the other states. Each transition is a time-independent conditional probability governed only by the current state; transitions do not depend on the length of time spent in any prior state. The model begins in a ventilated state prior to clinical suspicion of VAP ("Pre-Suspicion"). From the pre-suspicion state, it is possible to remain asymptomatic for VAP, transition to the extubated absorbing state, or transition to the clinical suspicion state ("Suspicion"). Clinical suspicion is determined through a combination of non-specific indicators for pneumonia. Upon suspicion, a specimen is obtained for quantitative culturing via bronchoscopic directed bronchoalveolar lavage (BAL) and empiric antibiotic therapy is initiated. BAL samples are considered positive with growth above 10,000 cfu/ml, leading to a series of possible states after clinical suspicion based on the BAL result and effectiveness of initial therapy ("BAL positive, covered," "BAL positive, uncovered," "BAL negative, growth below threshold, covered," "BAL negative, growth below threshold, uncovered," "BAL negative, no growth, empiric therapy," and "BAL negative, no growth, no therapy"). From these states, it is possible to remain in the suspected VAP state, return to the suspicion state due to the possibility of a repeat BAL, or transition to a post-suspicion ventilated state ("Post-Suspicion"). From post-suspicion, it is possible to remain ventilated or transition to the extubated absorbing state.



Non-Invasive Internal Brain Temperature

TEAM MEMBERS:

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PROJECT ADVISER:

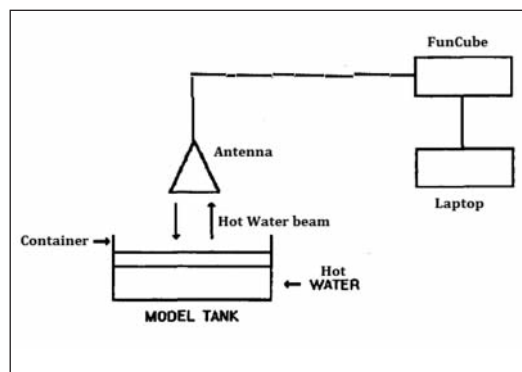
William Francis Walsh, M.D.

CLIENT:

William Francis Walsh, M.D.

PROJECT DESCRIPTION

Over the last decade, treatment of infants who have suffered an acute hypoxic ischemic event (HIE) with hypothermia to ameliorate long-term neurologic injury has advanced from concept to standard care. One of the modes of providing cooling for the infant with HIE is "selective head cooling" via an FDA approved Cool Cap device which cools the body to 34.5°C by applying a continuous flow of very cold (10°C) water to scalp. However, no one has ever demonstrated that the human brain can be cooled effectively, or if cooling is uniform. The goal of our project is to determine a method for evaluating the temperature of a human brain that is being selectively cooled.



Vertical Wheelchair Seat

TEAM MEMBERS:

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Basil Beirut

PROJECT ADVISERS:

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Dr. Khalid Aldakkan
Nasser Alshammary

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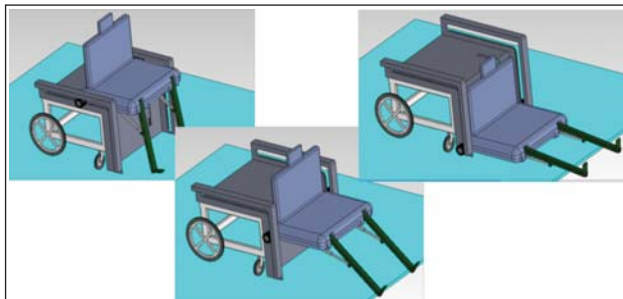
King Abdulaziz City for Science
Technology

PROJECT DESCRIPTION

We hope to make individuals with disabilities more independent by providing an assistive device that addresses one of their needs.

Wheelchairs have been in the market for many years, and have gone through great improvements. Motorization, dimensional customization, and enhancement of seat

comfort are some of those improvements. However, a neglected need that we have noted is the ability to ascend or descend to ground level. This need is especially prevalent in cultures where activities are mostly carried out while sitting on the floor. It is also found in disabled children who can't fully enjoy activities with other children because they are elevated from the ground.



GOALS:

1. Design a cost efficient device to be fitted to an existing wheelchair.
2. Design a device that allows a wheelchair user to descend and ascend unassisted.
3. Sufficiently integrate mechanism into a user-friendly control system that can be operated by individuals who may also suffer from other disabilities besides being unable to walk.

Innovative Platform Design for Delivery of Biological Solutions to Peripheral Nerve Injuries

TEAM MEMBERS:

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Junyu Lei
Samat Kabani

PROJECT ADVISERS:

Dr. Wesley Thayer
Dr. Kevin Sexton

CLIENT:

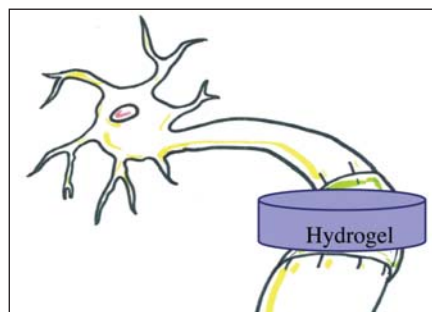
Vanderbilt University Medical
Center Department of Surgery

PROJECT DESCRIPTION

The purpose of this project is to create an easily implantable, biodegradable platform that will deliver soluble PEG continuously to peripheral nerve injuries. The top three objectives of this project are:

- To restore instantaneous nerve conductivity after implantation of the device
- To provide a directional conduit for the regrowth of severed nerves so they refuse properly
- To provide the sustained release of soluble, low molecular weight PEG which will aid in restoring full neural conductivity

We will be working continuously with Dr. Sexton and Dr. Thayer in brainstorming, experimentation, analysis, and improvements on the device design. The first steps of our project include discussions with them to discuss potential solutions and extensive literature reviews on biodegradable platforms. A preliminary design will be formulated and preliminary synthesis will take place towards the end of fall semester/beginning of spring semester. The device will be tested both in vitro (to determine PEG release profile) and in vivo (to determine therapeutic effect) settings. At the end of the grant period, we will have a product unit that has been shown to improve neural regeneration in vivo.



BB-Parathyroid Hormone Peptide Delivery from a Hydrogel Scaffold

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PROJECT ADVISERS:

Steve Porter
Matthew Walker III
Craig Duvall
Amanda Lowery

CLIENT:

Aursos, Inc.

Aursos Inc.

PROJECT DESCRIPTION

Each year, one million fractures occur that are long bone fractures with critically-sized defects that do not heal without therapeutic assistance. Current treatments for these fractures involve implantable bone grafts that have been successful but suffer from problems such as high costs, off-target effects, and biocompatibility. These issues engender a need for an inexpensive, safe, and effective bone-graft material.

Black bears hibernate for six months out of the year and experience no bone loss over this time while humans rapidly lose bone mass within weeks in the absence of mechanical loading. This quality led researchers to discover that black bear parathyroid hormone (PTH) maintains bone integrity and is useful for fracture healing. Results from initial experiments show black bear PTH is more effective in healing critical bone defects than human PTH.

The aim of this project is to develop a delivery system for black bear parathyroid hormone peptide that has found to be more efficient for healing long bone fractures that would normally not heal. The peptide has shown osteogenic potential in Swiss Webster rats but an adequate delivery system is needed to efficiently deliver the peptide. The main objectives to develop this system are:

- 1) Optimizing hydrogel properties,
- 2) Optimizing delivery method, and
- 3) Determining appropriate peptide dosage.

Areas of focus for hydrogel properties are assessment of the bioavailability of the hydrogel and tuning of the thermogelling parameters to physiological conditions. For the delivery method, we need to find the appropriate system to achieve the correct pharmacokinetic profile. In addition, the correct dosage needs to maximize osteogenic effect with minimal off-target effects.

Novel IV Catheter for Delivery of Multiple Fluids

TEAM MEMBERS:

Sasha Doust
Alec Grubbs
Owen Hendley
Mariele McDonald
Amanda Palmer

PROJECT ADVISERS:

Matthew Walker III
John A. Bers

CLIENT:

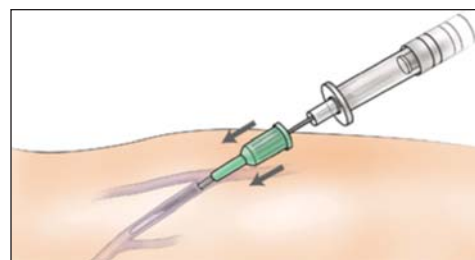
Tammy McCabe
Huntsville, Ala.

Mac Cath

PROJECT DESCRIPTION

When a nurse starts an IV, the smallest IV catheter size is preferred since it causes the least amount of pain and reduces the possibility of infection to the patient. Although IV fluids can be delivered through a small diameter catheter, larger diameter catheters are required to deliver more viscous fluids, such as blood, without shearing the red blood cells.

This requires the doctor or nurse to stick the patient again with a larger needle, which can cause further pain and increased exposure to infection. Overall about 1.4 to 1.6 peripheral IV catheters are used per bed per week in the U.S, and 10% of these catheters inflame the vessel wall, thereby causing phlebitis and the chance of blood stream infections. Also, in the US around 180,000 needle-stick injuries affect nurses every year as a result of injection. By reducing the number of times that a patient has to receive an IV catheter, the chance of complications for patients and injury to nurses can be significantly diminished. Our senior design team members along with our project sponsor, Tammy McCabe, have created a solution to this problem in the form of the Mac Cath catheter. The device only requires the patient to be stuck once with a small diameter needle, and it can accommodate a variety of fluids, including blood. In the U.S. alone, the market for peripheral IV catheters is \$1.37 billion with a growth rate of 10% over 5 years. This shows that the device can present a significant source of revenues for Mac Cath, LLC, as well as cost savings for hospitals since they will not have to order as many IV catheters in different sizes.



