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The Deloitte Kentucky Account is proud of its long history delivering quality services to the Commonwealth and of recruiting high-achieving students from the universities and colleges across the Bluegrass. Through mentorship programs, event sponsorships, and graduate program projects, we are “all in” on Kentucky!

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Deloitte prepares its practitioners to add value to government and public sector organizations through mission-driven work.
It is wonderful to be able to hold an in-person Engineering Design & Innovation Showcase, designed to be an annual Speed School Event, showcasing our students’ capstone design projects. Who would have thought that it would be 3 years after our inaugural event in Spring 2019 before we would have the follow-up to that first event, which was well-attended and received by many in the Louisville community. My hope is that this event will be at least as well received.

A big thrust at Speed School is preparing students to be workforce ready for industry. We are continually looking to improve our academic programs to help achieve this objective. A relatively recent change is the strong emphasis on industry-relevant and industry-sponsored capstone projects. These projects are not simple academic exercises as our students are tackling actual industrial problems and provide solutions that find their way into practice. One of the things that excites me is to hear how some of the project outcomes are adopted by the industry sponsors. This year, more than 310 students make up the 89 engineering student teams who, throughout the semester, have collaborated with their project partners to develop prototypes or solutions for real-world projects that involve design constraints, budgets, reviews and deadlines.

We also are including the 6 top teams from the ENG111 Cornerstone Project, a multidisciplinary, team-based venture that all first-year engineering students take; the Cornerstone engineering challenges are focused on integration and application of fundamental engineering skills, including problem solving, communication, programming, critical thinking, technical writing, and engineering design. This first-year project experience prepares students early in their academic careers for the capstone endeavor they will undertake as seniors.

The Engineering Design & Innovation Showcase is made possible by the generous support of our industry partners, project sponsors, faculty, staff, mentors, and judges. As a community, we are developing world-class engineers who are well-prepared to meet the challenges of tomorrow with competitive, critical thinking and problem-solving skills.

Our Speed School engineering students have worked hard to prepare for this showcase and welcome the opportunity to demonstrate how their projects developed into real-world products or solutions. Please join me in congratulating them on their achievements.

My sincere hope is that you enjoy this year’s Engineering Design & Innovation Showcase.

Emmanuel G. Collins, Ph.D

Dean, J.B. Speed School of Engineering
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**AWARDS**

**ChE**

1st Place: $500 per team
2nd Place: $200 per team
3rd Place: $100 per team

**CSE**

1st Place: Overall Best CSE Project: $200 per team
2nd Place: Most Innovative Design: $200 per team
3rd Place: Best Project Presentation: $200 per team

**ECE**

1st Place: $500 per team
2nd Place: $200 per team
3rd Place: $100 per team

**IE**

1st Place: $500 per team
2nd Place: $200 per team
3rd Place: $100 per team

**ME**

1st Place: $500 per team
2nd Place: $200 per team
3rd Place: $100 per team
Showcase Partners
DELOITTE

Judges

Senior Design Faculty and ENG 111 (Cornerstone) Instructors

Capstone Instructors:
• Chemical Engineering: Dr. Vance Jaeger, Dr. Jim Watters
• Computer Science & Engineering: Dr. Ibrahim Imam, Dr. Juw Won Park
• Electrical & Computer Engineering: Dr. Andre Faul
• Industrial Engineering: Dr. John Usher
• Mechanical Engineering: Dr. Gary Osborne

Cornerstone (ENG III) Instructors:
Dr. Nick Hawkins, Dr. James Lewis, Dr. Brian Robinson, Mr. Gary Eisenmenger

Administration

Dr. Emmanuel G. Collins, Dean
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Dr. Erin Gerber, Assoc. Dean of Undergraduate Affairs
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Dr. Ayman El-Baz, Bioengineering
Dr. Gerry Willing, Chemical Engineering
Dr. Zhihui Sun, Civil & Environmental Engineering
Dr. Wei Zhang, Computer Science & Engineering
Dr. John Naber, Electrical & Computer Engineering
Dr. Patricia A. S. Ralston, Engineering Fundamentals
Dr. Pratik J. Parikh, Industrial Engineering
Dr. Kevin D. Murphy, Mechanical Engineering
The Lifecycle of a Spring Project

August-November

- Proposals collected

November-December

- Proposals reviewed by faculty; projects selected; companies notified

January

- Semester begins, project ideas shared with students
- Students placed into project teams
- Project teams have initial meeting with industry partner

February-March

- Students work with industry partner throughout the semester to communicate progress

April

- Students finalize project work and review completed work with industry partner
- Students present at Engineering Design and Innovation Showcase
CAPSTONE / CORNERSTONE INSTRUCTORS

CHEMICAL ENGINEERING
Dr. Vance Jaeger
Dr. Jim Watters

COMPUTER SCIENCE & ENGINEERING
Dr. Ibrahim Imam
Dr. Juw Won Park

ELECTRICAL & COMPUTER ENGINEERING
Dr. Andre Faul

INDUSTRIAL ENGINEERING
Dr. John Usher

MECHANICAL ENGINEERING
Dr. Gary Osborne
In the past 25 - 30 years, textile manufacturing has increased in the Southeastern United States. Textile manufacturing plants have developed a negative connotation due to the release of dye-stained wastewater. Textile wastewater is known to be high in metals and other toxins that are harmful to the environment. The wastewater produced by these plants has increased the concern for environmental safety of the public and land in surrounding areas. A textile manufacturing plant is required to supply 15 million white and 15 million green t-shirts for the US Army. The goal is to design a treatment system to sustainably remove dye compounds.

The client, a military clothing manufacturer in Fort Knox, KY, benefits from the proposed treatment system by complying to EPA standards. This ensures continuous manufacturing of t-shirts sold. Thus, the client secures half of the annual t-shirt demands of the U.S. Army.

