innovation showcase 2018

Senior Capstone Projects in Engineering, Computer Science and Engineering Technology

SPECSET

College of Engineering

TENNESSEE TECH

Edited and compiled by:

Meenakshi Sundaram, Ph.D., P.E., FSME, FIIE
Industrial Liaison, College of Engineering
Professor, Mechanical Engineering

With help from the following individuals:

Joseph Biernacki, Ph.D., Chemical Engineering
Daniel Badoe, Ph.D., Civil and Environmental Engineering
Gerald Gannod, Ph.D., Computer Science
Omar Elkeelany, Ph.D., Electrical and Computer Engineering
Michael Baswell, Ph.D., General and Basic Engineering
Ahmed Elsawy, Ph.D., Manufacturing and Engineering Technology
Dale Wilson, Ph.D., Mechanical Engineerign
Cynthia Davis, College of Engineering
Sonja Higgenbotham, Mechanical Engineering

For more information on becoming involved with this program, please contact:

Meenakshi Sundaram, Ph.D., P.E., FSME, FIIE
Industrial Liaison, College of Engineering
Professor, Mechanical Engineering
College of Engineering
msundaram@tntech.edu
(931) 327-3790

www.tntech.edu/engineering/specset

Table of Contents

Each spring, the Innovation Showcase gives seniors in the College of Engineering an opportunity to present their Senior Capstone Projects in Engineering, Computer Science and Engineering Technology (SPECSET). These projects challenge students to integrate real-world designs – from concept to client presentations – into a meaningful, hands-on undergraduate learning experience. Under the direction of faculty advisors, student teams work with industry partners to solve practical engineering problems. Each year these projects are presented at the Innovation Showcase.

Thank you to Interim Dean Darrell E. P. Hoy for his support and encouragement and the staff in the College of Engineering for the success of Innovation Showcase 2018.

#CENGR228-SEL-18

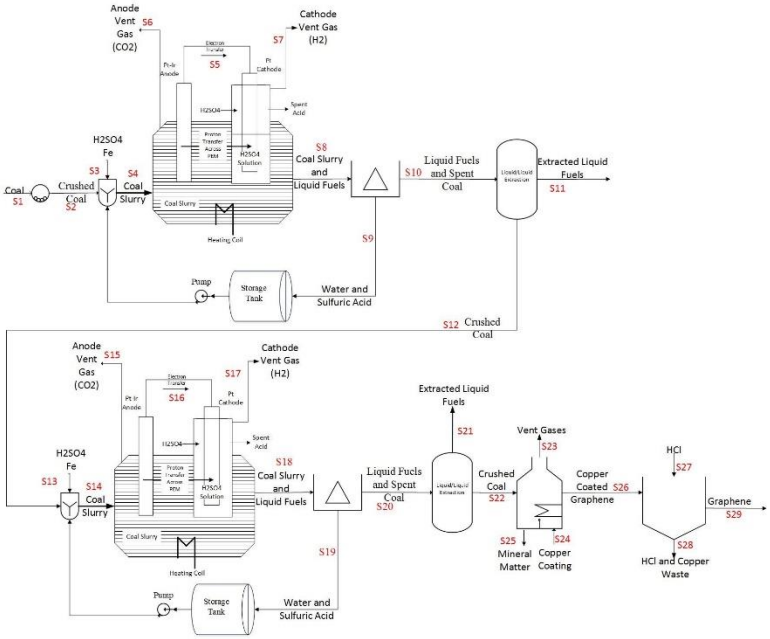
CHEMICAL ENGINEERING

Project Title: Alternative Cement Plant Utilizing Direct Carbonation of Ca(OH)2 using Supercritical CO2
Faculty Advisor: Joe Biernacki, Ph.D.
Students: Tyler Armstrong, Gage Dean, Daniel Klingenberg, Brady Lofton, Patricia Wamea

Abstract:

The production of Portland cement is responsible for about 7% of the annual global carbon dioxide (CO2) emissions. This equates to about 2.1 billion tons a year. Roughly one ton of CO2 is produced for every ton of cement. The direct carbonation of calcium hydroxide (Ca(OH)2) has recently been suggested as a possible CO2-neutral replacement for Portland cement in some applications, e.g. prefabricated cement-based construction components. The art of burning limestone (CaCO3), the formation of slaked lime (calcium hydroxide) and subsequent carbonation has been practiced since at least Roman times as a form of cement. The process, however, is generally too slow to be practical for most modern applications. Studies have shown the use of liquid and supercritical carbon dioxide accelerates the rate of the carbonation reaction and is definitely achievable on the experimental scale. The Sustainable Alternatives for Energy and Chemicals design section labeled as Team Green Cement developed a full-scale heat and material balance, sizing of unit operations, economic analysis, and optimization of a start-up plant utilizing this technology on the industrial scale. The goal of the design team is to provide accurate information that relates the efficiency, feasibility, sustainability, profitability, and environmental effects of this technology and its potential on the global scale.

Project Title: Electrolysis of Coal for Hydrogen Production
Faculty Advisor: Cynthia Rice, Ph.D.
Students: Savannah Hall, Dalton Maloney, Benjamin McComb, Victoria Petty



Abstract:

As the global demand for clean energy increases, there will also be an increased demand for hydrogen as a clean fuel. Currently, the majority of hydrogen is produced through steam reformation where high energy requirements and pollutants counteract some environmental benefits using hydrogen. A process centered around coal electrolysis has been designed with the primary objective of cleanly and cheaply producing hydrogen in addition to also producing hydrocarbon liquid fuels and graphene as byproducts. The design includes a heat and material balance for all processes involved, as well as optimization and an economic analysis to determine viability. Through coal electrolysis, pure hydrogen can be manufactured at a reduced price due to lower energy requirements with no need for separation processes. The overall process will consist of seven main operations: ball mill, slurry mixer, coal electrolysis cell, centrifuge, liquid-liquid extraction, furnace, and acid wash. Liquid-liquid extraction is used to remove the hydrocarbon liquid fuels that form a film on the surface of the coal and inhibit further electrolysis. Graphene is produced by pyrolysis and chemical vapor deposition of electrolyzed coal in the furnace. The process will produce 10,000 tons of hydrogen, 147,400 tons of liquid fuels, and 0.278 tons of graphene annually. An economic analysis shows that the process will have a positive cumulative cash

flow 10 years from start of plant construction. Over a 40 year period, the plant is expected to have an annualized 12.6% rate of return. The proposed design provides a viable alternative for production of hydrogen as well as a clean use for coal.

Project Title: Nylon 6 Carpet Recycling
Faculty Advisor: Holly Stretz, Ph.D.
Students: Destiny Bussell, Sarah Delozier, Parker Lusk, Luke Moore, Devon Smith

Abstract:

The purpose of this project was to investigate the viability of a process to recycle nylon carpet. This process studied consisted of operations to separate the nylon from the backing material, depolymerize the nylon to its monomer, caprolactam, purify the monomer, and finally crystalize caprolactam product for sale. The process required an input of approximately 106 million lb of carpet per year and predicted an output of roughly 10 million lb of caprolactam per year, which can be sold for approximately $1/lb. However, this sales price is not high enough to counteract the cost of manufacturing required by this process. The process was analyzed over a 12 year proposed project life, and found to be unprofitable over this life. In order for this process to break even, the sales price would need to be subsidized by some third party entity. It is therefore the recommendation of this design team that this process not be pursued by the investors.

Project Title: Production of Human Insulin Using Recombinant DNA on an Industrial Scale
Faculty Advisor: Robby Sanders, Ph.D.
Students: Abigail Collins, Mariah Martinez, Jeremy Moffett, Amber Monroe, Joseph Oliverius

Abstract:

It is estimated that 425 million adults in the world are living with diabetes mellitus, a disease in which the pancreas produces little to no insulin [1]. Insulin is a hormone that is needed to regulate blood glucose levels. The need for insulin production is driven by the increase in diagnoses of diabetes mellitus, as well as, the increasing cost of insulin. The current market sells insulin injections for upwards of $400 per month [2] and insulin pumps for over $5500 along with monthly supplies priced around $100 [2]. These price points have left many patients, without insurance, no way of funding their treatment. The employed method of producing insulin is through expression via E. coli. Through this method, E.coli overproduces Trp-LE'-Met-proinsulin, which is a precursor to insulin. The precursor is recovered and reacted to produce insulin, and then the insulin product is purified. This method of insulin production is a sustainable process that can be scaled as required to meet the increasing demand for insulin products. Although our plant is currently simplified to include only five unit operations, the process has shown to be profitable at a sales point of $70 per gram. This is well below the highest market value currently seen at $100 per gram [3], thus allowing for easier market share capture and expanding access of insulin to diabetics who are hindered in achieving optimal therapy due to the relatively higher price points of most insulin products currently

available. At our plant's intended scale with a startup cost of $3,712,871 and projected revenues, a net profit of $3,783,708 is expected by the fourth year of operation.

Project Title: Seawater Desalination using Waste Heat Energy from Nuclear Power Plants
Faculty Advisor: Laura Arias Chavez, Ph.D.
Students: Kyle DuCote, Zack Duncan, Harrison Finnell, Destin Vantine

Abstract:
Water scarcity is a global crisis; up to 57% of the US experiences droughts or water shortages in a given year. Seawater desalination provides a source of clean water for coastal regions, but it is intrinsically energy intensive. Two thirds of thermal energy produced by nuclear power plants is dissipated. Powering desalination with waste heat from a power plant provides clean water without increasing energy demand. To accomplish this goal, two schemes, each combining four separation processes, were developed. One combination starts with reverse osmosis while the other starts with multi-effect distillation. In both cases, three processes follow: membrane distillation, forward osmosis, and an evaporation pond. For each scheme, a complete heat and material balance was used to evaluate the economic feasibility and optimal configuration. Economic and "what if" analyses were completed to ensure operation will be sustainable.