Smartphone-Adapted Endoscope

TEAM MEMBERS:

Mallette Asmuth
Joel McManness
Margaret Means
Harrison Shapley
Raheel Thobani

PROJECT ADVISERS:

Dr. Arun Nair
Dr. Matthew Walker III

CLIENT:

Vanderbilt University Medical
Center Department of
Emergency Medicine

PROJECT DESCRIPTION

Current endoscopic devices are expensive, lack portability due to their size, and require dedicated ancillary equipment and trained personnel to operate. These factors limit the availability of such devices, reducing the quality of healthcare provided in resource-constrained and remote regions. Our senior design project aims to close the healthcare gap that has resulted from specialized, standalone technology by developing a low cost smartphone-adapted diagnostic visualization device.

Our design consists of a scope that can be connected to any Android device and operated using our designed Android application. The mobile application is developed using the Android platform because it is widespread, free, open-source and very supportive of developers and prototypers. The endoscope will consist of a flexible conduit with data transfer capabilities and a live video feed provided by a small camera module on its terminating end. A small tube is included in the body of the conduit to provide an analog water source to clear debris off of the acrylic bubble protecting the camera lens. LEDs surround the perimeter of the camera to provide illumination of the environment. The tube is 8 mm in diameter, this size being dictated by anatomical features.

This project will culminate in a diagnostic tool for use in both clinical and EMT settings as well as interdisciplinary applications, such as visualization of tortuous spaces encountered by mechanical technicians. Our device will serve as a portable and affordable tool meeting the need for accessible endoscopic visualization devices for resource-constrained communities.



BME design teams in national competitions

NATIONAL COLLEGIATE INVENTORS AND INNOVATORS ALLIANCE

- Finalist:** Innovative Platform Design for Deliver of Biological Solutions to Peripheral Nerve Injuries. *First round \$5,000 winner; in competition for \$20,000 Advanced E-Team funding.*
Team Members: Rasheedat Bukola Jaji, Samat Kabani, Cheryl Lau, Junyu Lei

DESIGN OF MEDICAL DEVICES CONFERENCE: INTERNATIONAL STUDENT DESIGN SHOWCASE

- Finalist:** On-chip bacterial detection and diagnosis with integrated mechanical micropump for low-resource setting
Team Members: Ben Brantley (ME), Erica Curtis, Ayeshik Kole, Brian Lesniak (ME), Erik Werner

RICE UNIVERSITY'S 360 BEYOND TRADITIONAL BORDERS UNDERGRADUATE NATIONAL DESIGN COMPETITION

- Finalist:** Low Cost Smartphone-Adapted Diagnostic Visualization Device. **Team Members:** Mallette Asmuth, Joel McManness, Margaret Means, Harrison Shapley, Raheel Thobani
- Finalist:** One Lead Electrocardiogram Device. **Team Members:** Stephen Hollabaugh, Catherine Majors, Hannah Pauly, Corey Peak

ABILITYONE NETWORK DESIGN CHALLENGE: NATIONAL INDUSTRIES FOR THE SEVERELY HANDICAPPED (NISH)

- Finalist:** Systems Engineering Approach to Closing the Gap. **Team Members:** Brian Akselrad, Chadwick Augusty, Allison Bull, Kimberly Ingraham, Joseph Morse Jr.

Glycerol to Renewable Propylene Glycol

TEAM 1 MEMBERS:

Liyana Nik Ibrahim
Jessica Smoke,
Grace Hayes
Kathryn Maxwell

TEAM 2 MEMBERS:

Hanum Abdullah
Siti Aishah Mohd Esa
Amirah Bazil Ahmad Kamal
Stewart Benefield

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

Propylene glycol (PG), is used to make unsaturated polyester resins, cosmetics, aircraft deicer, environmentally-friendly (and pet-friendly) automotive antifreezes, etc. PG is conventionally made from propylene. Since demand for polypropylene is growing faster than ethylene, propylene is in short supply and prices are rising. Demand and prices for PG are expected to increase. And there will likely be a price premium and plenty of demand for PG made from renewable resources.

Glycerol is a byproduct of biodiesel manufacture, with relatively few industrial uses. As the production of biodiesel increases, particularly in Europe due to government regulations but also in the U.S. due to public demand for renewable fuels, the price of glycerol is expected to continue to decrease. BASF has patented a catalyst to convert glycerol to propylene glycol in very high yield – up to 100% glycerol conversion and 98.5% selectivity

Design a process to make 100MM lb/yr of propylene glycol from crude glycerol. Your plant is on the U.S. Gulf Coast. Crude glycerol delivered to you costs \$0.22/lb (for the crude stream at 80% concentration). Hydrogen is available on your plant site for \$0.50/lb. Renewable propylene glycol can be sold for \$1.00/lb. Byproduct renewable n-propanol and isopropanol can be sold for \$0.80/lb. All products will need to meet normal specs for that product. All prices are forecasts by your marketing organization for long-term average prices, expressed in 2011 dollars on the Gulf Coast.

Algae to Biodiesel

TEAM 1 MEMBERS:

Skye Bacus
Daniel Jackson
Kassi Mast
Harry Watson

TEAM 2 MEMBERS:

Crystal Lampley
Lily Syafikah Mansor
Nurfatihah Hassan
Nurfarahani Nordin

TEAM 3 MEMBERS:

Irene Hukkelhoven
Carrie Tietjen
Diane BeCraft
Bruce Spencer

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

This design project, will focus on exploring the processing technologies described below to produce biodiesel from algae.

Algae Cultivation

Recently, the heteroboost photosynthesis-fermentation process was proposed to generate lipids for biodiesel production. First, *Chlorella prototocoides* algae are grown autotrophically to fix CO₂. Then these are metabolized heterotrophically using glucose to significantly increase the lipid yield.

Lipid Extraction

The OriginOil process involves the generation of sonic waves and microbubbles at high frequency. Energy costs are claimed to be 10% of conventional processing costs. An objective of this design project will be to gain better estimates of these costs – although this aspect of the design is likely to be deemphasized.

Lipid to Biodiesel

The conversion of the lipid fraction to useful products has several options. One approach is to convert it to biodiesel. Recently, two papers discuss the ASPEN PLUS simulation of a potential process to produce biodiesel. Your group will seek to improve upon these designs and will attempt to carry out design optimization. This will include sizing and costing the trans-esterification reactor and the remainder of the processing equipment.

Propylene from Biomass

TEAM 1 MEMBERS:

Mayo Adigun
Jiaqi Chen
Aizat Ismail
Judy Zhu

TEAM 2 MEMBERS:

Mohd Rhuee Rosle
Nor Afiqah Baharudin
Wan Nadzatul Najiah Abdullah
Tyler Cobb

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

The conversion of biomass to petrochemicals has been a subject of active research for over 40 years. The economics of breaking down biomass to its primary molecular building blocks – known as a synthesis gas – then building the synthesis gas back up to petrochemicals have always proved inferior to that of fossil fuel-based processes. Recent shifts in feedstock prices and technology improvements indicate that this may be changing. Your client is a large multinational oil company that has taken notice of these developments. They want to know whether or not propylene can be economically made from a biomass feedstock using an integration of best available technology. A processing rate of 1.5 million metric tons of dry biomass/yr is the baseline capacity.

Wood chips or sawdust can be converted into synthesis gas (or syngas) gas by pyrolysis. Since the original wood contains C, H, and O, the resulting synthesis gas has a composition of CO, CO₂, H₂, and H₂O that reflects the elemental ratios in the original wood. The CO₂ is normally considered to be undesirable. However, if the syngas is to be converted to dimethyl ether (DME), the CO₂ has the net effect of shifting the equilibrium towards DME. Furthermore the syngas produced from biomass has a higher CO/H₂ mol ratio than that produced from steam reforming of methane. The pyrolysis is very endothermic. Heat integration with the rest of the process is a must

Renewable 1,4-Butanediol

TEAM MEMBERS:

Richard Strode
Tracy Smith
Ben Morrison
Brion Lee

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

1,4-Butanediol (BDO) is a critical raw material for the production of polymers used to make spandex, automotive plastics, and performance thermoplastic elastomers. The majority of the world BDO production goes into tetrahydrofuran (THF) (an intermediate for spandex and other performance polymer production) and polybutylene terephthalate (PBT) for engineering plastics. There are several traditional petrochemical routes to BDO, including the Reppe, Propylene oxide, Davy, Mitsubishi, and Geminox processes

Through its research efforts, your company has developed new and innovative technology to produce 'green' BDO, through conversion of biomass-derived and renewable feedstocks, rather than crude oil or natural gas. Specifically, the research group developed a direct, bio-based production route with fewer steps than the traditional petrochemical processes. As the 1,4-butanediol from this technology has the identical structure and functionality of traditional 1,4-BDO, it serves as a direct replacement for petroleum-based BDO, to produce renewably-sourced polymers without modifications to downstream equipment or processes.

Your project team has been assembled to design the commercial demonstration plant for this new sustainable technology. The business objective is to design a commercial scale facility to produce 50 MM lb/yr of 1,4-butanediol from a renewable sugar feedstock. The BDO product purity and quality will need to meet or exceed current commercial requirements for polymer-grade material, to be acceptable to perspective customers

Ethylene by Oxidative Dehydrogenation of Ethane

TEAM MEMBERS:

Alexander Shanosky
James Peck
Sally Ingham
Alexandra Seamens

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

Ethylene is the largest volume organic chemical product, with world production over 50 billion pounds per year. It is normally produced by steam cracking of ethane or heavier hydrocarbons. This process is quite energy and capital intensive.