The group will be utilizing ultrasonic technology to rapid age white whiskey and create a bourbon-adjacent whiskey product.

Providing a method of rapid aging whiskey would allow project clients to cut down the time taken to produce a bourbon adjacent product through the traditional barrel aging process. Speeding up the process will save money and allow distilleries to delve into more research opportunities without risk.
When Life Gives You Timber

Renewable Researchers
Eli Best
Blake Clark
Ross Dillon
Sam Wilson

A plant proposal a biomass pyrolysis plant that uses switchgrass and southern yellow pine of the south east region of the United States to produce charcoal and bio oil to be utilized as an environmentally friendly fuel.

Project Description
Lumber plantation and private forest owners with excess harvested lumber have a problem processing lumber due to the shortage of lumber mills. Our plant project will give forest and lumber plantation owners an alternative source of profit outside of a traditional lumber mill. Bio oil and charcoal is also becoming a more prevalent form of green energy.

Project Benefits

Chemical Recycling of Plastic Waste Through Pyrolysis

License to Chill
Kevin Geho
Paul Goe
Rajie Hass
Chase Phillips
Dustin Williams

Design of an industrial process to convert mixed plastic waste to value-added chemicals.

Project Description
Chemical recycling of plastic waste creates oil, gas, and other valuable chemicals, and breaks the standard recycling loop of turning plastic into more plastic.

Project Benefits
Energy from Bourbon Stillage

Team Bourbon
Lindsay Eichhold
Bradley Esselman
Eleanor Laudenslayer
Ashten Molley

Project aims to determine alternative treatment method of used bourbon stillage that addresses current issues of bourbon stillage disposal.

The main benefit of this project is that it provides an economically viable solution to treating bourbon stillage through a self-sustaining semi-batch process.

Hemp-based Bioplastic Pellets

Group 8
Arvind Dhanapal
Zachary Kemmerer
Alec Mieske
Drew Shelton

In 2018, Congress passed provisions making the production of hemp legal again under strict control, because of this we have been tasked in creating a pilot plant that can produce hemp based material. We have decided to propose a pilot plant that produces bioplastic injection pellets that can be used by injection molding machines. Specifically, the bioplastic pellets are comprised of 30% weight hemp fiber, and the other ingredients include 50% protein soy flour, poly ester amide, and glycerol.

We do not have a client, however, the benefit to our project is being able to create biodegradable plastic using our injection molding pellets.
Private forest owners in the Southern US are finding it difficult to make a profit on their crops due to excess supply and limited sawmill processing capacity. An investment group wants to buy large tracts of land and covert the forests into solar power stations. The project is to develop a prospectus for the design of a 100 MW solar thermal energy plant, to be integrated with the existing power grid. This prospectus will compete with a solar photovoltaic plant and will include a full economic and technical evaluation.

The development of new sustainable and economic investment opportunities in renewable energy, while reducing dependence on fossil fuels.

A farmer wants to use his pear crops to create his own Pear Brandy. The Brandy Bunch team is designing a brandy production facility for the farmer to create his own brandy - Backcountry Brandy. The production design includes the processing of the pears, fermentation, and aging of the brandy in barrels.

The theoretical farmer would gain extra revenue from his Backcountry Brandy in addition to his main fruit-selling business. If the design proves to be profitable, there is room for potential expansion in production for the farmer.
Non-alcoholic beverages is an emerging but fast-growing market, with non-alcoholic (NA) beer being one of it’s biggest representatives. We have been contacted by a Midwest brewery who is seeking to expand their capacity to include NA beer production. It is our job to determine required capacities to reach benchmark IRR (internal rate of return) levels for the company, as well as decide the best technique and plant design for the future creation of their NA beer using prevaporation method.

NA beer is a great choice for people who do not want to or cannot consume actual alcohol due to health, personal beliefs, or other reasons. Other than consumption, those who enjoy the taste of cocktails but want to watch their health, a non-alcoholic beverage is a great alternative. Reducing accidents related to alcohol consumption is another benefit for those who drive on a night out.

We would like to attain a near carbon neutral world where emissions reach a net-zero, including creating an attainable means of reducing airline emissions and creating sustainable fuels. The aviation industry produces many emissions which increase the rate of climate change and require fossil fuels for transportation. There is no current integrated process to combat the use of fossil fuels in the airline industry and the carbon dioxide released. We will use the methodology from three proven studies by Carbon Engineering, LanzaTech, and Pacific Northwest Labs to create a plant to combat these stated issues in one location.

The benefits to our project client(s) would be an integrated process where airlines could achieve a net-zero carbon emission by turning their own wastes into fuel for their planes. This would save airlines a significant sum of money while improving their impact on the environment as airlines will be a part of society for the foreseeable future.
Recovery of Demineralized Bone Particles for Industrial Application

The Bone Crushers
Reese Bergschneider
Dylan Boone
Michael LaRoche
Kyle Mills

Develop a process to create bone particles of 106-micron particle size, demineralize the bone particles in a proprietary solution, rinse and recover the particles from the particle/water suspension. The entire process should be able to be conducted in under 24 hours, have a recovery rate of 90%, and be able to produce at least 500 g of demineralized bone particles per day.

The process will be used by the project client to produce demineralized bone particles of the desired size in a timely and cost-efficient manner which will allow them to use the particles as a raw material for product development.
Bat Cloud – Algorithm

CSE Capstone Drone Swarm Team 1
Drew Bender
Anthony Cole
Nicholas Kaminski
Caleb Klenda
Benjamin Strehl
Cameron Vincent

The algorithm portion of the Drone Swarm project. The goal is to create an algorithm that will determine the best possible formations for a swarm of drones equipped with various instruments such as cameras and lidars. This swarm will have applications, such as search and rescue or land surveying. The algorithm will determine the best formation via voting and then instruct the drones on the movements to make in order to achieve this formation.