Project Title: Syngas Production Using a Sustainable Cellulose Feedstock
Faculty Advisor: Joseph J. Biernacki, Ph.D. and Michael O. Adenson, Ph.D.
Students: Miranda Maples, Angelina Ortiz, Taylor Pinto, Jackson Penfield, Trent Rogers

Abstract:
The interest for sustainable alternatives to fossil fuels has been increasing in recent years. The production of synthesis gas from biomass, specifically cellulose, is a promising alternative to the traditional use of fossil fuels. Syngas, a mixture of hydrogen and carbon monoxide, is a product of great interest because it is burned for fuel and is used as an intermediate to create other chemical products such as synthetic natural gas, ammonia, and methanol. The process used to model conversion of feedstock to syngas implements a gasification step followed by separation steps. Through cellulose gasification, the following chemical species are produced: hydrogen, carbon monoxide, water, methane, and carbon dioxide. A pressure-swing adsorber is used for the first separation step, followed by two condensers for water removal. The sustainability of this process is driven by the use of both reusable feedstock and also environmentally-friendly purification techniques. Material and energy balances were conducted around all unit operations for the purposes of production scale, equipment sizing, economic analysis, and optimization.

Project Title: The Incineration of PCBs
Faculty Advisor: Guy Materi
Students: Rachel Presley, Mouhmad Elayyan, Leandro Nurmomade

Abstract:
With advances in sciences and technology over the decades, a myriad of new technologies have arisen to convenience human lives, such as electricity. However, some of these technological advances have proven to have harmful "side effects" to both the environment. Polychlorinated biphenyls, or better recognized as PCBs, are one specific example of this. PCBs are chemical compounds which are very stable under high temperatures, a quality which makes them superb dielectric fluids, but also makes them very resistant to any form of degradation. These compounds have proven to be highly toxic, bio-accumulative and difficult to dispose of by chemical means. In response to these findings, production of PCBs was banned and the immediate destruction of this material was mandated with the Toxic Substance Control Act (TSCA) in 1976 and the Stockholm Convention of Persistent Organic Pollutants in

2001. Due to their resistance to degradation and equipment longevity, this material remains undestroyed in less industrialized countries.

Burn Your Troubles Away (BYTA) Design Team has modeled an incineration process that specifically targets these harmful substances with a 99.9999% destruction efficiency as mandated by TSCA and the Stockholm Convention. Specifically, this process targets transformer oil contaminated with 500 ppm of PCBs. Using Aspen Plus, this incineration process was effectively modelled, and a heat and material balance was completed in order to determine the associated costs of implementing this project. BYTA implemented the following unit operations into the process: an incinerator, multiple boilers, steam turbine generator, induced draft fan, air blower, water pumps and a condenser. Approximately 2.9 MW of energy was recovered that could be recycled back into the plant in order to reduce operating costs, or potentially be marketed to the proximate communities in the less developed regions.

Project Title: Utilization of Electrolysis for Lithium-ion Battery Recycling
Faculty Advisor: Cynthia Rice, Ph.D.
Students: Kurt Dunham, Meagan Kessell, Mary Beth Ledford, Osvaldo Morales, Andrew Whittenbarger

Abstract:
The development of lithium-ion batteries has led to advancements in a variety of modern electronic products including cell phones, laptops, and electric vehicles. While the technological advances that call for lithium-ion batteries have positive implications for consumers, the finite supply of lithium must meet market demand, and the spent batteries are a significant source of electronic waste. In 2016, the worldwide lithium production increased by 12% due to an increased demand for the metal. By the year 2030, the annual demand for lithium in the United States due to electric vehicles is predicted to be as high as 22,000 tons. Moreover, from 2012-2015, 99% of the United States' lithium imports were from Chile, Argentina, and China, thus reinforcing the need for a sustainable supply source. As a solution, the design team is proposing an electrochemical battery recycling process that involves several steps to separate the various components of the battery and utilize electrolysis to recover a pure lithium product. Upon conducting a heat and material balance followed by a subsequent economic analysis, it is found that the proposed recycling plant makes a profit; however, the most valuable component in today's market is cobalt, not lithium. Lithium is a valuable metal, but there is not as much lithium in a lithium-ion battery, only 1.9% by mass for an electric vehicle. Hence, it is crucial that the plant salvage and sell every element of the spent power source. In addition to the profit made by the recycling plant, there are also significant environmental benefits. A single plant can reduce electronic waste and meet some of the demand for lithium without depleting the earth's natural supply of the metal. The process will only become more relevant over time, so it should be further developed and industrialized in the foreseeable future.

Project Title: Wastewater Reclamation from Fuel Production Process
Faculty Advisor: Dr. Laura H. Arias Chavez
Students: William Byington, Michael Chase, James Daly, Savannah Poole, and Matthew Whitaker

Abstract:
Reclaiming Process Water During Production of Diesel from Biomass Feedstocks

Synthetic diesel is revolutionizing the fuel industry by providing a renewable alternative for automobiles. One major concern with synthetic diesel production is its wastewater. This complex wastewater contains many potentially valuable hydrocarbons at low concentrations, along with cyanide, ammonia, and metals. A complete wastewater reclamation process was designed to recover or degrade these components using a hybrid forward osmosis - reverse osmosis system. Without treatment, this water does not meet TDEC regulations for disposal into the municipal wastewater system and must therefore be incinerated at high cost. Reclamation of this wastewater will reduce water and energy usage and lower economic costs. Wastewater is first concentrated with a highly selective, fouling-resistant forward osmosis membrane using a sodium chloride draw solution. The extracted water moves to an advanced oxidation process to degrade cyanide and ammonia that were not retained by the membrane. Reverse osmosis re-

concentrates the draw solution for reuse in forward osmosis, separating it from the final water product. Included with the reverse osmosis process is a pressure exchanger to conserve energy. A dynamic model was created to track all wastewater components and energy across the process. This code yields the concentration of each species with respect to time to predict how long the process can operate without exceeding regulatory limits. Safety and economic aspects have been analyzed to determine the viability of this process. According to the model, all of the species in the wastewater will be reduced to allowable concentrations except for benzene and phenol, which will require additional study.

CIVIL AND ENVIRONMENTAL ENGINEERING

Project Title: Structural and Site Design of LogiCore Corporation Headquarters, Huntsville, Alabama
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Nur Rizka Kareth, Michael Atkinson, Adam Longstreth, Kiersten Saunders, Patrick Hartman
Professional Mentors: Stephen Cotton, P.E., of SSOE Group, Jack Southard, P.E., of Fulgham MacIndoe & Associates Inc.

Abstract:
This project has as objective to undertake the structural and site design of an office complex in Huntsville for LogiCore, a company that delivers important services to the U.S. Government and commercial clients within and outside the United States. The Huntsville office will serve as LogiCore's corporate headquarters. The scope of the project includes design of roads to provide vehicular access to the two office buildings and parking areas, water and sanitary sewer lines to the site, identification and completion of environmental perrmits required, structural design of the primary office building which consists of a two-story structural steel structure.

Project Title: Design of Tennessee State Route 455 in Ashland City, Tennessee
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Blake Goans, Khaled Alsawaq, John York, Gregory Gash, Blake Fulton, David Strong
Professional Mentors: Eric Slayton, P.E., Rachel Gentry, P.E., Nathan Bartlett, P.E., Jesse Hoover, P.E., Seth Bradley, EI, Nick Kniazewycz, EI, Sharon Schutz, P.E., all of Tennessee Department of Transportation-Region 3

Abstract:
The purpose of this project is to modify the horizontal and vertical alignment of approximately 1,500 feet of SR-455 to accommodate the construction of a future proposed levee to be constructed by A. O. Smith Water Products Company. The company is constructing the levee to alleviate flooding experienced by their industrial site. Design constraints include the requirement for the new alignment to tie into the existing intersection with SR-249 (Cumberland St.) and just south of A. O. Smith's second site entrance. The existing side road and business entrances must also be accommodated. The project will require the design, including hydraulic analysis, of a structure to be constructed over a tributary to the Cumberland River. The project may include channel design as necessary to transition the stream through the proposed structure. An assessment of required permits, construction phasing including striping, signing, and installation of safety features, as well as a cost analysis will also be required. SP.E.,cific tasks include roadway horizontal and vertical realignment design, intersection design, bridge design, hydraulic analysis, stream channel design, permitting, construction phasing, and cost analysis.

Project Title: Design of Fentress County Local Route 0A073 – Rotten Fork Road Bridge over Rotten Fork Wolf River
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Ben Redden, Omar Alshammari, Blake Huffman, Jonathan Craig, Christopher Carey, Reed Allison
Professional Mentors: Joseph DeLorenzo, P.E., Megan Wildes, P.E., Eric Slayton, P.E., Joseph Deering, P.E., all of Tennessee Department of Transportation-Region 2

Abstract:
The purpose of this project, which is located on Rotten Fork Road in Fentress County, Tennesse is to redesign an existing single span steel bridge which has a sufficiency rating of 37.6. SP.E.,cific tasks include horizontal and vertical realignment of Rotten Fork Road, hydraulic modeling and analysis of Rotten Fork Wolf River, bridge design for the crossing, permitting, best management practice implementation, construction phasing, and cost analysis.