Dow Chemical has recently applied for a patent on a new process, which may require significantly less investment. In this process, ethane is passed over a catalyst at very high space velocity (100,000/hr or higher), and reacts with oxygen (exothermically!), producing ethylene in good selectivity (greater than 80% under some conditions) and high conversion. The selectivity is similar to that in the conventional steam cracking process, but the conversion is higher. Hydrogen in the feed improves the conversion while minimizing the amount of over-oxidation of the feedstock.

Your company has 1 MMM pounds per year of ethane, which is currently being produced at your Gulf Coast plant and sold for \$0.07/lb in 2009. Your team has been asked to evaluate the economic viability of the Dow process for your plant, as a way of upgrading your product and increasing your sales revenue. Your job is to determine the economic optimum design, maximizing the net present value (NPV) of the project.

Toluene Methylation to p-Xylene

TEAM MEMBERS:

Gyanba Ekua Davis
Michael Dickert
Andrea Pavela
Justin Smith

PROJECT ADVISER:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

Growing demand for polyethylene terephthalate has resulted in increased demand for p-xylene (PX), giving rise to the need for new sources of PX. The major source of PX is reformat from oil refineries. Additional PX is made by toluene disproportionation, but that process makes a mole of unwanted benzene for each mole of PX. In contrast, all of the toluene is converted to PX in the methylation process, as shown in the following reaction:



Your company has developed an improved catalyst for this reaction. The patent lists examples with 99.9% selectivity and 100% conversion of methanol at short contact times in a fixed-bed reactor. An excess of toluene is used to improve selectivity to PX, so the unreacted toluene must be separated and recycled back to the reactor. Your group has been assembled to develop the most economical process based on this patent.

Design a process to convert 400MM lb/yr of toluene, which is available at your plant complex on the U.S. Gulf Coast to PX. Toluene is available on your plant site for \$2.50/gal. Methanol can be purchased for \$1.00/gal. PX can be sold for \$0.60/lb. All prices are forecasts by your marketing organization for long term average prices, expressed in 2009 dollars.

Development of an Excel Software Tool for Designing Optimal Heat Exchange Networks and Water Recycle Networks in the Chemical Process Industries

TEAM MEMBERS:

Michael Thomas
Matthew Spellings
Farid Jamiran
Nurshazwani Musa

PROJECT ADVISERS:

Kenneth A. Debelak, Associate
Professor Chemical &
Biomolecular Engineering

Russell R. Dunn, Professor of
the Practice Chemical &
Biomolecular Engineering

PROJECT DESCRIPTION

The project design team will develop Excel-based process integration software that allows the identification of optimal heat exchange networks for chemical plants. The following are some requirements for this software:

- Built within the Excel software framework
- Handles a maximum of 25 hot streams and 25 cold streams
- Generates composite curves
- Allows adjustment of the minimum temperature driving force to trade off capital v. operating cost
- Incorporates entering and exiting streams (streams not currently heated or cooled)
- Generates stream matching networks (the HEN)
- Provides an annual cost of the total heating and cooling utilities used
- Provides a cost of heat exchangers needed for the network
- Provides a basic profitability assessment
- Validated with numerous HEN problems and solutions reported in literature

Photosystem 1-Based Biohybrid Photoelectrochemical Cell Fabrication

TEAM MEMBERS:

Andrew Couch
Treva Locke
Paul McDonald
Jason Ogg
Eric Dilbone, **ME**
Philip Ingram, **ME**

PROJECT ADVISERS:

Kane Jennings, Professor of
Chemical & Biomolecular
Engineering

CLIENT:

Environmental Protection
Agency

PROJECT DESCRIPTION

The diminishing reserves of hydrocarbon-based fossil fuels prompted the creative idea to use the protein Photosystem I (PSI) in small-scale photovoltaic cells as a source of alternative energy. PSI is located in the thylakoid membrane of plants that undergo photosynthesis and has tremendous electron transfer capabilities when exposed to light. This protein is extracted from spinach for use in photovoltaic cells. Each cell consists of a 75x 38 mm glass slide covered with nanoporous gold foil cathode. A polydimethylsiloxane spacer rests on the foil, creating a reservoir filled with PSI multilayer electrolyte solution. A polyethylene sheet covered in indium tin oxide (ITO) serves as the anode and is located above the multilayer. Copper tape runs under the ITO and connects individual cells in series to form a circuit. Another glass slide caps the cell and four clips fasten the device together. The desired final product is a 3 x 3 foot panel (~ 0.837 m²) consisting of individual cells. Each cell is 2.85 * 10⁻³ m², so the required number of cells is 294 cells. These cells will be mounted on a silicon base to form the panel.

Production of this device has never been attempted. Successful generation of even small amounts of electricity would have far-reaching implications in the quest for cleaner energy. While electrical output will not hope to rival polysilicon-based photovoltaic cells, its manufacturing process will ultimately require significantly less electricity and, with further development, could eventually become a viable source of clean energy. Perhaps most importantly, this project serves to raise awareness open the doorway for other innovative and unique attempts at cleaner energy.

2012 ASCE Concrete Canoe Competition – King KongCrete

TEAM MEMBERS:

Elise Haupt
Suzannah Montgomery
Devon Grace Bracher
Huntley Lewis

PROJECT ADVISER:

Lori Troxel, P.E.

CLIENT:

American Society of Civil
Engineers (ASCE)

PROJECT DESCRIPTION

Vanderbilt is requesting qualified engineering firms to submit a proposal for the design, construction, presentation, and competition of a concrete canoe. All phases shall meet the requirements of the 2012 ASCE Concrete Canoe Design Competition and the Vanderbilt Civil Engineering Department.

PROJECT SCOPE:

- Develop the mold, reinforcement, concrete mix, fabrication, and finished surface for a concrete canoe.
- Develop a safety program for mixing concrete, fabricating the canoe, finishing the surface, and racing the canoe.
- Develop a detailed schedule.
- Calculate total costs including reinforcement, mold, additives, transportation, and finishing.
- Calculate maximum stresses and buoyancy.
- Fabricate the canoe according to ASCE and Vanderbilt University rules.
- Make an oral presentation, display the canoe, and race at the 2012 ASCE Southeast Regional Student Conference.

Valparaiso Medical Office Building

TEAM MEMBERS:

Spencer Schwartz
Melissa Petersilge
William (Will) Booth
Colleen Heacock

PROJECT ADVISERS:

Sean B. Smith, P.E.
Bryan Tharpe, P.E.

CLIENT:

Gresham Smith & Partners
(GSP)



PROJECT DESCRIPTION

The proposed project is a new high-profile, four-story medical office building adjacent to an existing hospital in Valparaiso, Indiana. The structure will be comprised largely of glass and brick, and structured using composite steel framing and steel braced frames to resist lateral forces. A geotechnical investigation has been performed indicating a shallow foundation system. Soil bearing spread footings will be necessary to support the structure above.

PROJECT SCOPE:

The successful firm will be required to perform the professional services consisting of the following:

- Prepare a code analysis report indicating required design dead, live, snow, wind and seismic load criteria. Code references shall be included. Serviceability requirements, including dead and live load deflections, wind drift limits and seismic drift limits shall be included in the support.
- Perform the necessary calculations using the load criteria defined above to determine the required gravity and lateral design loads for the beams, girders, columns and foundations.
- Using the provided structural floor and layouts, design all primary gravity members.
- Design the steel braced frames per the locations shown on the provided plans.
- Design the shallow spread footings.
- Develop a cost estimate based on the design structural steel and concrete quantities.
- Prepare engineering drawings to convey the design information above.

Southwest Chemical Company Wastewater Treatment Plant Modification

TEAM MEMBERS:

Samuel (Sam) Levitan
Jacob Choi
Lucia Alvarez
Alec Richards

PROJECT ADVISERS:

T. Houston Flippin, P.E.
Steve McGuire, E.I.

CLIENT:

Brown and Caldwell

PROJECT DESCRIPTION

Southwest Chemical Company plans to add additional production capacity, which will increase the average TOC loading on the facility over time to 45,000; 55,000; and 65,000 lbs/day, with a modest flow increase to 3,000 gpm. The Plant wants to define what wastewater treatment facility capacity bottlenecks will be encountered at each of these TOC loadings and what alternatives will help eliminate the bottlenecks. Alternatives for eliminating wastewater treatment facility capacity bottlenecks should be developed in a two-phased approach. In Phase I, bottlenecks will be identified and a broad list of alternatives developed through conceptual level designs and relative positive aspects and negative aspects. Conceptual level operating, capital, and present worth cost estimates also will be provided.

A select group of up to four alternatives will be agreed upon with Southwest Chemical Company. These alternatives will be further developed in Phase II through preliminary design engineering, as required, to generate budgetary level capital, operating, and present worth cost estimates (+30 percent). Preliminary design engineering will include process flow diagrams, general arrangement drawings, and lists of major equipment as needed. The end product will be a document Southwest Chemical Company will use to assign production expansion projects with their associated cost of required wastewater treatment facility upgrades. This document must be thorough enough to stand against the likely challenges of management scrutiny of funding wastewater treatment facility upgrades.