Project Description
This is part of a research project with Dr. Lauf. Dr. Lauf hopes this project can be used for the above applications.

Project Benefits

Bat Cloud – Network

CSE Capstone Drone Swarm Team 2
Rebecca Castelly
Asim Hameed
Kasim Hammed
Joseph Mayrose
Kisan Patel
Kieran Waigel

Bat Cloud - Network is part of the two team project under Dr. Lauf. The goal of the overall project is to create a system that will allow drones to communicate with each other mid flight to coordinate formations to best survey an area. The Network part of the team focused on creating and implementing an ad hoc network that supports data transmission to any drone as well as supporting seamless exit and entry to the network.

Project Description
The main benefit to the project client is the implementation of the ad hoc network to progress towards the project goal. The new implementation allows drones to connect to each other without a predetermined structure to allow a dynamic roster to form during flight.
The Smartest Mower: GPS Based Robotic Lawn Mower

Making the cheapest smartest mower by using angle of arrival so the mower will always know where it is in the yard to be able to give better cleaner cuts for the yard.

The Lazy Mowers
Nicholas Gittings
Daniel Haynes
James Richardson

Project Description

MedScrape is a web-application that allows the storage and scanning of payer medical policies to determine changes over time as they are updated. Ultimately, the medical policies are displayed in lists on the application so there is easy retrieval and viewing of each of these policies, and their changes.

This will benefit eBlu Solutions by automating a previously manual task, thus increasing efficiency of their workflow which allows the practices using their system to provide quicker and more accurate care for their patients. Also, it will make it easier and more efficient to compare and review changes as newer versions of a particular payer medical policy are released in a single location.

Project Benefits

eBlu Solutions: Medical Policy Scraping

MedScrape
Isaac Emery
Erasmus Eustace Eusebio
Jie Li
Keyvan Parsan
Cristobal Short
Armin Sokoli
Phillip Walker

Project Description

Project Benefits
TheRealCapstone is a ticketing platform to allow users to find events and purchase tickets. The tech stack of this project is React, Python, GitHub Actions, and is serverlessly deployed using AWS. AWS is also where most of the backend implementation comes from, including DynamoDB for our databases.

Client gets to work with UofL students and receive a consumer experience created by the team. This brings in a new set of eyes and opinions to help grow the company and the website into something that users from all backgrounds will enjoy and be able to easily navigate.

Segway Loomo, an advanced personal robot, will be used in partnership with the CVG Airport as an airport concierge service that can act as a translator and guide for passengers. With the help of grid-based navigation, the Loomo robot is able to navigate autonomously to airport gates using an A* search algorithm that guarantees the shortest, most efficient path from a pre-defined starting position.

- Increases the CVG Airport accessibility by providing autonomous robotic assistance to elderly or disabled passengers.
- Assists Airport passengers with navigation and translation.
- Provides research and development services for CVG innovation.
- Offers the capacity to carry some luggage for Airport passengers.
**Put-to-Light System**

**Team Alliance**  
Michael Arno  
David Gibson  
Meghan Mihaljevic  
Zachary Owens  
Shawn Shankar  
Jacob Wood

Creating a prototype Put-to-Light system for a warehousing system to reduce human error by designating certain areas or bins using LEDs and a Raspberry Pi. LEDs will designate which bins will be used for picking/putting. These LEDs will be controlled by REST Request parameters sent by a Warehouse Management System.

This project will increase productivity by increasing the pick/put rate for a warehouse. This system also allows for a more organized warehouse with less mistakes. The prototype allows for better navigation of a warehouse by using LEDs to signal workers.

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**Papa John’s Inventory Management**

**Papa John’s Inventory Management Team**  
Tyler Caccamo  
Chelsea Chosta  
Jonathan Loyd  
Jose Nunez  
Francisco Rios  
Charles Weiss  
Makayla White

Our team is in charge of designing a prototype inventory management WebApp for the Papa Johns company. We will be creating a website for the users to be able to add and remove items from their inventory along with giving them away to generate a new order. These orders can be loaded up from previously created templates or they can be filled out with the last order, last year’s order, along with a way to create a new template to auto-fill orders.

This will give the company an idea of how they can improve their current websites to facilitate the daily lives of Papa John’s restaurant managers by improving the speed and efficiency of inventory management. This provides Papa John’s with ideas on how we can save the time of placing and updating orders and managing inventory.
**Pulsed Magnet Array Driven Motor**

**BOAS**
Owen Matthiessen  
Aaron Randall  
Mariah Ritz  
Spencer Sherlock

Improve the efficiency and reduce brush complications with the rotor of Henderson R&D ultra efficient DC motor.

Benefits of the project include increased longevity, reliability, and marketability of Henderson’s motor.

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**Dishwasher Component Failure Detection: DishMic**

**ECE Team 2**
Clayton Epps  
Gabriel Jones  
Christopher Spiller  
Ryan Zentner

The DishMic Algorithm will autonomously record dishwasher spray arm audio via a contact piezo mic. Existing dishwasher sensor data will also be monitored and checked by the Dish Mic algorithm. The algorithm will compare this recorded audio and sensor data with a database of successful dishwasher cycle audio and data. Based on the comparison, the Dish Mic algorithm will determine if the dishwasher spray arm operation was successful or unsuccessful.