Project Title: Design of Secondary Aluminum Recycling Waste Disposal Facility (Landfill)
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Jacob Blocker, Gregory Kyle Gibson, Hope Duke, Ali Alali, Harrison Bruce, Lydia Johnson
Professional Mentors: Nick Popkowski, P.E., Mike May, P.E., Barry Quinn, P.E., all of AECOM, Nashville

Abstract:
The purpose of this project is to design and permit a waste disposal facility (Landfill) for a secondary aluminum recycling client. The design/permitting process will include landfill siting, access road design, site grading, drainage calculations and design, storm water quality calculations and design, concrete structure design, and construction cost analysis. The overall goal of the project will be to maximize the landfill life expectancy for the given land parcel. It will incorporate Environmental, Transportation, and Structural Civil Engineering disciplines.

Project Title: Site Development for CenterPointe Hospital in Columbia, MO
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Brandon Anderson, Nick Antuna, Rachel Stewart, Tyler Wright, Talal Alshemeri
Professional Mentors: Bubba Ingram, P.E., and Samuel Bohannon, P.E., of Ingram Civil Engineering Group, LLC

Abstract:
The purpose of this project is to undertake the detailed civil engineering site design for a proposed 53,000 square-foot psychiatric hospital located in Boone County, Missouri. Also to be designed is the parking lot to accommodate the residents and staff. specific tasks include grading, design of parking lot, storm water drainage analysis and design, and environmental permitting.

Project Title: Replacement of Bridges over I-40 on Bennett Road, Cookeville, Putnam County, Tennessee
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Yousef Alawadhi, Jason Randolph, Kaitlyn Speck, Logan Inman, Dylan Allen
Professional Mentors: Wes Mattingly, P.E., John Pennington, P.E., Alex Carpenter, P.E., of HMB Professional Engineers, INC.

Abstract:
The existing bridge on Bennett Road over Interstate 40 (I-40) near mile marker 283 in Putnam County, Tennessee, is to be replaced by two bridges. Further, Bennett Road between Highland Park Blvd. south of I-40, and the beginning of a separate project north of I-40 managed by the City of

Cookeville is to be improved. The improvement on Bennett Road will involve a realignment, an upgraded road cross section to accommodate future traffic volumes, two new bridges over I-40, and a box culvert with wing walls to accommodate the existing tributary to Cane Creek. specific tasks for the senior design project team include roadway alignment and cross section design, drainage design, structural design of bridges and culverts, slope, stability analysis, environmental permitting, and a cost analysis.

Project Title: Design of an Additional Lock System at Barkley, Kentucky
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Cortney Thomas, Joseph Brockwell, Jackson Caldwell, Taylor Newcomb, Ali Husain
Professional Mentor: Stephen Salaman, EI, U.S. Army Corps of Engineers

Abstract:
The Kentucky Lock (KYL), located near Grand Rivers, KY is the second-busiest lock in the United States. To reduce traffic and operational outages at KYL, a new lock at Barkley has been proposed. The senior design project team is tasked with designing this new lock. specific project tasks include the design of the lock-monolith geometry with the requirement of it being stable both during and post construction; the design of the filling/emptying system for the lock; the design the culvert valves for the lock filling/emptying system; the determination of the construction staging for the new lock; and finally, the creation of an operation plan, including emptying and filling curves for the lock chamber as well as valve positions for each operation.

Project Title: Design of Relocated BG-Line 69 kV in Strawberry Plains to Increase Reliability and Capacity of the Electrical Grid, Tennessee
Faculty Advisor: Daniel A. Badoe, Ph.D.
Students: Ashley Hazlett, Talal Abdullah, Zachary Grigg, Aaron Gillogly, Dakota Goodwin
Professional Mentors: Monica Satin, P.E., Brent Coates, EI, Matt Howard EI, all of Power Consulting Associates, Brentwood, Tennessee

Abstract:
To increase the reliability and capacity of the electrical grid in the Strawberry Plains area, Knoxville Utilities Board has identified the need to construct a new 69 kV Transmission Line between the East Knox Substation and Strawberry Plains Substation. The new TS-Line, along with the existing BG-Line, will create a loop feed into Strawberry Plain Substation. Due to routing and future maintenance requirements for the new TS-Line, a 1-mile section of the BG-Line requires relocation.
The senior design project team was tasked with the structural design, environmental permitting, and the project and construction management of the BG line relocation.

COMPUTER SCIENCE

Project Title: Seedfork: Web Application
Faculty Advisor: Martha Kosa, Ph.D.
Students: Johnathon Bryant, Levi Koger, Collin Mabus, Rebecca McCullough, Patrick Williams
Sponsor: Seedfork of the Highlands / Gerald Gannod, Ph.D.

Abstract:
Seedfork is a local organization that is dedicated to providing economic, education, and therapeutic opportunities by connecting plants, people and food. One of Seedfork's goals is to connect farmers who have excess produce with food pantries, soup kitchens, and other organizations that help people with food insecurities. To do this, they need a system that can keep inventory on what has been donated, who has donated it, and where to pick-up and drop-off these donations. Our solution is to provide a web application that allows local farmers to provide this information for any excess produce that they want to donate.

Project Title: Voke Recommendation Engine
Faculty Advisor: Ania Jennings
Students: Nicholas Cothran, Caleb Huck, Jordan Johnson, BJ Ledbetter, Chelsey Long
Sponsor: Cru - Aaron Thomson

Abstract:
Voke is a mobile and web app which enables users to engage in deeper conversations about their faith. It provides meaningful media and content that users can both view and share with others. The goal of this project is to provide a backend system for the Voke application which stores user feedback and analyzes it to score videos. Each video can be related to multiple themes such as addiction, depression, and hope with a score that describes how strongly it is related to each based on user activity. VokeBot, the system that transfers information between the user and the recommendation engine, asks a user how he is feeling and, based on the response, prompts the user to select a theme. VokeBot asks the recommendation engine for up to three videos that are strongly related to the chosen theme. After the user watches a video, he is asked to rate its relevance to the topic he chose. Several aspects of the interchange are stored, including the user's response, how long he watched a video, and whether he shared the video, and those values are processed to update the scores.

Project Title: Relatient Reminder System
Faculty Advisor: Ashiqur Rahman, Ph.D.
Students: Mina Abdel-Nour, Amanda Carpenter, Colten Anderson, Eljon Gasmen, Sam Wehunt
Sponsor: Kevin Montgomery

Abstract:
Reminding patients of upcoming appointments is a core offering of Relatient. Sending reminders has been shown to greatly improve appointment attendance, which in turn leads to greater efficiency and profits for healthcare providers. This project intends to expand the Relatient patient reminder system through a natural language and artificial intelligence interface. More specifically, it will remind patients of all their appointments through SMS (text) and Voice messaging. Then patients can confirm, reschedule, or cancel appointments. The system will also answer a variety of common patient questions including doctor's instructions, appointment confirmation status, and directions to the doctor's office.

Project Title: Cummins Falls Park Visitor Counting System and Mobile Application
Faculty Advisor: Ania Kaczka Jennings
Students: Anh Dao, Connor Gannon, Jon McClung, Samuel O'Neal, Mason Stooksbury
Sponsor: Charles Womack, M.D.

Abstract:
Cummins Falls State Park is an idyllic, but rugged, 211-acre day-use park located nine miles north of Cookeville. The area has been a scenic spot and swimming hole for local residents of Jackson and Putnam counties for more than 100 years. Cummins Falls is Tennessee's eighth largest waterfall in volume of water and is 75 feet high. We have designed and implemented a system of hardware and software which serves Cummins Falls visitors and park personnel seeking updates, closures, warnings, and other information. Unlike the park's current website, the application provides immediate notifications about flood warnings as well as the visitor statistics. It also provides notifications related to closures and allows visitors to plan their visit by viewing upcoming closures. This application will serve the needs of those visiting and working at Cummins Falls.

Project Title: Ridership Counter Solution
Faculty Advisor: Gerald Gannod, Ph.D.
Students: Gage Garner, Amela Gjishti, Jorge Ortega Lopez, Jacob Perdue, Daniel Tyler
Sponsor: CARTA (Chattanooga Area Regional Transportation Authority)

Abstract:

The project assigned to us by CARTA (Chattanooga Area Regional Transportation Authority) is a smart passenger counting system using some form of sensors. The current system that CARTA uses is called RiderCheck and has proven to be inaccurate. Ridercheck is the software aspect of the system, the hardware implemented is Infrared Sensors. Our goal with this project was to create a new solution with a higher accuracy rate. We examined several different technologies for counting passengers such as heat sensors, pressure sensors, ultrasonic sensors, motion sensors and also IR sensors. We evaluated the alternatives, and concluded that if implemented appropriately IR sensors offer the best balance of accuracy, cost, and scalability.

Project Title: iMakerTrack
Faculty Advisor: Josh Tinker
Students: Jonah Aberle, Kimberlyn Dunn, Anthony Kniazewycz, Jacob Smith, Trevor Summers
Sponsor: Terry Guo, Ph.D.

Abstract:

The iMakerSpace provides students and faculty at Tech with 3-D printers to use for class projects or personal use. With the growing number of people who want to use these 3-D printers, the iMakerSpace staff needed a system that would help manage the 3-D print jobs as well as store data of these print jobs for data analytics. Our solution was to create a website called the iMakerTrack for both the users who want to submit a 3-D print job and the iMakerSpace staff who manage these print jobs. Unlike the iMakerSpace's current system, the iMakerTrack facilitates 3-D print job submission, organization of the 3-D print jobs, and storing data of the 3-D print jobs.