DELIVERABLES:

All reports must be developed with the end product in focus – a technically defensible present worth expenditure outlay for effective and reliable upgrades required of the WWTF at increasing influent TOC loading targets. The Phase I report must consider alternatives that are demonstrated applicable, and historically cost effective. These criteria will address future challenges regarding the breadth of alternatives considered. The Phase II report must only develop those alternatives deemed most promising. This development must be of sufficient detail to address challenges regarding the soundness of the budget-level cost estimates. The combined documents must equip Southwest Chemical Company to soundly justify investment in the WWTF in step with planned production increases. The proposal must identify the schedule proposed for performance and completion of the work in a timely and efficient manner. Major milestones shall be identified.

Reddick Street Redevelopment Project

TEAM MEMBERS:

Garrett Hamontree
Christena Holcombe
Mohamad Firdus Che Man

PROJECT ADVISERS:

Lennie Arnold, P.E.
Adam Crunk, P.E.

CLIENT:

Littlejohn Engineering
Associates (LEA)



PROJECT DESCRIPTION

The project shall consist of the site development for the Franklin Housing Authority Reddick Street Redevelopment located in Franklin, Tennessee.

Professional services shall consist of the following elements:

1. Site due diligence to determine the feasibility of constructing this product on this site. This shall include investigating existing zoning, surrounding infrastructure, and regional storm water requirements;
2. Preparation of Engineering Drawings, to consist of the following:
 - Design of finish contours for grading the site, including critical spot elevations.
 - Design surface and subsurface drainage systems, denoting the size and invert elevations of structures as appropriate.
 - Site layout plan locating the building on the site and providing geometry for the layout of roadways, parking areas and walkways.
 - Site utility plan locating water and sanitary sewer services to the building envelope.
 - Site details appropriate for the referenced project including, but not limited to, storm sewer structures, headwalls, curb details, flumes, pavement details and concrete walkways.
3. The design of a storm water detention facility that will limit the post-development peak runoff rate to less than the pre-development runoff rate.

Primrose Schools East Church Street Project

TEAM MEMBERS:

Pauline Roteta
Michelle Grossman
Clay Christian

PROJECT ADVISERS:

Rick Schuff, P.E.
Ashley T. Smith, E.I.

CLIENT:

STANTEC

PROJECT DESCRIPTION

The proposed project is located on East Church Street within the jurisdiction of the Metropolitan Government of Nashville & Davidson County, Tenn. The project includes designing the site for a preschool with associated surface parking, driveways and utilities.

PROJECT SCOPE:

1. Review of the city's zoning codes in relation to the proposed use and determine necessary zoning appeals and approvals.
2. Development of two preliminary site layouts showing arrangement of building with vehicular parking and driveways. The owner will approve the layout for final design for submittal to the Metropolitan Planning Commission for compliance with Metro's Zoning Ordinance.
3. Design the final layout including the following:
 - a. Verification of site circulation for automobiles, garbage, and fire trucks
 - b. Development of site layout and utility plans
 - c. Development of grading plans, including critical spot elevations
 - d. Development of erosion control plans
 - e. Hydrologic and hydraulic analyses
 - f. Drainage design
 - g. Water quality design
 - h. Detention design
4. Develop engineer's cost estimate for infrastructure improvements

Middle Tennessee State Student Services Building

TEAM MEMBERS:

Sharifah Syed Salim
George Gebelein
Chris Moore

PROJECT ADVISERS:

Elizabeth Surface, P.E.
Randall Wilson, P.E.

CLIENT:

Ross Bryan Associates, Inc.
(RBA)

PROJECT DESCRIPTION

The proposed project is a student services building on the campus of Middle Tennessee State University. The building program includes a large, two-story lobby, tour (orientation) room, open counters for information, general assistance and cashiers, offices for Admissions, Records, Financial Aid, Business Office, Advising, and Scheduling and their shared break room and conference rooms. The new building is two levels with a mechanical penthouse and is approximately 50,000 sf. The structure will be comprised largely of structural steel framing and steel moment frames to resist lateral loads caused by seismic and wind forces. The building will be clad with a combination of brick veneer, limestone panels, and window curtain wall systems. The building will have colonnades on the east and south elevations. Columns at the colonnade are round and will be wrapped in formed brick and limestone. A geotechnical investigation has been performed, indicating a shallow foundation system. Spread footings will be adequate for supporting the structure.

PROJECT SCOPE:

1. Prepare a code analysis report indicating required design dead, live, snow, wind, and seismic loads criteria. Code references shall be included. Serviceability requirements, including dead and live load deflections, wind drift limits, and seismic drift limits shall be included in the report.
2. Perform the necessary calculations using the load criteria defined above to determine the required gravity and lateral design loads for beams, girders, columns, and moment frame elements.
3. Using the provided structural floor and roof layouts, design all typical gravity members.
4. Design the steel moment frames per the locations shown on the provided plans.
5. Design the typical spread footing foundations.
6. Prepare engineering drawings to convey the design information above.

Miller Avenue Wastewater Treatment Plant Headworks Improvements, Jackson, Tennessee

TEAM MEMBERS:

Peter Thomas
Adam Nicholas
Ethan Franc

PROJECT ADVISER:

Bill Hamilton, P.E.

CLIENT:

Barge Waggoner Sumner &
Cannon (BWSC)

BWSC

PROJECT DESCRIPTION

The Jackson Energy Authority (JEA) is requesting proposals from qualified engineering firms to evaluate and make recommendations to improve the operation of the Miller Avenue Wastewater Treatment Plant (WWTP) headworks facility in Jackson, Tennessee.

Currently, the Miller Avenue facility receives hauled grease at an existing grease concentration system. Effluent from this system, which contains considerably more grease than typical domestic wastewater, is directed to the head of the plant. The plant's existing aerated grit/grease removal system was sized for 'typical' domestic wastewater. Grease removal efficiency must be improved to protect downstream processes.

Recently, the facility upgraded the secondary treatment process from a countercurrent aeration system (Schrieber) to a full-floor coverage, fine bubble diffused air system. During this project, considerable quantities of grit were removed from the basin. Improved grit removal is necessary to prevent grit from accumulating on the bottom of the basins, potentially ruining the new diffused aeration system.

PROJECT SCOPE:

1. Perform project administration and conduct meetings;
2. Review existing data and perform on-site investigations;
3. Identify appropriate technologies for grit removal, flow measurement, and grease handling. Summarize technologies succinctly, including advantages and disadvantages;
4. Characterize relevant waste streams;
5. Size technologies for flows ranging from minimum diurnal to peak hydraulic;
6. Develop an evaluation matrix based on cost and non-cost factors to select the optimal technologies;
7. Develop conceptual layouts for each system;
8. Prepare an alternatives evaluation report, summarizing the benefits and limitations of each recommendation. Include opinions of probable construction cost based on equipment manufacturer quotations and other factors.

2012 ASCE Steel Bridge Competition

TEAM MEMBERS:

Mark Allen
Jillian Goldstein
Annette Fleishman
Aaron Coonley

PROJECT ADVISER:

Lori Troxel, P.E.

CLIENTS:

American Institute of Steel
Construction (AISC)

American Society of Civil
Engineers (ASCE)

PROJECT DESCRIPTION

The proposed location of the project is a river crossing. The design will use steel as the structural material. Vanderbilt is requesting qualified engineering firms to submit a proposal for the structural design, fabrication, and erection of a scale model of the river crossing. All phases shall meet the requirements of the 2012 AISC Steel Bridge Design Competition.

PROJECT SCOPE

- Develop 3 preliminary designs showing steel layout, sizes, and fabrication costs.
- Develop a safety program for fabrication and erection.
- Final design shall consist of:
 - Design of beams, columns, base plates, and connections
 - Construction sequencing
 - Design and construction schedule
 - Cost estimates
 - Fabrication techniques
 - Provide detailed structural drawings for fabrication of bridge
- Fabricate the bridge
- Erect the bridge model according to AISC and Vanderbilt University rules.

Mack Hatcher Parkway Expansion: Intersection of Mack Hatcher Parkway and Columbia Avenue, Franklin, Tennessee

TEAM MEMBERS:

Scott Guthrie
Robert (Robbie) Zettler
Kristen Raber

PROJECT ADVISERS:

Ken Diehl, P.E.
Bo Butler, P.E.

CLIENT:

Smith Seckman Reid, Inc.



PROJECT DESCRIPTION

Mack Hatcher, S.R. 397, is an important part of the City's street network. The widening of the existing lanes and the extension of the roadway to complete the loop around the City is included in the City's Major Thoroughfare Plan. Context Sensitive Design (CSD) will be used to ensure the roadway compliments the natural surroundings. Proposed improvements are to extend Mack Hatcher from the Westhaven Subdivision's southern property line to Columbia Pike (U.S. 31). The cross section is proposed to be 4-lanes (12' wide each) with raised median, multi-use path on the inside, street lighting at intersections and other appurtenances as required. Many approved CSD elements have already been used in previous sections of Mack Hatcher Parkway. The project length is approximately 22,000 LF.

PROJECT SCOPE:

1. Develop traffic loading parameters based on existing traffic studies and previously designed sections of the Parkway.
 - a. Confirm and incorporate design speed calculations for the new section.
2. Develop a preliminary alignment for the Parkway that minimizes right-of-way impacts and maximizes connectivity, given this is a controlled access roadway.
3. Acquire approvals from state and local agencies: (a) Tennessee State Historical Commission, (b) TWRA, (c) TDEC, (d) archeological and (e) other reviews and approvals.
4. Perform the design of the roadway and associated drainage designs to meet state and local standards: (a) geometric layout of the Parkway, (b) sub-grade, (c) asphalt design, (d) accommodate future utilities, (e) lighting and (f) signalization.
5. Provide estimated cost of the project.
6. Provide a project schedule.