The dishwasher systems have a variety of sensors that detect and measure various attributes of the system like temperature, water pressure, currents, and other metrics. Despite the array of data currently present, additional data is required for reliably detecting component failures. In other appliances cameras have been used. However, due to the nature of dishwashers, inconsistent and unusable data would be collected from splashing water, soap suds, and steam. An external microphone and algorithm have been proposed as an additional sensor system to aid in detecting dishwasher spray arm failure. In conclusion the dishwasher will become smarter in detecting failures, therefore decreasing time spent by an engineer or technician when troubleshooting.
The T200N+ Reflow Oven Rework’s goal is to enhance the printed circuit board (PCB) production process of the University of Louisville’s ECE research labs by fixing the dysfunctional T200N+ Reflow Oven. The T200N+ is dysfunctional due to its poor design, broken components, and outdated software. Additionally, the T200N+ is no longer supported by its manufacturer. Thus, the rework includes documenting the T200N+’s electrical circuits, troubleshooting and replacing components that have failed, and creating new software for interacting with the oven via a Windows 10 computer. Upon completion, the reflow oven rework will result in a functional oven and new software that allows ECE research to achieve its original PCB production rate.

**Project Description**
- Decrease in soldering failure rate of Printed Circuit Boards (PCBs)
- Prevention of potential failure cases, such as dangerous oven temperatures, due to implementation of new parts and an emergency stop switch
- $1000 to $3000 cost savings due to low-cost solution (cost savings range based on prices of new reflow ovens)
- Modular software that may be used in future projects related to PCB production

**RFID Interrogator for Glaucoma Symptom Tracking**

A compact battery-powered Radio Frequency Identification (RFID) interrogator is to be developed to read pressure and temperature data from a Glaucoma Drainage Device (GDD) surgically installed laterally on the globe. The RFID interrogator supplies power to the GDD using a 13.56 MHz field and reads data using load modulation. The main components in the interrogator are the RFID transceiver IC, microcontroller, LCD, reference barometer, and power circuit. Design efforts include firmware development, circuit design, PCB design, and packaging using 3D printing.

**Project Description**

The interrogator will make it possible for patients to monitor pressure in the GDD helping manage glaucoma treatment and to ensure the GDD is functioning properly. This version of the interrogator specifically targets device testing. An interface on the device is included for data logging and remote medicine functions on later versions.

**Project Benefits**
- Decrease in soldering failure rate of Printed Circuit Boards (PCBs)
- Prevention of potential failure cases, such as dangerous oven temperatures, due to implementation of new parts and an emergency stop switch
- $1000 to $3000 cost savings due to low-cost solution (cost savings range based on prices of new reflow ovens)
- Modular software that may be used in future projects related to PCB production
IMU-based Upper Body Motion Tracking System

Team 5
Anton Afanasyev
Matthew Mayfield
Noah Oliver
Gavin Watkins

Inertial Measurement Units (IMUs) are to be integrated into wearables and used to gather data on the position and movement of a subject’s arm. This data is to be compared to conventional motion tracking methods to test accuracy. The data gathered will be utilized by LARRI’s robotic arms to allow for more fluid and human-like movements.

The project will allow for higher accuracy data collection at a much lower cost than conventional motion tracking.

Variable Height Control System for Robot Manipulator on the Nursing Assistant Robot

Ideas R Us
Weikang Chen
Jacob Manning
Andrew Moore
Kevin Nguyen

Design a closed feedback loop system that can drive the riser platform of the nursing assistant’s robotic arm to various heights. The goal is to be able to drive the platform with very little positional error. Using an optical encoder, a microcontroller, a motor driver, motor, and batteries the group will create a precise height control system with a very slim margin of error.

Restore function to the riser platform. This will allow the platform that the robot’s main 6-DOF robotic arm rests on to raise and lower to specified positions. Essentially, the main benefit resulting from the group’s work will be a wider grabbing radius for the robotic arm that will now be able to grab items at varying heights.
PiezoElectric Rehabilitation Rocking Chair Sensor Analysis

Team 7
David Crabtree
Taran Kurtz
Hunter Lewis
Thang Tuang

Data analysis and circuitry design to implement soft PiezoElectric Sensors for a rehabilitation applications.

To motivate the Rehabilitation of Spinal Cord Injured (SCI) children and to analyze the data to determine movement progression over several sessions.

MicroMill Restoration

Run CNC
Braden Deifel
Jack Palmer
Ethan Tracy
Natalie Warning

Inspect and rehabilitate the MCTC’s MicroMill CNC machine to operational status.

The MNCTC will be able to use the Micromill to complete milling operations that are not yet available in the cleanroom and to reduce the time and cost of current processes.
A CNC routing machine that prints and cuts printed circuit boards.

ECE department can use it as an inhouse milling machine for 400 level classes.
Air Force Research Laboratory Biomanufacturing Supply Chain

AFRL Biomanufacturing Supply Chain Team
Jacob Averill (IE)
Andrew Schreacke (IE)
Dalton Sparks (IE)
Keeley Slade (IE)
Phillip Thorberry (IE)

This project requires the creation of a detailed supply chain model for the fermentation based biomanufacturing industry. The final deliverable is a detailed summary of the necessary information required for the Air Force Research Laboratory (AFRL) to begin development of assessment and investment tools for a supply chain, and will cover a wide variety of fermentation based biomanufacturing products.

Project Description
The client will receive an easy to use software tool that will assist them in assessing a fermentation based biomanufacturing supply chain. The report deliverable will also include detailed information on the research references utilized to create this model. Supplemental information will also be provided for their awareness of and desire to implement various safety, security, and sustainment policies as well as industry 4.0 technologies.

Project Benefits

Ford Manpower

Ford #1 Capstone Project
Cameron Mills (IE)
Matias Pegorari (IE)
Patrick Ryan (IE)

The project is based around manpower reduction in forklift operators moving materials between stamping and the P558 body shop at Fords Kentucky Truck Plant. This will be achieved through the implementation of AGVs. The implementation includes deciding which commodities to move and to what location, the route used to move those commodities, and where the AGVs will charge at. We plan to compare the current condition with our proposed condition using tools such as flow planner and Auto CAD.

Project Description
The major benefit is manpower reduction through the implementation of AGVs. The main objective is to push for automation, that will potentially reduce costs and time of manufacturing processes. We plan to propose new ideas in order to seek for improvement opportunities regarding the routes used to move parts through the plant.