Project Title: Unum Ticket Analysis
Faculty Advisor: Gerald Gannod, Ph.D.
Students: Susan Jeziorowski, Shaun Starnes, Justin Foster, Mark George, Orlango Wiley
Sponsor: Unum

Abstract:

As the manager of Unum's IT Stability Office, our customer needs a way to analyze ticket data so that they can find ways to be more efficient in their work and reduce the number of tickets they work on as an IT organization. Our solution was to create a website that allows a user to track tickets trends over a specified data range. The types of statistic on the website include the average number of tickets per day, average time to close per ticket, average opened to closed ratio per day, average time to initial contact per ticket, average reassignment count per ticket, and knowledge base coverage percentage over the dataset. Our website features a variety of tables, graphs, and charts to make trend analysis simple and intuitive for our customer.

Project Title: Vokebot
Faculty Advisor: Ania Jennings
Students: Nathan Martindale, Jasmin Baniya, Mitchell Stooksbury, Adam Harms, Antoun Hanna
Sponsor: Aaron Tomson

Abstract:

Meant for people who need hope and connection in their lives, who want to feel better and more deeply connected with their friends, VokeBot is a chatbot meant to recommend inspirational videos that can be shared with a user's friends and spark more meaningful conversations. We have built a front-end for this service as WordPress plugin that other organizations can download and embed in their WordPress websites. This VokeBot plugin connects to the Voke API, and allows people to chat with the

bot, walk through a conversation flow, and get video recommendations all while on a website they may already be familiar and comfortable with.

Project Title: Urban Science Hybrid Application
Faculty Advisor: Bill Eberle, Ph.D.
Students: Jeremy Chosie, Leonard Garrison, Austin Hunter, Alyssa Montgomery, Victor Torres
Sponsor: John Welchance - Urban Science

Abstract:

For employees of automotive dealerships that are clients of Urban Science who need instant nationwide access to inventory, this application is a means of connection and organization that allows quicker and more relevant views of inventory, unlike the current means of pen and paper, our solution is more reliable and faster.

Project Title: UC-Victory
Faculty Advisor: Doug Talbert, Ph.D.
Students: Derek Coblentz, Hannah Hoffman, Luke Lambert, Derek Schafer, Robert Scollon
Sponsor: Doug Talbert, Ph.D.

Abstract:

Due to the rural aspects of the Upper Cumberland region, healthcare providers and patients have a hard time knowing what opioid addiction resources are available. To address this problem, we created a one-stop resource pool for healthcare providers, opioid addicts, concerned family/friends, and resource providers alike. Our website provides easy to understand information about opioid addiction, treatment options specific to the Upper Cumberland area, and a map of addiction resources in the region.

Our site is easy-to-maintain, dynamic, and simple. For healthcare providers and recovering addicts, we created an efficient way for them to find resources in the Upper Cumberland area. For concerned family and friends, we provide resources to help them educate themselves on opioids and help them form a plan. For resource providers, we have a form for them to submit their local resource information to the site, and once approved, will appear on the map.

Project Title: Relatient Natural Language Scheduling System
Faculty Advisor: Mohammad Rahman, Ph.D.
Students: Nathaniel Anderson, Joseph Bivens, Matthew Roberts, Samantha Voss, Cory Young
Sponsor: Relatient

Abstract:

For patients in the digital age who want a more natural, human way to schedule healthcare appointments, the Relatient Natural Language Scheduling System, or RNLSS (pronounced “RainLess”), is a Natural Language and Artificial Intelligence solution that uses Relatient’s self-scheduling system. RNLSS is designed to be more human-like by talking to the users in a more conversational manner, but without the human resource requirement on the other end. Unlike the currently existing HTML5 page, which is just a form page asking for various information and providing dates, our RNLSS allows users to interact more naturally with the system using standard conversations. RNLSS is flexible and provides an intuitive user experience whether patients choose to interact with RNLSS via SMS or over the phone.

Project Title: Automated Ridership Counting System Using Camera Technology
Faculty Advisor: Gerald Gannod, Ph.D.
Students: Amber Patterson, Silvio Mayolo, Dhairya Nishar, Evgeny Vasilyev, Monte Offutt

Abstract:

We are developing a system to track passengers that get on and off the buses used by CARTA in Chattanooga, Tennessee. They currently have an outdated tracking system and want something more reliable. We have developed a tracking system that uses person-detection software on the camera feeds from the buses to see when passengers get on and off. This way we can track the total number of passengers effectively. We are using a neural network that we can train on footage from CARTA's buses, which allows the system to differentiate a human from a pet or inanimate object. We believe the neural network combined with our software could provide an improved tracking system from the one currently being used by CARTA.

Project Title: SAIC Full-Text Search Application
Faculty Advisor: Gerald Gannod, Ph.D.
Students: Jonathan Davis, Landon Michel, Marshall Lambeck, Mustafa Kabakci
Sponsor: SAIC

Abstract:

A typical business application has data that is stored in a structured relational database. In Information Technology Outsourcing, or ITO, we typically use Microsoft SQL Server as a backend data store. When we develop an application, we usually store data to best perform for data entry via a form with relationships and foreign keys, typically down to third normal database form. Most applications have some sort of search form that you fill out to find records. This type of search form can become difficult to use when you have little domain knowledge of the application. As the data set grows over time, this problem grows as well. We will try to make such structured data easily searchable by creating an application capable of performing a full-text search on the data.

For SAIC employees who want to find relevant search results from a database given certain search criteria, SAICSearch is a full-text search solution that provides context-relevant search results. Unlike other search solutions, SAICSearch's full-text search implementation requires fewer queries to get relevant results.

Project Title: Optimizing Real-time Business Intelligence Tool
Faculty Advisor: Gerald Gannod, Ph.D.
Students: Muzakhir Amanzholov, Katherine Brown, Nicholas Hall, Curtis Patel, Robert Roth
Sponsor: Kuan Collins, Ph.D., Scientific Applications International Corporation

Abstract:

For business intelligence officers at Science Applications International Corporation (SAIC) who want a workflow analysis system with performance benchmarking, Optimizing Real-time Business Intelligence Tool (ORBIT) Project is a centralized data processing and analytics tool that will use Splunk ITSI to visualize workflow data, identify trends within the data, and benchmark performance. Unlike the current manual process utilized by SAIC, our solution automates the discovery of performance and workflow trends and notification thereof.

Project Title: Digital Dream Forge Project
Faculty Advisor: Josh Tinker
Students: Nathan Kendall, Blake Smith, Jay Brown, Ismail Abuqudaira, Wade Shaw
Sponsor: Digital Dream Forge (Alan Haugen)

Abstract:

For this project we were given the task of building a management tool. Which will be used to track employees that are out of the office, generate reports for projects and employees. This was achieved by using a Ruby on rails server with embedded JavaScript and CSS. Also using a SQLite3 database that is compatible with the client's current system for easy deployment and integration.

ELECTRICAL ENGINEERING

Project Title: Asphaltene Separation from Crude Oil
Faculty Advisor: Venkat Padmanabhan, Ph.D
Students: Fawaz Alotaibi, Ali Eidi, Osama Elkelany, Jonathan Ghulam, Devin Johnson

Abstract:

With the gradual depletion of “light-oil” reserves, oil companies around the world have begun to exploit heavy-oil reservoirs. These heavy oil reservoirs contain high amounts of asphaltenes. Asphaltenes pose a challenge in crude oil processing as they have the potential to come out of solution and stick to the walls, thereby inhibiting flow by fouling pipelines and storage tanks. Thus, finding a viable solution in order to separate asphaltenes from crude oil would prove economically valuable. In this project, two separation methods are proposed to remove asphaltenes from crude oil: separation by a heptane solvent and separation by nanofiltration. After the separation process, both design methods include a distillation process in which jet fuel is sold as a product and the bottoms waste stream is both recycled and sold as an asphaltene-free crude oil. Both processes were compared based on separation effectiveness and economic analysis after having carried out a total material and heat balance on each process.

Project Title: Strain Gauge ECE 3270 Final Project Creation
Faculty Advisor: Michael Baswell, Ph.D.
Students: James A. Cayton and Roxanne Johnston

Abstract:

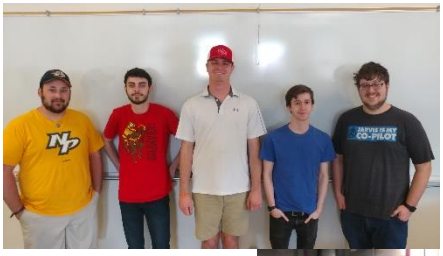
A strain gauge is a special type of measuring device. It is a transducer, to which it converts a mechanical or physical quantity into an electrical quantity. Strain gauges are widely used today in a variety of applications. Just to name a few; smart bridges, car identification (University of California), and train rails. Incorporating strain gauges with a Programmable Logic Controller, PLC, provides a precise way to measure the small resistance changes seen in the gauges with a tool that industrial applications already employ. Thus, allowing students to integrate hands on experience with this technology is a logical step to creating more adept Engineers who enter the job force. We were tasked with the creation of a laboratory experiment for ECE 3270 that will serve as a final project for students to demonstrate their overall knowledge learned throughout the course and to integrate knowledge of thermocouples, the Wheatstone bridge, and the use of analogue input/output PLC modules. Students will apply PLC programming knowledge to measure the resistance change in a strain gauge as different weights are applied to a structure, causing it to bend. Students will apply HMI knowledge to create an interface to the system allowing them to “zero” the scale before use, as well as display values for scale operation verification.