Five Mile Crossing over Five Mile Creek

TEAM MEMBERS:

Katy Plott
Scott DeVoe
Stephen Jimenez
Henry Stokes

PROJECT ADVISERS:

Jon Zirkle, P.E.
Draghina Icobescu

CLIENT:

Tennessee Department of
Transportation (TDOT)



PROJECT DESCRIPTION

The Tennessee Department of Transportation is requesting proposals from qualified engineering firms for hydraulic and structural design and preparation of contract plans for the new alignment bridge carrying Five Mile Crossing over Five Mile Creek, Williamson County, Tenn. The successful firm will be required to perform the following tasks:

1. Perform the necessary hydrologic computations to determine the peak discharges for the 2, 5, 10, 25, 50, 100, and 500 year recurrence interval floods.
2. Perform a hydraulic analysis of the site based on the above discharges to determine flooding conditions without any structures and with the existing structure and determine the overtopping frequency if less than the 500 year event. Describe existing conditions at the site (drainage area, design discharge, design velocity, design backwater, design overtopping, 500 year discharge and 500 year water surface elevation).
3. Perform hydraulic computations sufficient to propose a structure that meets department design criteria (hydraulic adequacy, overtopping frequency, appropriate roadway profile, span arrangement, pier and girder selection, flood clearances, scour analysis, deck drainage).
4. Prepare a hydraulic layout showing an elevation and plan along with the required hydraulic data show on the layout, as well as a hydraulic design report that meets department standards, stamped by a licensed engineer.
5. After formal approval of the preliminary layout, complete the structural design for the bridge. Elements to be designed, utilizing Load Resistance Factor Design in accordance with the AASHTO Standard Specifications for Design of Highway Bridges, 2004, with addenda, are: (1) slab, (2) pre-stressed beams, (3) intermediate supports and (4) abutments.
6. Based on the foundation investigation provided, complete the foundation design.
7. Based on the final design, prepare contract plans for the bridge, utilizing TDOT's plans format.

Belmont University - 15th Avenue and Acklen Avenue Traffic Control Study

TEAM MEMBERS:

Kelsey Gerber
Austin Petersen
Ian King

PROJECT ADVISER:

Amy L. Burch, P.E.

CLIENT:

RPM Transportation
Consultants, LLC



PROJECT DESCRIPTION

Belmont University's Master Plan includes continued enrollment growth as well as construction of new classroom buildings, resident halls, and recreational facilities over the next 10-15 years. Traffic volumes on campus and the surrounding roadway network are expected to increase as the university grows. Currently, Wedgewood Avenue is being widened at 15th Avenue to install left turn lanes. The intersection will then be signalized. Smooth traffic flow at the adjacent intersection to the south will be critical to the operation of the newly signalized intersection. The intersection of 15th Avenue and Acklen Avenue is located on Belmont's campus, approximately 400 feet south of Wedgewood Avenue. The intersection is an all-way stop with four approaches. In the Master Plan, the intersection will provide access to multiple campus buildings with parking structures. Three intersection traffic control alternatives should be evaluated for the intersection of 15th Avenue and Acklen Avenue. The three alternatives should include all-way stop control, traffic signal and a modern roundabout.

PROJECT SCOPE

- Capacity analyses using Synchro & SimTraffic software tools should be conducted to evaluate the projected volumes and traffic control alternatives. (Traffic volumes will be provided by RPM.)
- Determine required laneage and storage based on the capacity analyses and 95th-percentile queue lengths for each traffic control alternative.
- Conduct site visits as necessary to confirm roadway and intersection geometrics, traffic control, signs, sight distances, and other pertinent roadway/intersection characteristics.
- Prepare detailed CAD designs of the three intersection traffic control designs, including specific design materials and quantities lists. (Base survey will be provided by RPM.)
- Designs should adhere to guidelines set forth in the MUTCD 2009, AASHTO Green Book, and Metro-Nashville standard drawings.
- Designs should incorporate necessary improvements and accommodations for pedestrian traffic.
- Each design should incorporate aesthetic value and context sensitive solutions. The design materials should complement the existing and future architectural themes on the University's campus without impacting the traffic operations of the intersection.
- Prepare preliminary cost estimates for each traffic control design.
- Prioritize the traffic control alternatives based on level of service, cost, ROW acquisition, and context sensitive design.
- Provide recommendation for the most appropriate traffic control and design for the intersection of 15th Avenue and Acklen Avenue.

The 2012 ASCE Steel Bridge Team qualified for national competition in May. The team placed third in the regional meet in Tallahassee. (SEE PROJECT, page 24.)

Left to right: Mark Allen, Aaron Coonley, Annette Fleishman, Jillian Goldstein, Jacob Choi.



QMSI Automated Scale

TEAM MEMBERS:

Aaron Stevenson
Hassan Alsada
Jonathan Newkirk
Josh Fain
Sara Morimoto

PROJECT ADVISER:

Ferrell Jennings
QMSI Corporate Strategies

CLIENT:

Quality Manufacturing
Systems, Inc.



PROJECT DESCRIPTION

The goal of this project is to design and build an automated high-speed, high-resolution vial weighing scale for use in the pharmaceutical industry. Workers in automated pharmacies must examine each filled prescription vial to ensure the accuracy of its contents as part of the quality control process. Our system will enhance the verification process with an automated system that weighs the contents of each vial and compares it to the expected weight, ensuring that the correct type and number of pills have been properly dispensed.

The QMSI Automated Scale system will utilize electromechanical manipulators, a programmable logic controller, and a high-speed precision electronic scale. Vials will be automatically placed on the electronic scale, weighed, and then removed. The final design will reduce dispensing errors in the automated pharmacy fulfillment system, while increasing overall system speed. As a result, individuals who receive their medications via mail order pharmacies can be confident that their prescriptions have been accurately filled.

GOALS:

- Construct a system to manipulate and weigh prescription vials for automated fulfillment of pharmaceutical orders.
- Design control system to compare measured vial weights to expected weights and reject out-of-spec vials.



Electric DeLorean DMC-12 Conversion

TEAM MEMBERS:

Hasnur Hassan
Ross Montague
Robert Price
Tara Welytok

PROJECT ADVISER:

A.B. Bonds

CLIENT:

Jon Kim, GaN Corporation



PROJECT DESCRIPTION

The DeLorean DMC-12 was an iconic car of the 1980s. Our client has asked us to convert his DeLorean automobile from an internal combustion engine to an all-electric powertrain. Our goal is to provide detailed information on the parts and implementation of an electric DeLorean with optimized performance and range, and to create a comprehensive “designer’s manual” specific to the DeLorean DMC-12 electric conversion process.

The DeLorean conversion team will determine what components of the original car can be removed, reused or replaced. Careful consideration must be made to choose the ideal EV components specific to the DMC-12. These new components, including batteries, electric motor and power controller, will be placed in the existing engine cavity and trunk space after unnecessary original parts are removed. Available space must be optimized in order to ensure successful placement of new components. The final report will provide detailed information on a complete electric conversion of the DeLorean vehicle, to be used by the sponsor or a future project team to complete the physical conversion.

GOALS:

- Provide comprehensive electric conversion “manual” for the DeLorean DMC-12.
- Optimize engine power consumption to provide longest distance possible.
- Choose components that optimize the trade-offs between cost, performance and range.

RadFxSat: Latchup Protection and Measurement

TEAM MEMBERS:

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Zach Fleetwood
Dylan McQuaide
Kyle Rewick

PROJECT ADVISER:

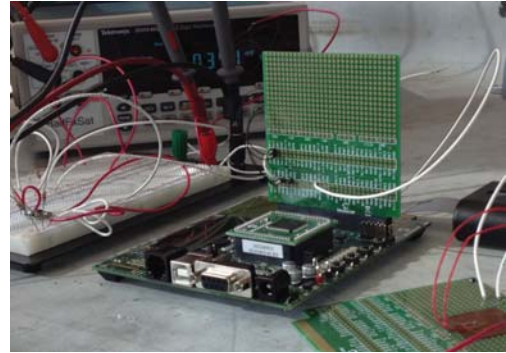
Robert Reed

CLIENT:

Vanderbilt University Institute
for Space and Defense
Electronics

PROJECT DESCRIPTION

Radiation effects in electronic components are a serious reliability concern for integrated circuits used in space environments. For this project, an experiment card will be created for placement in a low-cost satellite (CubeSat) designed by the Vanderbilt University Institute for Space and Defense Electronics (ISDE) and St. Louis University. The goal of the experiment card is to measure and transmit data about single-event latchup events in earth orbit. Single-event latchup



is a radiation effect that induces a high-current state in a semiconductor, potentially leading to catastrophic damage to a circuit. This failure mechanism is a concern for all satellite designers, and is suspected to be the specific failure mechanism for the recent Russian Phobos-Grunt probe.

The experiment card will detect single event latchup events, record latchup currents and operating temperatures, and transmit this information via the Cubesat radio link. ISDE engineers will compare the latchup data with ground test data to develop more accurate space environment modeling software. The CubeSat mission will be launched in conjunction with a NASA mission in summer 2013.

GOALS:

- Detect and record single-event latchup events in a small satellite (CubeSat).
- Design an experiment card to operate with significant power and area restrictions.