Project Benefits
Hawthorne Elementary
Carpool Analysis

Carpool Bandits
Cameron Beck (IE)
Mallori Cooper (IE)
Abbie Piotrowski (IE)
Cathryn Sebree (IE)
Alex Strickland (IE)

The overall goal of the project is to develop a baseline of Hawthorne’s carpool operations, from vehicle arrivals to departures, that can give Hawthorne’s stakeholders a clear view of the operations and the best practices for further improvements.

Project Description
Reduced time to pick up children, improve the safety of the process, provide the school with a detailed analysis of how their pick-up line process works, and provide the school and PTA with a list of best practices and baseline for car rider pick-up lines.

Project Benefits

FlexSim: Analyzing the Impact of Scheduled Surgeries on Hospital Census

FlexSim Fan Club
Noah Baker (IE)
Megha Dhanapal (IE)
Kayla Funk (IE)
Christopher Kemper (IE)

Using simulation to estimate the impact of scheduled surgical admissions on patient holds and hospital census.

Project Description
Able to estimate patient hold ups in the hospital and aid in scheduling surgeries to optimize hospital flow.

Project Benefits
Unique Fabricating would like us to observe their six Preco machines and processes to identify any issues, and/or improvements that could increase process flow and throughput as well as decrease downtime from operation to material handling. We spent time investigating different causes and giving recommendations to make improvements across the whole process.

The client would benefit by increased throughput by several means such as better communication, improved documentation and location processes, work tool and material placement. The client will be provided with a final report of statistical data analysis and methods, as well as our final recommendations for them to implement.

**A Unique Team**

Austin Bodenhamer (IE)
Garrison Koch (IE)
Dieumerci Isidor (IE)
Tammy Wimsatt (IE)
**Nauti-Dawgs Boat Ladder**

**Nauti-Dawgs**
Spencer Conner  
Christopher Milligan  
Jared Nason  
Wayne Stephens

Collapsible boat ladder for all breeds of dogs that does not require mounting.

Allows dogs to enter and exit the water without being assisted, adjustable for multiple size boats and swim platforms.

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**Lab Viscosity Ball Cleaner and Sorter**

**Rasipuram’s Ball Cleaners**
Aubrey Goldsborough  
Ethan Mills  
Gabvy Rodriguez  
Hallie Stemler

A device that cleans and sorts balls of two different diameters and different materials into their respective groups.

This project will provide more efficiency, and faster process time for organizing balls used in lab courses. It will save money for the ME department by preventing excess purchases of materials.
Enclosure for Soft Piezoelectric Sensors for Rehabilitation Applications

Piezotec
Landon Hammons
Colin Shalosky
Michael Snook
William Wasko

Our team, worked with Ali Tofangchi to design, analyze, and test an enclosure for piezoelectric sensors on existing rocking chairs. The piezoelectric sensors are placed on the arm rest, seat, back, and rocking arm of the chair to record data from the child while using the chair. The position of the sensors needed to be adjustable to consider the size of the child so they are comfortable when rocking and so data can be accurately recorded. The enclosure needed to house the sensor so that no matter where pressure was applied the signal was accurate and consistent to evaluate the progress made throughout rehabilitation. The enclosure needed to be easy to implement on the rocking chair and replaceable in case of any damage caused to the enclosure itself. Our approach to designing the enclosures was using a similar functionality of a Roberval balance using a compound beam system.

Project Description
- The enclosure provides the following benefits:
  - Accurate and consistent signal readings no matter where pressure is applied on the plate.
  - Easy to implement on the rocking chair for each configuration (arm, back, seat, rocking arm).
  - Replaceable enclosures, in case of a fracture or wear and tear over time.
  - Position of enclosure on chair is adjustable for patients’ body characteristics.
  - Protection of piezoelectric sensors while in use.

Design of a 3D Flow Battery

Team 4
Zachariah Forman
Tristan Howes
Nathan Overkamp
Evan Scrivner

Design the flow pattern, materials, and fabrication method for a small flow battery system. This would be used as a modular battery that can be scaled to the size needed by the customer.

Project Description
This project would determine the most effective design and flow pattern for ionizing the fluid flowing through the battery. It would also improve the existing model of a flow battery created by previous students. This could also possibly be used to manufacture in the future.
3D Printed Fractal Lattice Metamaterials with Enhanced Energy Absorption

Team 5
Noah Allgeier
Jeremy Coates
Dhanika Jayawardana
Jacob Potts

In this project, three orders of fractal cut patterns will be generated to assemble fractal lattice metamaterials and then produced via a multi-material 3D printer. The energy absorption characteristics under in-plane and out-of-plane compression will be experimentally evaluated. The team is expected to complete the following two design tasks: 1) designing and manufacturing the fractal lattice metamaterials for implementation into a selected product and 2) measuring the energy absorption characteristics under in-plane and out-of-plane compression. This research will not only provide a fundamental understanding of tailoring strategy and mechanical metamaterials produced by additive manufacturing techniques but will also enable the creation of architected materials with tailored energy absorption characteristics.

The project client gains more research on energy absorption for 3D printed fractal lattice metamaterials.

Accelerated Aging Bourbon

The Bourbon Boys
Matt Allen
Jeffrey Bell
Griffin Leighty
Sam Wethington

Design elements for cost-efficiently inducing mechanical and/or thermal cycles within the structure of a barrel for aging bourbon.

The client is interested in finding a way to accelerate the aging process while still maintaining the definition of bourbon. The team's benefit is to help the client begin to explore the possibility of aging bourbon by inducing stress.
During times of crisis, such as natural disasters or geopolitical conflict, access to housing or shelter is one of the major issues faced by crisis victims. Our project’s focus is to develop emergency shelters and storage sheds 3D printed from filaments reinforced with renewable materials that are quick and simple to assemble, even in remote areas with limited access to the supply chain. Various renewable filament reinforcement materials will be analyzed to develop a filament optimized for compatibility with consumer-grade 3D printers. Additionally, several shelter designs will be analyzed to optimize ease of assembly and additive manufacturing practicality.