MANUFACTURING AND ENGINEERING TECHNOLOGY

Project Title: NASA Human Rover Exploration: An engineering design challenge changing the future
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Macy Williams, Tyler Wilson, Gordon VanHoy, Justin Finks, Kyle Monnin

Abstract:
NASA's engineering design challenge focuses on current plans to explore planets, moons, asteroids, and comets through advanced surface missions, once the space shuttle has landed on the planet's surface. The challenge's focus is on designing, fabricating, and evaluating technologies for mobility devices to perform in the harsh extraterrestrial conditions that astronauts experience. This provides practical, real world experiences that engage students in critical thinking and the engineering design process, while allowing NASA to observe and review new potential ideas that can be used as the basis for research and development on new technologies that can be used on future missions into outer space. Tech's team participated in this competition for over two decades. While in the past they have been a fierce competitor, recently they have placed lower than expected. This challenged this year's team to design and manufacture a highly competitive rover. We put an entirely new twist on the rover design this year, straying from complicated suspension and parts to simple and durable components in hopes to see fewer failures during the running of the course this April. Along with a simpler suspension design, the middle latch of the rover has been completely rebuilt to avoid failures and motion in the frame. Higher quality components such as bearings and gearing systems have also been added this year, contributing to our confidence and helping to ensure the team to place higher than previous years.

Project Title: Tracking of Livestock Using Connective Technology
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Christopher Bennett, Austin Kiger, Matthew Warner, Jacob Kennedy, Kurtis Boehms



Abstract:
Spraying livestock with an insecticide every two weeks is crucial in keeping away flies and pests. This is often a time consuming, but necessary task. Livestock must either be sprayed all at once, or a log must be manually written to keep track of which animals have been sprayed and when they were sprayed. The goal of this project is to develop a fully self-sustaining mineral feeder equipped with sprayers that will automatically spray approaching cattle, if needed. Data will be collected and updated each time cattle visit through the use of a privately-owned server, database, and network. In addition, with livestock thievery becoming a more prevalent issue, two security features will be implemented: a live camera feed embedded on the website, and detailed weekly email updates on cattle who have not visited the mineral feeder within two weeks. The core of this project will be achieved by outfitting the mineral feeder with a Raspberry Pi and Y-Tex RFID reader.

Project Title: Increase production rate of the Biodiesel Using a Solar Powered Thermally-Efficient High-yield Ultrasonic Processor
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Anthony Taylor, Caleb Parker, Kareem Williams, Robbie Mannankara, Warren Klapp

Abstract:

Production of biodiesel from waste vegetable oil is an economical, and benign environmental option to use as an alternative energy source and reuse of waste vegetable oil. This study has two objectives. First, increasing the production rate biodiesel using sonication to reduce the processing time and utilizing a high voltage to reduce the biodiesel/glycerin separation time. Second, reducing the energy needed for the production of biodiesel using solar energy beside electric energy. The processing rate will be improved using a Raspberry Pi 3 Model B in place of the current Arduino Mega for better process control. This will allow simultaneous tasks to be executed. Furthermore, with the addition of larger diameter piping will allow for higher rates of fluid to be transferred from storage containers. With the addition of a second separation tank to increase the amount of separation of the biodiesel and glycerin mixture. This paper will discuss the improvements and suggestions for future improvement.

Project Title: Development of a Hybrid Water Desalination System
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Brandon McMahan, David Beaty, Devin Scott, Nicholas Byrd, Nhan Nguyen

Abstract:

With the scarcity of freshwater in some parts of the world, water desalination is becoming a necessity. Water desalination is a process that converts saltwater into drinkable potable freshwater is becoming human necessity. The ultimate goal of this project is to develop a hybrid-water desalination system using vacuum tubes solar collector and supplemented by electrical energy. We will be using thermal evaporation/condensation method. The water evaporator is a modified 40-gallon water heater in which we inserted a copper coil and pumping glycol to a vacuum tube solar collector located on the building roof. Through solar radiation, the vacuum tubes heats up the glycol which in return heats up the seawater in the 40-gallon hopefully to boiling temperatures. The tank is also equipped with two inserted heating elements to supplement the solar energy needed for evaporate the seawater. The boiling tank is further equipped with two insulated drum heater - fixed Temp 145° F as a supplement heat source on the evaporation thank. In the condensation tank, the water vapor flowing in another copper coil heat exchanger will be cooled by the seawater being pumped from the source, causing the vapor inside the tube to condense and be stored separately from any brine byproduct. The timing of the pumps, solenoid pumps, heating elements and other system components controlled by a Raspberry Pi controller.

Project Title: Design and Implementation of Safety Solution for Hands off Lathe Machining of Torque Converter Hubs
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Justin R Brown, Chelse Smith, Austin Ochi, Christian Molina and Wyatt Gravitt

Abstract:

TRANSTAR DACCO is a Re-Manufacturing company specifying in Torque Converters here in Cookeville, Tennessee. The company has been a historically unsafe environment relative the industry's standards. The team's goal was to improve company safety by implementing light curtains and a hand off approach to polishing the converter hub on a lathe. Our design consists usage of various burnishes, a cleaning tool and an automatic lubricator for the tool. The lathe will not be able to operate if the light curtain is broken. All polishing and machining will be done away from moving parts preventing injury to the operator.

Project Title: Design and Metal Casting of the Tau Alpha Pi Honors Society Emblem
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Niki Cherry, Hunter Hinshaw, John Mackel, Tony Patterson II, Jarred Smith

Abstract:

Tau Alpha Pi is the National Honor Society for engineering technology. It is fostering Excellence in Engineering Technology Education. The MET Department's Tau Alpha Pi chapter was just approved as a Tech student organization in fall of 2017. The goal of this project is to design and create the Tau Alpha Pi Emblem to be placed in front of Lewis Hall. The dimensions for the emblem were received from Tau Alpha Pi national organization. This project will involve 2-D and 3-D solid model designing and pattern printing and casting an aluminum and bronze alloy Honor Society Emblem. Using the networking of the Manufacturing Engineering Department's American Foundry Society, Tech Chapter, our team was able to contact a High Tech Foundry in Arkansas, which has the ability to cast the larger pieces of the Emblem. Our group will be responsible for casting the remaining pieces of the Emblem here at Tennessee Tech. Nowadays, foundries are using newer, more abstract means of patterning molds for metal casting. Recent developments in additive manufacturing and robotics are being implemented as a replacement for traditional mold making techniques. The construction of the Tau Alpha Pi emblem for display in front of Lewis Hall will utilize these new techniques. Additively manufactured patterns and robotic milled molds will be utilized in the metal casting process. Casting will occur both on Tennessee Tech's campus and off-site at Southern Cast Products in Jonesboro, Arkansas. The manufacturing of the Tau Alpha Pi emblem takes traditional methods and combines them with innovative techniques to produce an accurate, near-net-shape product.

Project Title: Automation of Nutrient Injection System in Hydroponics System
Faculty Advisor: Ahmed Elsawy, Ph.D.
Students: Hannah Burns, Michael Colby, Austin Ribley, Daniel Schlenker, Garrett Thompson, Elijah White

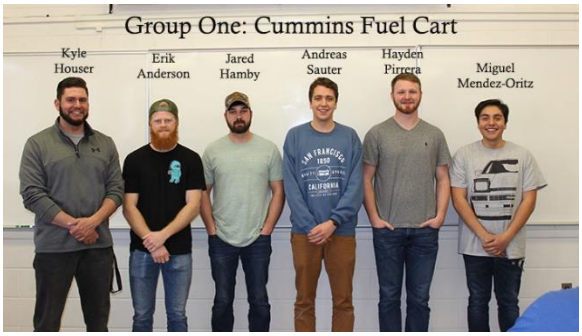
Abstract:

Hydroponics is the cultivation of plants by placing the roots in liquid nutrient solutions rather than in soil. It is mainly used by farmers who live in areas where the environment may not be conducive to traditional farming like arid places or places with nutrient-lacking soil. The one thing that is very different about hydroponics compared to traditional farming is the fact that the nutrients that are normally already present in the soil must be added to the water that the roots are being kept in to grow successfully. Farms that currently use hydroponics must manually provide the nutrients for the water, which requires them to test the pH (acidity of the water) and EC (the nutrient presence). These tests must performed very often and regularly, which can be a hassle to farmers who grow a larger volume of crops. Farmers must also regulate the flow of water through the plants' roots; if water sits too long algae will grow and kill the plants, but if the water flows too quickly the plants won't absorb enough nutrients, causing them to die. The ultimate goal of this project is to fully automate the testing process and monitor the pH and EC and adjusting them accordingly in the water flowing through the plants' roots. We will be using a Raspberry Pi to program the pH and EC sensors that will sit in the water-holding tank. The nutrients will then be introduced to water in the correct water to nutrient ratio, which is determined by the program we write. Once the water pH and volume of nutrients are correct, the water will be pumped through the plumbing system that holds the plants in a way that allows the roots to hang down in the flowing water. The water will drain back into the holding tank in such a way that the plants will be able to absorb the nutrients but no algae will start to grow. We want this

system to be user friendly and effective in a way that allows farmers with no tech background to be able to run the system with success.