DeathRay: A GUI program to control and visualize radiation experiments

TEAM MEMBERS:

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Jack Minardi

PROJECT ADVISER:

Daniel Loveless

CLIENT:

Vanderbilt University Institute
for Space and Defense
Electronics

PROJECT DESCRIPTION

The goal of this project is to design a graphical user interface to control and visualize integrated circuit (IC) radiation experiments. The Institute for Space and Defense Electronics (ISDE) at Vanderbilt University routinely performs comprehensive tests to determine how integrated circuits respond to various types of radiation. To facilitate these test efforts, ISDE has constructed a modular testing platform to subject a wide



variety of integrated circuits to different radiation sources. The costs involved in the radiation testing process are significant, so any method to reduce time spent irradiating an IC is beneficial.

The DeathRay test software platform interfaces with the ISDE modular testing platform, utilizing a graphical user interface (GUI) to provide real-time plots of a running radiation experiment, as well as allow electrical control of the devices placed under test. The use of DeathRay's real-time plotting capability can potentially provide thousands of dollars in savings per experiment, as radiation tests can be quickly halted in case of equipment malfunction, or stopped as soon as the correct amount of data has been collected.

Schneider Electric Remote Metering via Android Tablets

TEAM MEMBERS:

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Nadhirah Mustafa
Lauren Arpin

PROJECT ADVISER:

Cedric Short, Technical Services
Manager

CLIENT:

Schneider Electric



PROJECT DESCRIPTION

The goal of this project is to develop an interface using an Android tablet to remotely provide the same power measurement data that is currently obtained by directly checking a Schneider Electric meter. The major design challenge is the development of software for the tablet that will mimic the Schneider meter interface. Schneider Electric is primarily interested in the tablet's ability to consistently provide remote metering services across a wireless Internet connection. A major concern is whether a basic wireless interface can provide a sufficiently robust connection to avoid lost or corrupted data in a factory or industrial environment. The design uses an Arduino Diamondback microcontroller board to connect to the meter's RS-485 port and acquire power measurement data. The data is then transmitted to the Android tablet using the embedded Wi-Fi connection of the Arduino board. The tablet provides a quick and convenient display of remote power measurements in a manner consistent with current Schneider metering technology, but without the need for direct reading of the meter.



GOALS:

- Implement a wireless measurement interface that can be easily integrated with a Schneider electric meter.
- Design a software interface using the Android operating system on a tablet computer.

Open Source Android Home Automation

TEAM MEMBERS:

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Sarah Ruhama
Hasith Ediriweera

PROJECT ADVISER:

Gabor Karsai

PROJECT DESCRIPTION

As home automation systems become more popular, an opportunity arises to provide a simple, easily integrated system that offers users the ease of remote control over household appliances at minimal cost. Many commercial home automation systems require proprietary components that must be installed within the walls and floors of a home, making them invasive or impractical for apartments or rental homes. A practical low-cost system must combine ease of use with ease of installation for non-technical users.

The Open Source Android Home Automation project will permit a user to control household devices using a mobile application on an Android smart phone. Using a smart phone as the home automation controller not only lowers cost but also reduces the learning curve for the user. By relying on inexpensive open source hardware as device controllers, and by using wireless technology to eliminate the need for hardwired connections, the system cost can be dramatically reduced, and the market for home automation can be easily expanded to leased and rental housing.



GOALS:

- To implement a wireless remote device controller prototype using open source hardware
- To create a mobile Android application to access and communicate with remote devices

Development of a Compliant Part Loading and Unloading System for Use with a Dual Spindle Lathe

TEAM MEMBERS:

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Trevor Bruns
Thomas Trepanier
Christopher Capobianco

PROJECT ADVISER:

William Barkman

CLIENT:

Y-12 National Security Complex



PROJECT DESCRIPTION

The Y-12 National Security Complex has a long history of involvement in national security issues dating back to WWII, with primary concern being nuclear-related activities. This includes manufacturing of nuclear devices and related systems, which have many operational constraints associated with the processes necessary to produce them. These constraints include difficult physical machining characteristics of the nuclear materials, radioactivity associated with these materials, and restrictions on human contact and interaction with the manufacturing process. Also, the nature of the devices under construction is such that they are required to have very strict accuracy and precision standards.

The Design Team's task is associated with the restrictions on human contact and also related to the nature of the materials being machined. In the case of human interaction, a device/system was requested that would allow the transfer of components being manufactured from one lathe spindle to another without human intervention.

The nature of the components being produced is such that even a very small scratch or dent in the material will make the component unusable. Therefore, the team designed a component-transfer system which would allow a certain amount of compliance (lack of rigidity) that allows the transfer to proceed gently and without the possibility of dents or scratches that might occur with a conventional (rigid) robotic or automated parts transfer system.

The team designed and built a full-scale prototype of their proposed system that demonstrates the multi-axis movement required for accurate parts manipulation (loading and unloading) while allowing the compliance necessary for prevention of unintended damage to the part(s) being transferred. They also provided to the customer a complete CAD design giving exact dimensions and components of an actual functional system.

Welding-Tool Actuation System for Two-Sided Friction-Stir Spot Welding

TEAM MEMBERS:

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Nur Fadhilah Haji Mat Hanij
Syahirul Mohd Khairi
Kyle Walker

PROJECT ADVISERS:

Alvin Strauss, Ph.D., ME Dept.
George Cook, Ph.D., EE/CompE Dept.
Chase Cox
Tracie Prater
Brian Gibson

CLIENT:

NASA/Vanderbilt University
Welding Automation Laboratory



PROJECT DESCRIPTION

The Vanderbilt Welding Automation Laboratory (WAL) has been involved for many years in the development of advanced welding technologies, with emphasis on sensing and control issues involved with welding processes. Presently the WAL is involved with research concerning the Friction-Stir Welding Process, a solid-state (non-fusion) welding process. A specific aspect of the FSW process currently being investigated is the use of the FSW process for spot-welding, a welding process used extensively in manufacturing.

Present test equipment utilizes adapted conventional machine tools to perform the FSW process and the goal is to design and eventually build a dedicated FSW test facility.

The Design Team was asked to design a welding-tool actuation system for two-sided friction stir spot welding to be used in the WAL's next-generation FSW test facility. For the welding-tool actuation system for the future FSW system the relevant design criteria were 1) weld-sample holding and stability methods, 2) tool actuation (vertical movement) mechanisms, 3) tool RPM control, 4) accuracy and precision of tool movement, and 5) overall structural issues (strength).

To accomplish those design goals the team designed and built a 2x scale model of their proposed system to verify and demonstrate the system's behavior. They also designed a production version using ProE that contained information concerning materials, components, dimensions, tolerances, and manufacturing and assembly concerns. This final design was presented to the WAL staff for use in the proposed FSW test facility.

Determination of Root-Cause-Solution for Intermittent Noise in Nissan Maxima Door Assemblies

TEAM MEMBERS:

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Mohammad Naquidden Abd Razak, EE/CompE

PROJECT ADVISERS:

Ashley Gatlin
Tyler Stokes

CLIENT:

Nissan North America



PROJECT DESCRIPTION

Nissan North America in Smyrna, Tenn. is a major manufacturer of automobiles for the American market and produces several models of Nissan vehicles at the Smyrna plant. A high priority for Nissan is to produce vehicles that meet in all ways the expectations for quality of their customers.

The task assigned to the VUSE Team originates from the Nissan Warranty Management group and involves the determination of the source (root cause) of an intermittent noise upon door closure in certain vehicles. This noise occurs rarely and intermittently and requires a significant effort in terms of time and manpower to resolve prior to final approval for customer sale.

By use of Fault-Tree Analyses, Ishikawa (Cause-and-effect) Diagrams, physical measurements and testing, and by observation of the assembly process, the team was to determine whether the fault was due to: 1) original design factors (configuration and/or tolerances) of the component parts, 2) manufacturing issues involving the component parts, 3) assembly methods (including human factors), or 4) a combination of the first three factors. The problem was made more difficult due to the intermittent and rare nature of the perceived fault and by the requirement that the costs associated with the solution be as low as possible. By using the "4-M" method of fault evaluation (Man, Machine, Method, and Material) the team provided suggestions to resolve the intermittent noise problem by identifying the most technically-effective and cost-efficient method(s) of solution.

Manufacturing-Process Improvements of Fiberglass Mats for Roofing Materials

TEAM MEMBERS:

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Noorazman Zulkairnain, ME
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PROJECT ADVISERS:

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Leslie Horton

CLIENT:

GAF Corporation, Research and Development Office



PROJECT DESCRIPTION

Founded in 1886, the GAF Corporation has become North America's largest manufacturer of commercial and residential roofing. The Research and Development Office of GAF in Nashville, Tenn. is charged with developing improved products and manufacturing processes for the various manufacturing facilities of the GAF Corporation.

A major product of the GAF Corporation is roofing shingles for residential and commercial applications. Such shingles are constructed of a fiberglass mat (core) coated with asphalt material. A significant portion of the shingles' strength and potential service life is determined by the properties of the fiberglass core.

The Design Team's task was to investigate the parameters of the fiberglass core's construction process and determine production-process improvements. Manufacturing parameters of the fiberglass include the agitation, in an aqueous medium, of glass fibers 1.25 inches long by 16 microns in diameter. These fibers are collected and compressed to form the inner mat of the composite shingle structure.

The project design goals were to produce a fiberglass core that is physically smaller (thinner) while having increased strength. Process variables investigated included improvements in 1) agitation methods, 2) curing methods, 3) molding techniques, and 4) vacuum application in mat formation. Subsequent tensile testing of fiberglass mats indicated that superior dimensional and tensile properties were achieved compared to previous manufacturing techniques.

A Fatigue-Testing Machine for Use with Ceramic Materials

TEAM MEMBERS:

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Mohd Amirullah Abdul Razak
Muhamad Hafiz Kamarudin
Richard Gronberg

PROJECT ADVISER:

Andrew Wereszczak, Ph.D.