This project will streamline the process of constructing emergency shelter and storage solutions in times of crisis by 3D printing structures from an environmentally friendly filament. Disaster victims and military personnel in areas with temporarily or entirely unavailable access to the supply chain will be able to quickly and easily manufacture and deploy shelters directly on-site using 3D printers and renewable materials.

LARRI team is currently developing the NeXus system, a novel robotic instrument for rapid prototyping and automated flexible manufacturing of complex multiscale systems (spanning micro to macro scales.) Fabrication is realized by incorporating: precision robotic assembly, additive manufacturing, and multiscale integration of miniature devices and systems. Nexus includes various additive manufacturing processes, such as customized FDM 3D printing, Aerosol Jetting, and traditional direct write InkJet deposition. The goal of this project is to build a custom automated InkJet printing station as a part of the NeXus system which will include Nordson EFD Pico Pulse InkJet printer integrated with custom robotic 6 DOF positioner, and vision inspection tool.

NI Labview User Interface (UI) for Pico Pulse InkJet printing – full control of the instrument via workstation, Pico Pulse printing head adapter, Characterization of the printing process; PEDOT:PSS ink deposition – with the help of vision processing tools.
**Design of an Environmental Chamber for Precise Electrospinning**

ElectroChamber
Ryan Finley
Corey MacGeorge
Morgan Miller
Chase Stepp

The development of an enclosure with the ability to control relative humidity and bulk air flow during the electrospinning process. An automated system is being developed for precise control of relative humidity levels within the enclosure.

The environmental chamber will improve the quality of fibers produced by electrospinning and allow for further research to be conducted based on electrospinning results.

**Design and 3D Printing of OctoCan, STructural Electronics for Human-Robot Interaction Application**

Team 10
Nicole Harris
Mason Knight
Warren McWilliams
Jared Roberts

We are exploring a new generation of tactel sensor that is targeting human robot interaction applications, which requires it to be flexible in both construction and fabrication process. Specifically, the sensor needs to be able to bend and warp around a non-flat surface of a robot or any other type of surface and provide pressure feedback information. To achieve such goal, we have developed SkinCell sensors in our group with semiconductor device fabrication process in a cleanroom, and we are transforming this process into an on-demand additive process with aerosol ink jetting technique. Meanwhile, we are studying the impact to HRI application by integrating the SkinCell sensors into a 3D printed joystick, called OctoCan.

We need to design and fabricate the body of the OctoCan with either a FDM or SLA printer, to meet electrical design requirements. We are also required to design and fabricate a soft encapsulation for the SkinCell sensors with silicone rubber, as part of the OctoCan.

Ease of movement of robot arm. Increased compatibility of robot to human interaction.
In the coming weeks there is going to be a truss built at Larri that is going to have motion tracking cameras. Our job is to design a retractable net, so that the drones can have a safe area to fly around. We have to create a layout for how the net will work, make sure the net is sturdy enough so that it doesn't flap around, while keeping the costs to a minimum.

This project allows the client to have a safe, enclosed area to fly the drones around. The project will also provide a major convenience for the client because they will be able to get a custom made net that will be structured based on their design requirements.

Our team was given components that are currently being produced by Monticello Tool & Die using traditional manufacturing methods. The components are all fairly small and made of steel. Our capstone team has been working closely with members of Materials Innovation Guild on campus to investigate whether these components can be successfully 3-D printed via MF3 using Aluminum 6061 filament. To gather supporting data, we look at whether the 3-D printed Aluminum 6061 components will have the similar strengths to the original steel components. The components we produce through MF3 must be put through a sintering process to obtain the purely Al-6061 composition and associated mechanical properties. We also come up with some geometric modifications of the original components using generative design/topology optimization that can be presented to the client if interested.

Producing some parts using additive manufacturing processes can often be a cheaper option for the client. For example, in scenarios where a large number of the components are not being ordered, it would be easier to 3-D print a small batch. Also, training time for some of the software and hardware required to successfully produce a part using MF3 is a lot less than training someone on traditional manufacturing machinery like mills and lathes.
Customized Rodent Testing Chamber

TMNE
Nolan Bedwell
Luke Botica
Justin Bray
Matthew Cullen

To engineer a customized rodent testing enclosure to be used with a video fluoroscopy system. This enclosure will support delivery of solid and liquid foods to constrain a rat to a preferred location while being filmed on high speed x-ray (video fluoroscopy). For testing to be continuous and stress free for the rats, the enclosure will feature replaceable viewing windows, adjustable volume for rats of all sizes, and be able to be easily replicated or repaired.

Expanding the spectrum of testable foods, providing a higher rate of successful x-rays, and reducing test costs. Previous enclosures were only capable of testing liquid substances and would be discarded after a layer of barium built up and fogged the enclosures walls.

Laser Scribes for Plastic Solar Cells

Team 15
Ben Anderson
Matthew Brewer
Kevin Brown
Will Stodghill

Perovskite solar technology has been demonstrated to be very low cost and can be printed using high-speed presses. At the Conn Center, we are producing these on plastic substrates and have demonstrated very high efficiencies for flexible devices. The area that this project addresses is a high-speed scribing process to manufacture the cells. Conventional scribing methods are conducted via chemical washing with an edge resolution of approximately 1 mm. The new system hopes to approve the 1mm edge resolution while maintaining conductivity in transparent conducting oxide layers and be capable of making multiple scribed lines over a flat surface.