MECHANICAL ENGINEERING

Project Title: Cummins Hedgehog Fuel Filter Cart
Faculty Advisor: Meenakshi Sundaram, Ph.D.
Students: Erik Anderson, Jared Hamby, Kyle Houser, Miguel Mendez Ortiz, Hayden Pirrera, Andreas Sauter

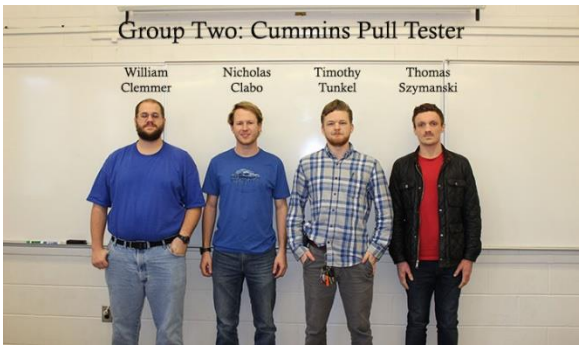


Abstract:

Cummins Filtration is a branch of the Cummins Incorporated that is based in Cookeville, Tennessee. They are in the process of testing the ninety five liter “Hedgehog” locomotive fuel filtration system and have proposed their dilemma of transporting the large filter housing within their facility. The filter housing has a wet weight of one-thousand one-hundred pounds when it is full of diesel fuel, so a hurdle that needs to be addressed is the transportation of this heavy housing safely and efficiently. Another feature Cummins has requested to be implemented on the cart is the ability for the housing to be elevated to a standard desk height which would allow for more ergonomic interaction when servicing the filters and connecting fuel lines. The last requirement Cummins gave was the ability for the housing to be tilted ten degrees to allow for the drainage of all diesel fuel in the housing when filters are changed.

The overall goal with this project is to develop a form of transportation for the Cummins Hedgehog fuel filter system that will safely and efficiently transport the setup around the facility, provide a mode of lift to the housing for an ergonomic platform to work with, and allow for ten degrees of tilt to aid in maintenance.

Project Title: Cummins Pull Tester
Faculty Advisor: Meenakshi Sundaram, Ph.D.
Students: Nicholas Clabo, William Clemmer, Thomas Szymanski, Timothy Tunkel

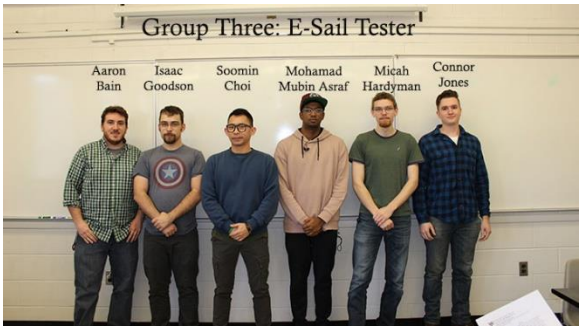


Abstract:

Cummins Filtration is a branch of Cummins, Inc., which manufactures and distributes industrial-sized diesel engines and related components. Located in Cookeville, TN, Cummins Filtration assembles the fuel filters which are used in conjunction with these diesel engines. These cylindrical fuel filters are composed of arrayed filter media sandwiched between plastic end caps on either side of the filter. Epoxy is the bonding agent used to hold the end plates to the material, but time has shown that the bonding process is not always perfect. After the filters are expended, they must be removed from their respective housing by the end user. The issue, however, is that when the filter handle is pulled to change out the filter, the end cap can potentially separate from the filter media. This renders the remaining filter media and second end cap stuck within the filter housing. The epoxy is the apparent culprit. It is believed that it is not curing properly, nor being evenly distributed on the end caps.

Our filter pull tester aims to catch this problem before the filters are sent off to the customers. With the utilization of pneumatics, load cells, and other components, we are proposing to fabricate a device to apply a test load on each filter that comes off the assembly line. With a filter production cycle time of approximately two minutes, our filter pull tester will have a sufficient period to carry out the quality checks of 500 N (112.40 lbs.) of force. With the user in mind, ergonomics has played a key role in our design. Repeated lift of these filters can quickly become a physically demanding task. Our goal is to fabricate a device which will allow Cummins Filtration to deliver a superior product to their customers and render failing filter end caps a thing of the past.

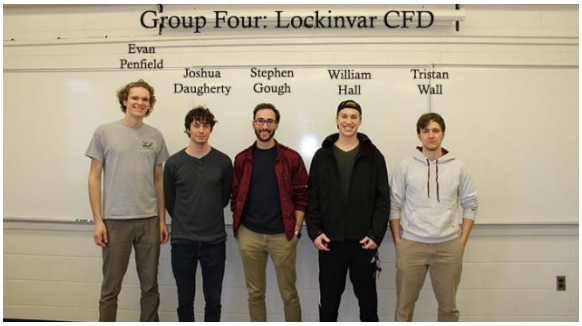
Project Title: NASA Electric Sail Tether Deployment System
Faculty Advisor: Meenakshi Sundaram, Ph.D.
Students: Mohamed Mubin Asraf, Aaron Bain, Soomin Choi, Isaac Goodson, Micah Hardyman, Connor Jones



Abstract:

Tennessee Tech has been participating in the Heliopause Electrostatic Rapid Transport System (HERTS) Electric Sail project led by NASA Marshall Space Flight Center. In Phase II of the NIAC HERTS project the goal is to have working proof-of-concept models in the form of nano-satellites or CubeSats demonstrate tether deployment in space before the mechanism is attempted on a full-scale probe. Tech has developed a simulation model for tether deployment under various conditions but further experimental verification of the models is needed. This needs to be accomplished through the building of a small satellite model that can successfully manage a tether reel-out demonstrate. An appropriate tether reel-out mechanism, satellite positioning system, and thruster system need to be developed in a CubeSat form factor. The goal of the Senior Design project is to develop a working CubeSat model to test tether deployment first at Tech facilities and ultimately, at Marshall Space Flight Center's Flat Floor 2-dimensional satellite and robotics test facility. Upon completion of the project, the prototype should provide: data concerning tether deployment velocity and tension profiles for validation of NASA's simulations, evaluation of tether deployment and damping strategies, a working control system for the CubeSat positioning and deployment in a micro-gravity environment. The prototype should fit within a standard 12U CubeSat launcher so that all components could be transferred to or developed for a low orbit test mission.

Project Title: Lochinvar Light Industrial Fire Tube
Faculty Advisor: Meenakshi Sundaram, Ph.D.
Students: Joshua Daugherty, Stephen Gough, William Hall, Evan Penfield, Tristan Wall



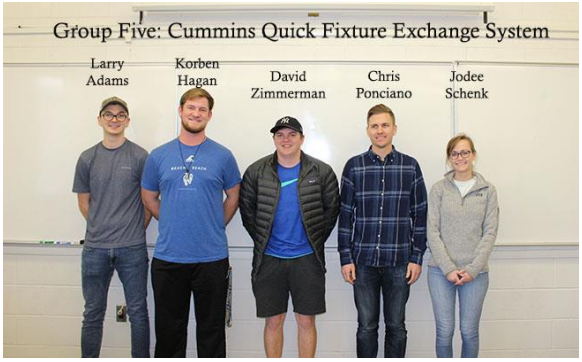
Abstract:

Lochinvar LLC is a producer of high efficiency, high quality condensing water heating systems. They are interested in producing an even more efficient water heater, and are our acting sponsors for this design project. Their current light industrial water heaters are 96% thermally efficient, but Lochinvar would like to push that efficiency even further as there are no heating systems currently on the market that offer higher efficiency. In essence our task is to generate a new fire tube design to further increase the efficiency. The most significant issue for us with this project has been learning to effectively

use the fluid simulation program Ansys Fluent. This is a very complex program with a bevy of features and abilities, and thus is very challenging to become versatile with.

The final objective is to design a new fire tube that utilizes novel design concepts to increase the thermal efficiency of Lochinvar's light industrial grade water heating systems. The new tube design will need to conform to the length, end-diameter, thermal loading, pressure, etc., of the current tube design. In addition we would like to fabricate a model of the new pipe. While it may differ from any potential final product as Lochinvar's fabrication process is quite expensive this would at least give us an idea of the tube's tangible dimensions. This is so that the entire heating system does not need to be designed so as to accommodate the new tube design.

Project Title: Quick Fixture Exchange System
Faculty Advisor: Meenakshi Sundaram, Ph.D.
Students: Larry Adams, Korben Hagan, David Zimmerman, Chris Ponciano, JoDee Schenk



Abstract:

Cummins filtration is a manufacturer of diesel engine components specifically: air filters, oil filters, and fuel filters. Their filters are used in numerous diesel engines as well as some machinery. Cummins tests the efficiency of their fuel filters using a device to run fluid through the filter material. This device is called a multipass stand.

Our challenge is to design a quick fixture exchange system that will make testing multiple housings more time efficient and single operator friendly. The design will be able to hold two housings and be able to rotate into set positions, allowing the housing to purge air. It will also allow them to run a multitude of different configurations (ie. sizes, rotation angles) that they haven't been able to run with their current set-up. At the moment, in order for Cummins to test more than one housing, they have to attach a bracket from the first housing to the second making them both fixed. As well as testing multiple of the same size housing, there is a larger housing that needs to be tested simultaneously with the first housing. Currently there is no device that allows the larger housing to be attached to anything so it is normally placed on the counter and ran. Our device will allow for multiple configurations of sizes and rotation angles to be run simultaneously.

Project Title: Baja SAE CVT Case
Faculty Advisor: Dale Wilson, Ph.D.
Students: Isaac Baird, Ryan Grijalva, Kade Howard, Anthony Kratz, Megan Rawls, Dakota Smith

Abstract:

The Baja SAE Collegiate Design Series pits collegiate-level teams across the nation in a performance, design, and presentation driven competition to push the next generation's engineers to create and gain real life experience in engineering problem solving by constructing a vehicle. The Tennessee Tech Baja vehicle has many components, and takes just as many engineering team members to solve the issues from the chassis to the roll cage to the all-important continuously variable transmission (CVT) case. The method used to design and create the CVT was design optimization. Since the CVT is not a new invention, the design came into fruition based on the team's previous engineering and Baja vehicle building experience. The design that was chosen was proven to be the easiest to manufacture, modeled in Ansys Fluent to be the most efficient when in use on the Baja vehicle, and will meet the customer's needs. The CVT case will be fabricated by

the Baja CVT Case Team out of aluminum, and used in the two spring Baja competitions that Tennessee Tech University is participating in 2018.