CLIENT:

Oak Ridge National Laboratory



PROJECT DESCRIPTION

The Oak Ridge National Laboratory is involved in a wide range of scientific and technical activities, including studies of nuclear chemistry and physics, inquiries into global warming, energy conservation, high-temperature superconductivity and new materials.

Studies in materials research by the Ceramic Science and Technology Group, within the Materials Science and Technology Division, have involved the experimental characterization and modeling of the relationship between mechanical response of brittle materials and their microstructure, and the design of structural components made from them.

The Design Team was given a task involving the determination of properties of ceramic (brittle) materials – specifically the fatigue life of such materials. Existing fatigue-testing machines, which are designed primarily for the testing of ductile materials, have limitations when used to test ceramic materials. Therefore, the specific task for the Design Team was to re-design and add features to an existing fatigue tester to make it more suitable to test ceramic materials.

After initial testing to calibrate the test apparatus, a controllable variable-load system was designed and added to the basic fatigue-tester. Using this system, the load applied to the test sample can be varied in a controlled fashion as a function of time. Addition of a user-interface on the input and output allows experimental testing of brittle materials in a way that gives more accurate results concerning fatigue properties in a shorter-duration test period.

Cutting-Blade-Wear Testing System for Manufacture of Diabetes Test Strips

TEAM MEMBERS:

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Bret Berie

PROJECT ADVISERS:

Michelle Brouner
Peter Goodwin

CLIENT:

Roche Diagnostics



PROJECT DESCRIPTION

Roche Diagnostics, Indianapolis, Ind., is a subsidiary of Roche, Inc. Roche Diagnostics develops diagnostic tests and systems for early-detection, evaluation, and monitoring of disease. The specific testing system under consideration by the Roche Design Team was a system (test strips) for monitoring blood-glucose in diabetic patients.

The test strips under consideration are cut from very long rolls during the manufacturing process. Due to the composite plastic/metallic construction of the test strips, wear and dulling of the cutting blade is an issue in large-quantity production.

The Design Team was asked to design an off-line blade-wear testing system that will allow the evaluation of blade wear as a function of product production. In this system the magnitude of the cutting force and changes in the cutting force (with time/production) of the cutting blades can be monitored. A proof-of-principle testing system was designed and built to allow quantification of the cutting forces involved in test strip production. Further, the system allowed the tracking of cutting force changes (force-sensitivity variation) as simulated wear is introduced into the test blades.

A finalized test-system design using the information gained from the proof-of-principle testing was produced, and CAD files giving materials, dimensions, and production details were delivered to the client.

Tuned Induction System for a Formula-SAE Engine

TEAM MEMBERS:

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Houston Hatchett
Benjamin Hodges
Luke Bellet

PROJECT ADVISER:

Phil Davis

CLIENT:

Vanderbilt Motorsports



PROJECT DESCRIPTION

Formula-SAE is a motorsports formula and racing series sponsored by the Society of Automotive Engineers. In it, racing vehicles are designed and built by university engineering students and are operated in competitions among those engineering schools.

Formula-SAE, as with other racing-vehicle formulas, has a specific set of guidelines for design and operation of the vehicles in competition. These include chassis specifications, engine specifications, safety specifications, and many others.

The Design Team's goal is to produce an induction system for the Formula-SAE race car under construction at Vanderbilt. Among the primary engine-related design constraints are the engine displacement (600cc) and intake restriction (20mm orifice) to reduce the amount of power produced to a level commensurate with vehicle safety (reduction in speed capability).

Within those primary limits the team's goal is to produce an induction system that produces the most power possible by use of basic fluid-mechanical design techniques, such as minimizing flow restrictions in other (non-restricted) areas of the intake system, by maximizing the flow velocity at the intake port, and by using the Helmholtz resonance phenomenon to "ram-tune" the intake pipe so as to maximize the volumetric efficiency at the desired rpm.

Traditional fluid-mechanical design techniques, along with internal-combustion-engine theory and practice, were used to set the basic induction specifications. Computational Fluid dynamics techniques were used to refine the basic design. After construction of a preliminary version of the intake system, flow bench testing was performed to verify the theoretical results. A complete induction system was delivered to the Formula-SAE team for use on the race vehicle.

Design of a Noise Mitigation Strategy for Denso Manufacturing Tennessee

TEAM MEMBERS:

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Eizaq Zainuddin
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PROJECT ADVISERS:

Britt Autrey
Mark Shepard
Joe Talley

CLIENT:

Denso Manufacturing
Tennessee



PROJECT DESCRIPTION

Denso Manufacturing Tennessee, Maryville, Tenn. produces electrical and electromechanical components for the automotive and motorcycle industries. As such, they produce starters, alternators, fuel systems, and instrumentation for such companies as Chrysler, Toyota and Harley-Davidson. All processes at Denso are based on a foundation of Kaizen (continuous improvement). Denso principles underscore that everything can be improved and that nothing is insignificant. Also, a stated goal of Denso is to establish a more human-friendly workplace for its associates.

Using the principles of Kaizen, an area of desired improvement at Denso Manufacturing Tennessee assigned to the Design Team was that of achieving a "more human-friendly workplace" by reducing the ambient noise level in the manufacturing area to a level substantially below that required by national Occupational Safety and Health Administration (OSHA) standards. This reduction would result in improved safety due to improved communications as well as enhance personal job satisfaction and productivity due to improved working conditions.

The task was implemented by making several sound level surveys of the Denso plant and determining the noise-profile existent in the plant. The design team made additional noise evaluations to determine the exact nature and specific sources of the elevated sound levels in the plant. The team then researched noise mitigation and reduction strategies and devices, and determined the applicability of each to the sources identified as the most significant.

Recommendations were made by the Design Team to Denso concerning anticipated noise reduction benefits (magnitude dB) and the cost-effectiveness (dollar/dB) of the various methodologies. Certain noise reduction strategies were implemented and the resulting benefits were measured, indicating significant improvements in the noise level at the Denso plant were feasible.

Commercialization Strategy for Jericho Sciences

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PROJECT ADVISERS:

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Jericho Sciences, LLC

John Bers
Associate Professor of
Engineering Management

CLIENT:

Jericho Sciences LLC,
Nashville, Tenn.



PROJECT DESCRIPTION

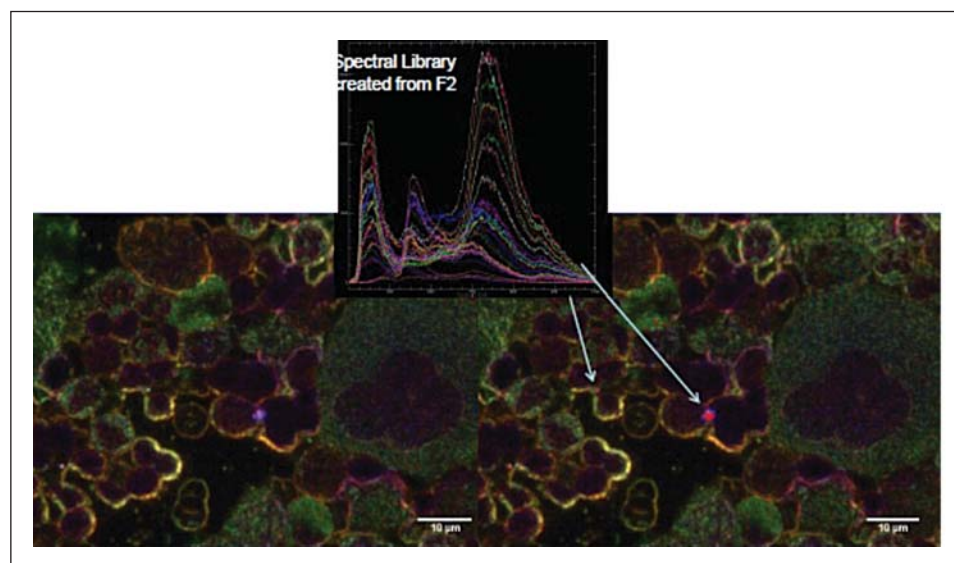
According to the World Health Organization, more than 34 million individuals are currently infected with the human immunodeficiency virus, HIV-1. While current antiviral drugs are capable of controlling active virus replication in HIV-infected individuals, they fail to eliminate virus reservoirs, leading to a resurgence of viral replication. Together with constraints of virus mutational resistance, daily dosing requirements and adverse side effects, novel therapeutics of effective targets are urgently needed. Jericho Sciences seeks to drastically improve the lives of HIV-infected individuals with its novel antiviral compound: FX.

This small molecule targets late translational events in the virus production cycle. It achieves this by acting upon a unique, highly conserved viral motif shared across many viruses, including HIV. Ongoing research evidences no to low adverse effects through toxicology and pathology screening in two animal models.

Drug development is estimated to cost approximately \$1 billion, largely due to FDA requirements through clinical trials. Meeting these requirements calls for external sources of funding, which starts with a detailed commercialization strategy. The team will assess host capabilities and limitations, and develop short- and long-term strategies centered on this innovation.

GOAL:

- Develop a commercialization strategy for Jericho Sciences to be incorporated in Jericho's strategic business plan toward a proposal for a Small Business Innovation Research Phase II (commercialization) grant.



Jericho's use of cell culture assays and microscopic techniques demonstrate drug penetration into cellular compartments known to harbor viral reservoirs.