Laser scribing affords a much more defined edge (<1mm) and can reduce the time required to etch perovskite solar cells. Both a reduction in form factor and processing time would benefit scalable deposition efforts for perovskite solar cell technologies.
IR-Transparent Test-Rig for Barocaloric Characterization

Team 16
Robert Borders
Chase Carpenter
Christopher Carter
James Logan

The project is to design a part that will fit inside of a barocaloric heat pump which will aid in the diffusion of heat away from the barocaloric material, shredded rubber. The design will need to incorporate elements such as a large surface area with which to transfer heat and a low volume to maximize the volume of amount of the barocaloric material in the heat pump. The material we choose will need to have a high heat transfer coefficient and a low stiffness to allow pressure to permeate throughout both our part and the barocaloric material.

The benefits of this project and our design will be to maximize the heat pump’s efficiency, which will make the utilization of the heat pump more feasible in applications which require solid material refrigeration systems.

Low Temperature Distillation from Waste Heat

Salty Brews
Riley Barker
Jonathan Hellmann
Jonah Hermes
John Stumpf

Multiple Effect Distillation (MED) is a common process for purifying water, but it is limited by the temperature at which water vaporizes. By modifying the process such that a vacuum is pulled in each chamber, we can vaporize the water at temperatures much lower than its atmospheric boiling point. More efficient methods of desalination have the potential to lower the cost of water and increase its accessibility for people all around the world. Our project demonstrates that a multiple effect system can be fabricated and operated at relatively low cost. The system takes advantage of multiple natural effects and relies on principles from thermodynamics, heat transfer, and fluid mechanics. Our goal is to construct a system that can perform the MED process at a variety of different temperatures using a vacuum.

System demonstrates a novel way to purify water and could have greater efficiency than other MED systems. Lowered distillation temperature creates the opportunity for more stages and therefore more potable water. Additionally, the solid minerals or concentrated brine can be collected and sold for other purposes. Project presents an marketable opportunity to make desalination easier by simply taking advantage of waste heat.
A contact sensing build plate and data collection module was designed to be compatible with a Laser Powder Bed Fusion Machine (LPBF), one of UofL’s additive manufacturing machines. Design considerations included sensing technique, temperature considerations due to the laser, and reconfigurability of the system to allow for multiple build part shapes and sizes.

The primary benefit of this build plate is that it will record quantitative strain data as a part is being generated. This will assist the client in part generation by giving context to part failure in terms of time and build stage. This may also allow for testing of prototypical manufacturing methods and machine parts.

Our project involves the design and improvement of a Perovskite Solar Cell Durability Testing Chamber. Through the implementation of high intensity light and a Nitrogen sourced humidity control, alongside a water-cooled temperature control, our device will ensure that solar cells can be tested for efficiency and durability within a controlled environment over a time period of up to 1,000 hours. Additionally, our device will have connectivity to provide a direct alarming notification to the operator if the Nitrogen supply begins to deplete, giving the operator the opportunity to service the system without disturbing operations.

Our device will allow the project client to test their solar cells in a much more efficient and user-friendly manner than current circumstances allow.
Low Grade Waste Heat Recovery for Solar Farms

The Heat Savers
Samantha Brockman
Aliyah Davis
Hayden Northcutt
John Powers

As a building is cooled, condensers reject heat to its surroundings. This low-grade waste heat doesn’t serve another purpose besides acting as a byproduct of an air conditioning loop. Capturing this waste heat holds potential in providing power for different applications rather than simply releasing it into the atmosphere. In order to harness this heat without supplying any additional energy, our team designed and built a self-sustaining system to prove that energy can be recovered from this low-grade waste heat.

1. Generate power from low-grade waste heat
2. Lower CO2 Emissions

3D Printing Non-Ferrous Scaffold Structures via Metal Fused Filament Fabrication (MF3) for Applications in Heat Exchangers

Team 21
Cameron Foutch
Brady Hollingsworth
Dylan Hoskins
Maddie Terrell

The goal of this project is to design, simulate and fabricate 3D scaffolds of Copper and Bronze for novel applications in heat exchangers. Generative design and topology optimization tools are implemented to identify optimal distribution of material for a part while simulating the part’s behavior when subjected to expected loads. Softwares such as Altair and AutodeskFusion360 would be utilized to investigate the limitations in MF3 3D printing and study the effect of design optimization on component efficiency of 3D printed parts. Such tools are typically utilized to minimize material consumption and weight, without compromising on the performance of the parts printed using different AM technologies. A working prototype of heat exchangers fabricated at UofL would be subjected to characterization techniques to measure and quantify the performance of the 3D printed part.

This project provides a new way of manufacturing heat sinks. Hopefully it can prove to be less expensive form of manufacturing. Either way, 3D printing allows for a more flexible design and creates a more flexible manufacturing location. Companies working from the sea that do not have access to normal manufacturing tools could use a 3D printer to create a variety of small products needed for their technology. This project examines the advantages of using metals in 3D printing.
The quadcopter tether project is the creation of a base mount and tether that limits the quadcopter motion, measures specific forces on the quadcopter and can produce an external force on the quadcopter.

The primary reasoning for this project is for research purposes. A couple benefits that our base mount has are that it is universal and can be attached to any small-scale drone. Also, external loads can be added or taken away and can also be applied to a specific side or sides of the drone.
**Kentucky Truck Plant - Ford Manpower Database**

**L1C4**
Nick Driskill (IE)
Jackson Schieber (IE)
Kevin Smith (CSE)
Alex Stovall (CSE)

Create Excel workbook to consolidate manpower/labor data and offer automation.

Client can navigate through, find, and edit relevant data faster. Client has to input less data.

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**Community Event Coverage Planning: Managing Safety Logistics at Public Fitness Events**

**UofL Health and Sports Medicine Team**

Dalton Blake (CSE)
Matthew Hisle (CSE)
Jeff Keeling (IE)
Noah Israel (IE)
Erik Musselman (IE)
Andrea Ruiz (IE)

The goal of this project is to maximize participant safety while minimizing adverse health related events during community endurance exercise events (for example Urban Bourbon, Live in Lou, Tour de Lou). Our group’s primary objective is to generate event maps that allow healthcare providers to plan safety stations and equipment.