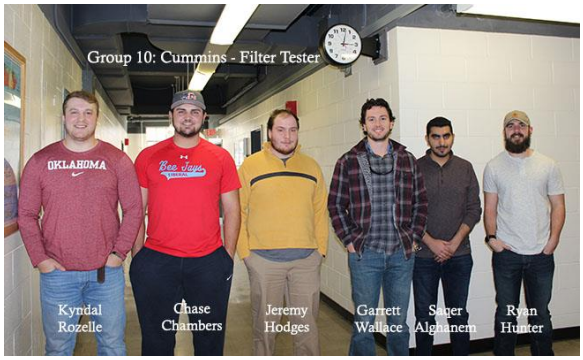
Project Title: Baja CVT
Faculty Advisor: Dale Wilson, Ph.D.
Sponsor: Dale Wilson, Ph.D.
Students: Patrick Feiten, Daniel Jonynas, Viktor Dimitrovski, Cody Jones, Caleb Goodson, Caleb Walker

Abstract:

Dale Wilson, Ph.D. and the Baja team here at Tennessee Tech are interested in modifying the continuously variable transmission (CVT) transmission on the Baja car to make it shift gears quicker and more precisely. Wilson is also the sponsor for this project. Currently, there really aren't many teams who are working with an electric CVT transmission on their Baja cars, so this will be a very interesting opportunity for everyone involved, although it will be a challenging task. There are several issues to overcome, such as creating a reliable electronically controlled mechanism, and programing it to work in the most efficient way possible.

The objective of this project is to do just that; create an updated version of the CVT mechanism that is reliable and that can possibly be installed on the Baja car at some point in the future. The CVT needs to be as reliable as the current setup and needs to be able to shift gears quicker with the ability to have different "tunes" and shift patterns programmed via a computer. Some other characteristics of this mechanism include a reliable actuator, and a reliable microcontroller that can be programmed to run different shifting patterns for successfully creating this electronic CVT mechanism.

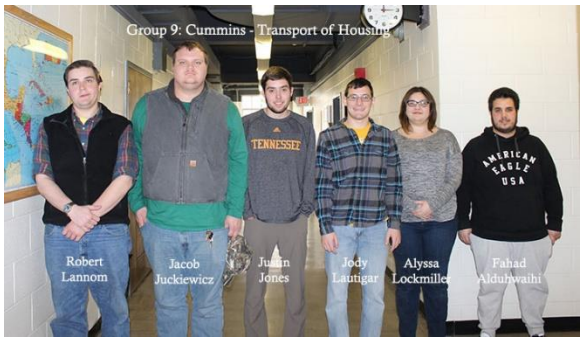
Project Title: Cummins Filter Tester
Faculty Advisor: Dale Wilson, Ph.D.
Sponsor: Cummins Filtration
Students: Kyndal Rozelle, Chase Chambers, Garrett Wallace, Jeremy Hodges, Ryan Hunter, Saqer Alghanem.



Abstract:

The Cummins Filtration facility located in Cookeville is responsible for manufacturing diesel, hydraulic, air, and oil filters. Cummins Filtration is in the process of designing a new fuel-water separation filter that fits inside a large 95-liter locomotive engine. Cummins is experiencing difficulties with filters seizing inside their housings due to swelling of O-rings attached to the filter. This issue causes the removal force of the filter to increase to approximately 100 pound-force, or 500 newtons, during routine maintenance of the engine. Cummins Filtration has requested the design team to build an end-of-line tester capable of applying a tensile force to verify the strength of an epoxy bond between the filter media and the filter's plastic end plates. Cummins also requests a cycle time of 30 seconds and the ability to provide a force vs. time graph for further analysis. In addition, the test mechanism needs to be adjustable to accommodate variations in diameter and height. The current iteration of the tester will be semi-automatic, requiring some manual control by operators, but further automation potential is factored into the design.

Project Title: Filtration Housing Transport
Faculty Advisor: Dale Wilson, Ph.D.
Sponsor: Cummins Filtration
Students: Fahad K. Alduhwaihi, Justin M. Jones, Jacob L. Jurkiewicz, Robert M. Lannom, Jody Lautigar, Alyssa F. Lockmiller

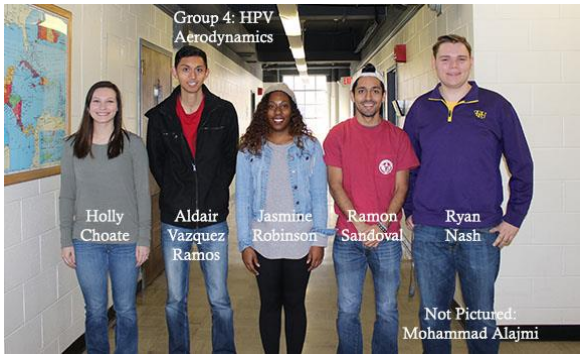


Abstract:

Cummins filtration are developing a new filtration housing for a locomotive and require a transportation device for the unit. They are sponsoring a project to develop a transportation device for the filtration housing. Cummins needs to have the transport hold the housing during testing and maintenance. There is nothing on the market currently to meet the needs for transporting the housing, so designing a system will be a unique but difficult challenge.

The final goal of this project is to design and build a transportation system for a prototype filter housing. The system must be able to lift and tilt the housing for testing and maintenance. A drip pan is also required for the catching of excess fluid. Motorization is also preferred to ease transport as well. The critical goal of the design is to create a safe and useful transportation device for the filtration housing.

Project Title: HPVC Aerodynamic Team
Faculty Advisor: Dale Wilson, Ph.D.
Students: Mohammad Alajmi, Holly Choate, Ryan Nash, Aldair Vazquez Ramos, Jasmine Robinson, Ramon Sandoval



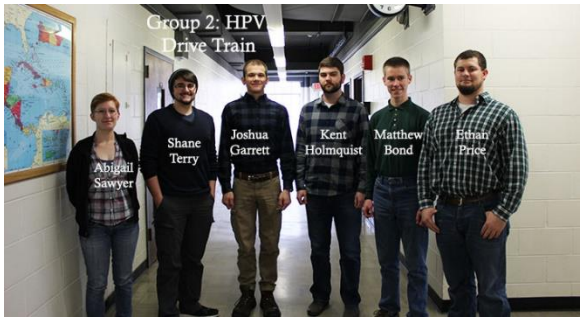
Abstract:

The American Society of Mechanical Engineers (ASME) holds a human powered vehicle competition at the E-Fest every year in the East and West regions of the United States. Last year the Tennessee Tech chapter of ASME competed with a design team of five members and placed 14th overall. Our sponsor, Dale Wilson, Ph.D., would like for this year's team to place higher with 3 separate teams being devoted to drive train, frame and aerodynamics. Concurrent design will ensure that the best design will be achieved through innovation and iterative design for each team.

The objective of the aerodynamics team is to create a competitive package for the team vehicle in the ASME HPV Competition that will minimize air resistance and maximize the speed capability. The aerodynamics package must be lightweight and be able to attach to the existing frame without detracting from the safety precautions taken for each driver. Forming and creating the most efficient shape to protect the driver from the elements and manipulate air currents in a unique system will be the main focus of the project.

Project Title: Human Powered Vehicle Drivetrain System
Faculty Advisor: Dale Wilson, Ph.D.
Students: Ethan Price, Shane Terry, Matthew Bond, Kent Holmquist, Josh Garrett, Abigail Sawyer

Abstract:

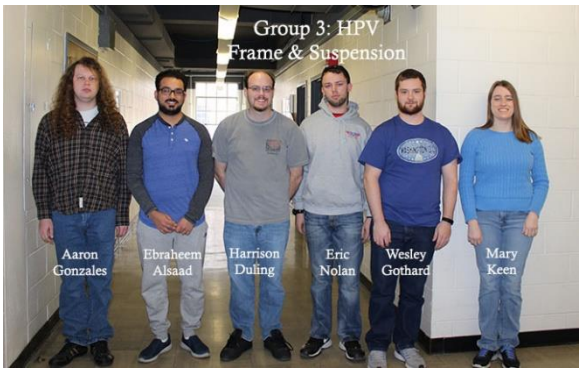


American Society of Mechanical Engineers (ASME) holds a human powered vehicle competition at the ASME E-Fest every year in the East and West regions of the United States. Last year the Tennessee Tech chapter of ASME competed with a design team of five members and placed 14th overall. Our sponsor, Dr. Wilson, would like for this year's team to place higher with 3 separate teams being devoted to drive train, frame and aerodynamics. Concurrent design will ensure that the best design will be achieved through innovation and iterative design for each team.

The objective of the aerodynamics team is to create a competitive package for the Tech's team vehicle in the ASME HPV Competition that will minimize air resistance and maximize the speed capability. The aerodynamics package must be lightweight and be able to attach to the existing frame without detracting from the safety precautions taken for each driver. Forming and creating the most efficient shape to protect the driver from the elements and manipulate air currents in a unique system will be the main focus of the project.