Computer-aided Drug Discovery

TEAM MEMBERS:

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PROJECT ADVISERS:

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Department of Chemistry

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Associate Professor,
Departments of Chemistry,
Pharmacology, and Biomedical
Informatics

John A. Bers
Associate Professor of the
Practice of Engineering
Management

CLIENT:

Vanderbilt University Meiler
Lab-Computational Chemical
& Structural Biology

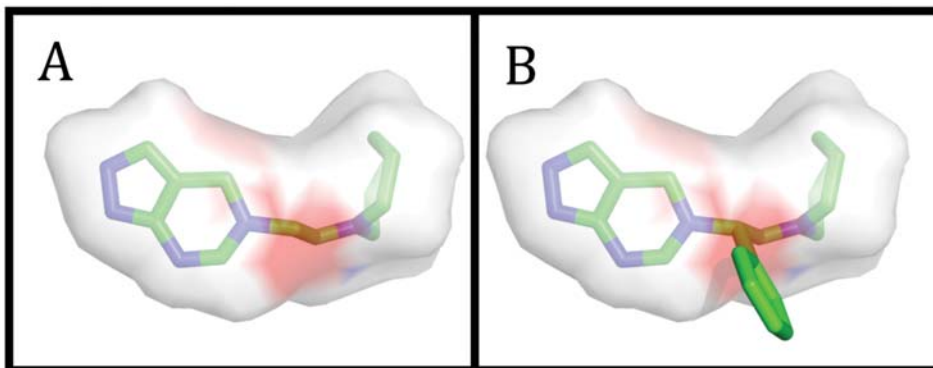
PROJECT DESCRIPTION

The Biochemistry Library (BCL) is a software suite of data analysis techniques that leverage machine learning algorithms to guide the drug discovery process. The BCL suite offers two primary advantages over currently available algorithms. The first is to reduce the quantity of preliminary molecules needing to be screened by an order of magnitude. This module of the BCL library constructs mathematical models that identify the key physicochemical properties responsible for eliciting the desired biological response. A second novel module, PHARMMAP, translates this mathematical model into a visual representation or graphic (shown above) that iteratively guides the optimization of potential drug candidate molecules leading to more potent and efficacious drugs.

Our team's goal is to work with the sponsor's Meiler Lab and the creators of the BCL to generate a business strategy for releasing the BCL to commercial interests for their use. Working with Vanderbilt's Center For Technology Transfer and Commercialization, we will:

GOALS

- Establish Meiler Lab's IP rights and patentability
- Determine an effective product model and pricing scheme
- Identify potential customers
- Develop a go-to-market strategy



A) PHARMMAP-generated pharmacophore map around a scaffold of interest for steric bulk suggesting preference for increased steric bulk (red).

B) A synthesized compound with improved biological activity with increased steric bulk at the site suggested by PHARMMAP

Life Recovery Systems: ThermoSuit

TEAM MEMBERS:

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Matthew Vonderheide
Thomas Hardy

PROJECT ADVISERS:

Courtney Nunnally,
President, Acklen Park
Consulting Group

John Bers
Associate Professor of the
Practice of Engineering
Management

CLIENT:

Life Recovery Systems



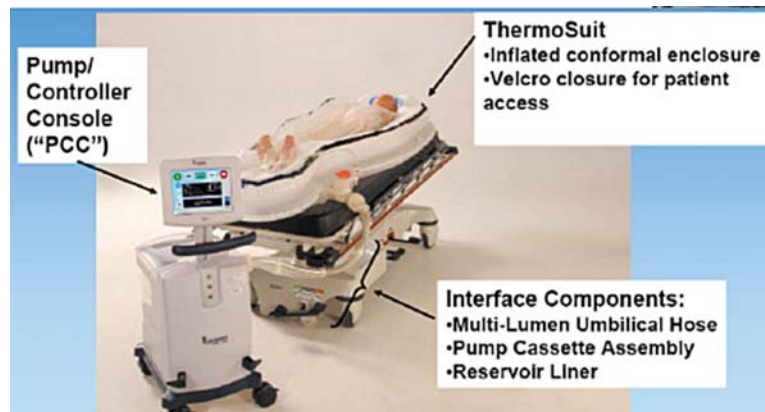
PROJECT DESCRIPTION

Therapeutic hypothermia has shown promise in preventing neurological damage and brain death associated with heat stroke, cardiac emergency, ischemic stroke and traumatic brain injury. After any of these events, the brain is deprived of oxygen critical to its survival. Even if blood and oxygen flow can be quickly restored in a hospital setting, intracellular complications set in motion resulting from the oxygen deprivation triggers massive, often fatal neurological damage. By quickly inducing therapeutic hypothermia after the emergency, the brain's destructive oxidative metabolism is arrested and the cells enter a hibernating state where they can recover and survive. The American Heart Association endorses therapeutic hypothermia.

Developed by Life Recovery Systems (LRS), the ThermoSuit® System is a fast, easy, cost effective, non-invasive and safe means of administering therapeutic hypothermia. The FDA cleared ThermoSuit® System can be administered rapidly with minimal training and can effect full body cooling to therapeutic temperatures of 32-34°C in under 30 minutes – approximately 5-6 times faster than its closest competitor. The patent protected device has been shown to increase the functional survival of cardiac arrest victims up to 70% from 18% without therapeutic hypothermia. There are an estimated one million eligible patients annually in the U.S. alone, and the ThermoSuit® System saves hospitals an average of \$4,000 per patient.

GOAL

- To assess the capabilities and position of LRS, analyze the current and future market environment, and to develop a custom tailored strategy for market penetration. We have identified numerous high-potential markets, and with our recommendations, we envision the LRSThermoSuit® System becoming a latchkey medical device that will save life, preserve human capital and create shareholder value.



Deployed ThermoSuit System
on Hospital Gurney.

Thermosuit product logo.





INSIGHT. INNOVATION. IMPACT.®

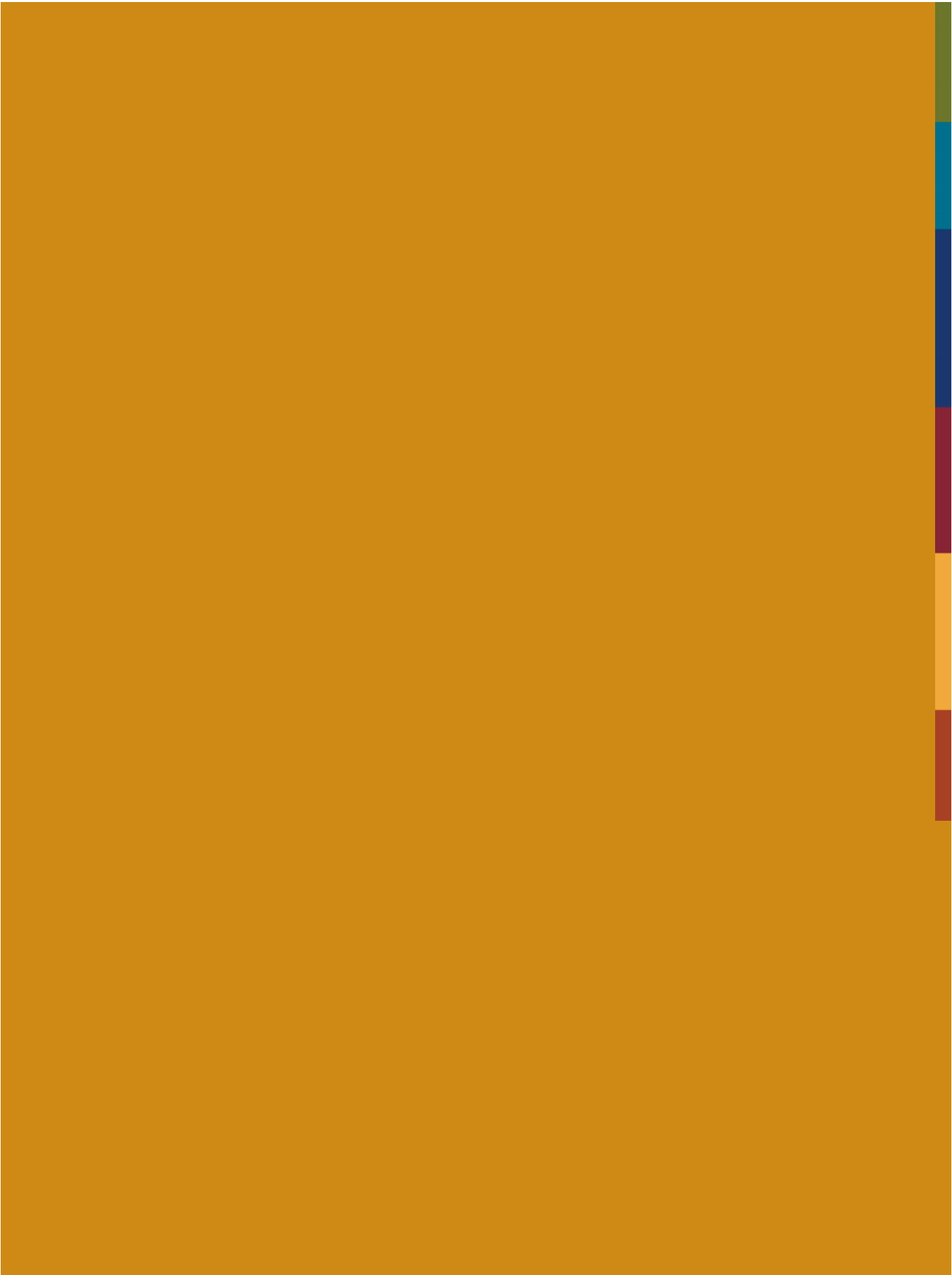
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**APRIL 19, 2012
3-5 P.M.
FEATHERINGILL HALL**