Meet crucial response times when action must be taken for best outcomes. Collate inventory and ordering information of any equipment needed at safety stations. Generate custom Emergency Action Plans that can be easily communicated with the healthcare provider team and EMT services. Produce participant safety guidelines that can be easily shared with registrants ahead of time.
**Project Description**

Creating a digital library of 3D scans of various downtown assets including street light foundations and bases, public sculptures, and other significant artwork.

**Project Benefits**

Having a 3D scan of a certain asset allows for accurate replication in case it is damaged or stolen.

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**Project Description**

For the Papa John’s Curbside Innovation project, we are creating a proof of concept which will show the idea of adding location tracking to curbside pickup orders for Papa Johns. Our implementation will be to track a customer’s location so that once they arrive at the store they ordered from, the store would receive an alert of the customer’s arrival with the make and model of the customer’s car, the order number that is associated with the customer and finally the items in the order.

**Project Benefits**

This project will benefit Papa John’s Curbside Pickup because it will solve one of their big problems, customers not hitting the “I’m Here” button in the app at the right time. Customers should press the “I’m Here” button upon arrival at the store. However, some customers hit the button before arriving or forget to hit the button when they arrive. The location tracking feature would provide stores with location data they can trust.
The group has been tasked to re-design a kickstand for the MK45 slide testing assembly. The new design must offer a higher factor of safety than the original while maintaining the same, or better, overall functionality. Additionally, the assembly should be modular and use easily obtainable parts to lower maintenance time and costs.

The new kickstand design offers a much higher factor of safety in the testing of equipment to give the client a safer work environment. Additionally, the new design should be able to operate at a lower nominal cost as well as allow for smaller maintenance costs to save the client money.
What are Senior Capstone Design Projects?

Senior design courses are required for undergraduate students and are the culminating experience that allows them to put into practice the curriculum that they have been learning. Students in capstone are typically 1-2 semesters from graduating and will have already completed three semesters of an engineering co-op. Students in the capstone course will be divided into teams of 4-5 members and will have 14 weeks to complete the industry project.

The Benefits of Partnering with a Capstone:

- Move forward your innovative idea or back-burner project.
- Interact with potential future employees.
- Gain a fresh set of ideas/designs from talented students.
- Support the J.B. Speed School of Engineering & engineering education.

Intellectual Property (IP) & Non-disclosure Agreements:

The J.B. Speed School of Engineering has worked with UofL legal office to develop an IP agreement that covers all capstone projects. Students can also be asked to sign non-disclosure agreements when working on an industry capstone project.

FINANCIAL SUPPORT

Industry partnered capstone design projects require a donation of $2,000 - $5,000 depending on your classification:

- $5,000 - Corporations
- $3,000 - Start-Up Companies (50 employees or less) / Non-Profits / Government
- $2,000 - Individuals

Please note that 80% of your support is deemed tax deductible.

How is the support used?

Of the money contributed, up to $1,000 will be available for your student team to use toward the completion of the project. Any project needs above that amount will need to be covered by the industry partner. The additional amount of the gift is used by the engineering department to improve facilities, provide training, and cover program costs related to capstone and/or the overall academic mission of the Speed School.

FOR MORE INFO PLEASE CONTACT

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502.852.3196
AMIST 3D Printing Camps
Ages: 11 - 15 | June 7th-9th, 2022 | 9a.m. - 4p.m. | Introduction to 3D Printing and Advanced Manufacturing Practices
Ages: 13 - 18 | June 21st-23rd, 2022 | 9a.m. - 4p.m. | Advanced 3D Printing Design and Manufacturing
Ages: 12 - 18 | July 26th-28th, 2022 | 9a.m. - 4p.m. | CNC Manufacturing for Beginners
Location: AMIST | Cost: $259

LEGO Mindstorm Robots
Middle School Students (6th-8th Graders) | June 13th-15th, 2022 | 10a.m. - 3p.m.
Location: Engineering Garage | Cost: $300

Scottsburg Advanced Manufacturing Youth Camp
Ages: 11 - 15 | June 20th-22nd, 2022 | 8a.m. - Noon
Location: Mid America Science Park | Cost: FREE

Brown-Forman INSPIRE
High School Students (9th-12th Graders) | June 20th-July 1st, 2022 | 10a.m. - 3p.m.
Location: Engineering Garage | Cost: FREE

The Future Civilization
Elementary School Students (3rd-5th Graders) | July 11th-13th, 2022 | 10a.m. - 3p.m.
Location: Maker13 | Cost: $275

Logistics & Supply Chain
High School Students (9th-12th Graders) | July 11th-15th, 2022 | 9a.m. - 4p.m.
Location: LoDI | Cost: $250

Engineering is FUNdamental
Grades: 3rd - 5th | July 14th, 2022 | 10a.m. - 3p.m. | Location: New Day Ministries
Grades: 3rd - 5th | July 20th, 2022 | 10a.m. - 3p.m. | Location: Central High School
Cost: $150

Let’s Start Coding
Middle School Students (6th-8th Graders) | July 15th, 2022 | 10a.m. - 3p.m.
Location: Engineering Garage | Cost: $150

Coding for Beginners
Grace James School Students Only | July 18th, 2022 | 10a.m. - 3p.m. | Location: Grace James
Location: Grace James | Cost: $150
As the demand for technical talent rises and the needed skills diversify, the University of Louisville J.B. Speed School of Engineering has risen to the challenge by integrating industry feedback through various programs. With more than 250 employers engaged in our freshmen cornerstone projects, mandatory co-op program, or senior design projects, industry connection leads to the development of work-ready engineers in all sectors.

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