Project Title: Human Powered Vehicle Frame
Faculty Advisor: Dale Wilson, Ph.D.
Students: Ebraheem Alsaad, Harrison Duling, Aaron Gonzales, Daniel Gothard, Mary Keen, Eric Nolan

Abstract:

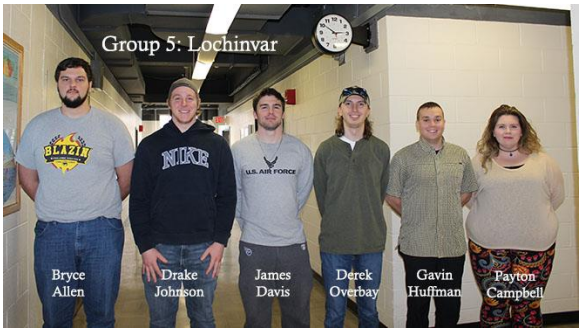


The Human Powered Vehicle Challenge (HPVC) frame team was tasked with designing a frame for the Human Powered Vehicle (HPV) to compete in the American Society of Mechanical Engineers (ASME) HPVC in the spring of 2018. The frame team had to work alongside two other HPVC teams, the drivetrain team and the aerodynamics team, in order to create a vehicle that would compete and be judged in four events: design, innovation, speed race, and endurance race.

The ASME HPVC has several sets of safety rules and guidelines that the HPVC team put in the forefront of the frame's design. Other major factors for design considerations were driver ergonomics and power output. Decision-making matrices were used during the design processes to decide several design parameters. Software packages such as Inspire, Solidworks, and ANSYS were used to create virtual models to test different design options. The final frame design specified that the frame be made of 4130 steel and put the driver in a semi-recumbent position.

Project Title: Lochinvar Super Tube
Faculty Advisor: Dale Wilson, Ph.D.
Sponsor: Lochinvar
Students: Bryce Allen, Payton Campbell, J.R. Davis, Gavin Huffman, Derek Overbay, Drake Johnson

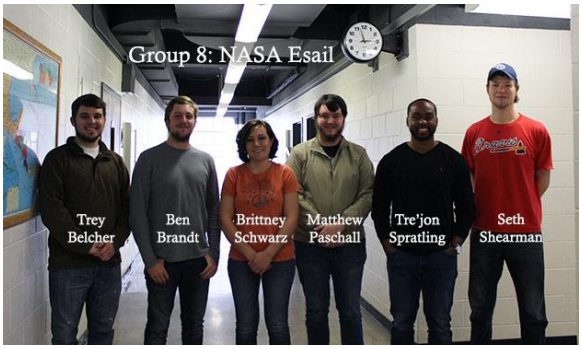
Abstract:



The purpose of the project was to help identify the next generation of “fire tube” for Lochinvar’s residential platform. The goal is to design a new fire tube that has an efficiency of at least 96%. This will place Lochinvar at the forefront of the high efficiency residential water heater market. Computational Fluid Dynamics was used to help determine geometry design and test its functionality against the given constraints. The greatest driving force in the design choices of the new fire tubes was the need to increase the surface area of the tubes while ideally maintaining the same size constraints as the previous design. In order to increase the efficiency of the boilers, the heat transfer rate of the tubes needed to be increased. The heat transfer rate is defined by the equation Q = uA(T2-T1), and, provided the constraints given, the easiest and most versatile variable to alter was the surface area, as an increase in surface area results in a direct increase in heat transfer.

Project Title: NASA HERTS E-sail Tether Deployment System
Faculty Advisors: Stephen Canfield, Ph.D. and Dale Wilson, Ph.D.
Students: Seth W. Shearman, Tre’jon C. Spratling, Benjamin F. Brandt, Brittney N. Schwarz, Matthew K. Paschall , Trey R. Belcher

Abstract:



The NASA HERTS (Heliopause Electrostatic Rapid Transit System) or E-sail concept describes a method by which a satellite can be propelled by solar wind via a charged tether. The tether lengths can be in excess of 10km and require accurate positioning of their end modules for system feasibility. This accuracy is difficult to achieve due to the significant length and low mass of the tethers. The tether assemblies must conform to strict velocity and tension profiles to maintain stability in a microgravity environment. A two dimensional model is to be constructed that will verify the ability to launch these bodies apart in a controlled manner. The primary objective of this project is to gather data for the validation of a dynamic system model, assess alternative deployment strategies, and evaluate tether reel-out control strategies. The general layout of this project consists of two 6U CubeSats mounted on air bearings and connected by a tether. The tether’s deployment is controlled by a damping device on the reel and an inline friction device. The air bearings allow the model to simulate a 2-D microgravity environment. The pose is controlled by brushless propellers and monitored by a visual tracking system. The key tests to be performed are 1-D and 2-D deployment of the CubeSat for dynamic model validation.

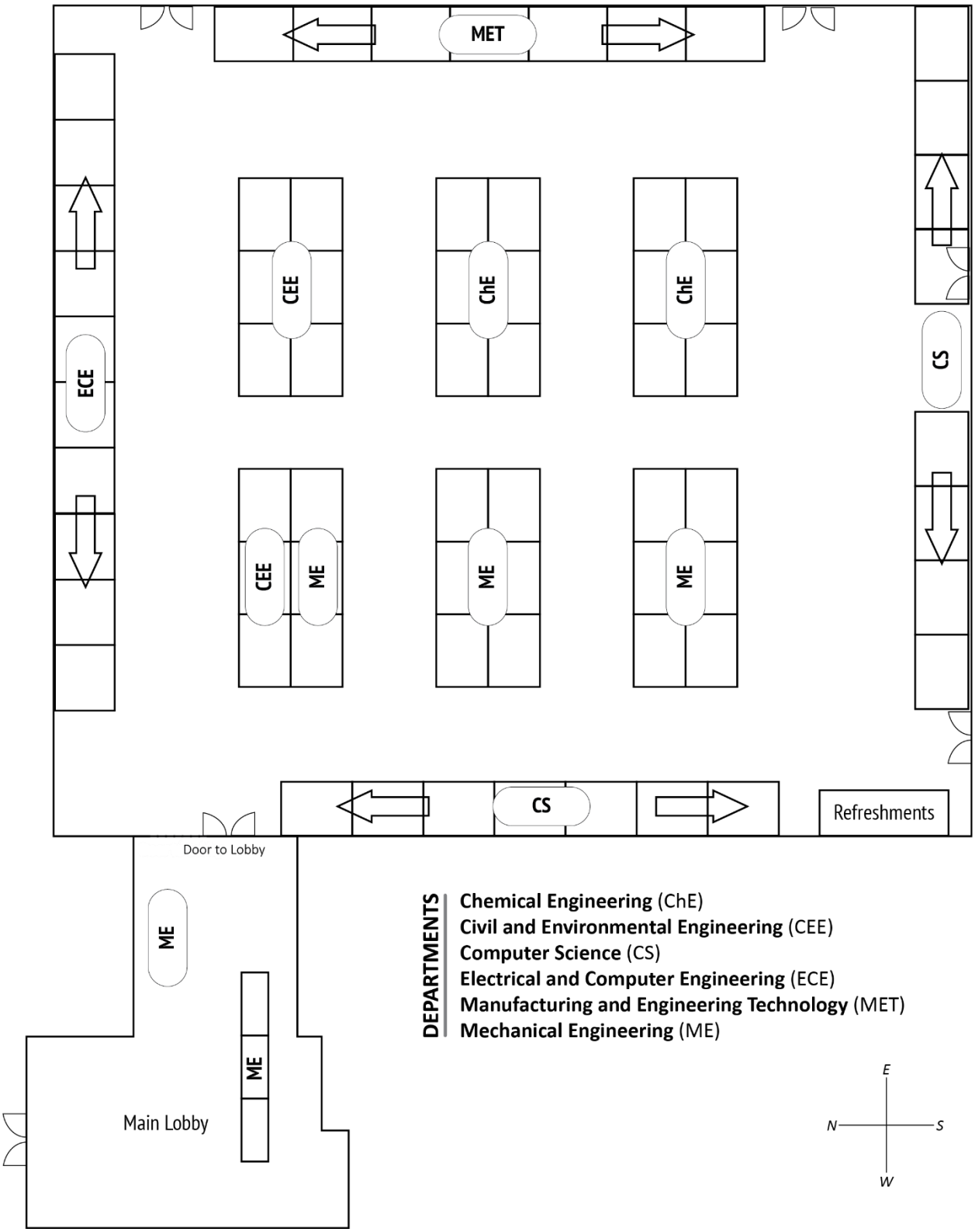
Project Title: Project Regrind
Faculty Advisor: Dale Wilson, Ph.D.
Sponsor: Tennessee Tech Sustainable Campus Committee
Students: Chas Davies, Cody Long, Madison Dittner, Roya Eatebarian, Brad Wright, Ace Staton
Abstract:

Over the past few semesters, Tennessee Tech has pushed for one thing from the engineering department: Innovation. To accommodate this push, the university has given students access to a maker space, with the most used items being the 3-D printers. The main issue that has arisen is that the university is at a point where students now have to be charged for this service. The team knew that there had to be a way to overcome this problem. From this, Project Regrind was created.

The objective of Project Regrind is to find a sustainable method of making filament. With Tech being a very active center of recycling, it was quickly decided that water bottles could be used as an essentially endless resource. The bottles are taken directly from the recycling bin and processed all the way to extrusion. The process is performed completely in house to ensure that the service remains free to students. Due to the type of plastic that water bottles are made from (Polyethylene Terephthalate), the entire process has to be very fine tuned as this plastic is not as forgiving as the traditional plastics used in 3-D printing filaments.

To accommodate these needs, the project was broken up into three smaller subprojects: Temperature Control, Cooling, and Preparation and Storage. Each sub-team worked diligently to fix all issues associated with these sections, which led to the proper plastic extrusion, and in turn, spools of 100% recycled plastic 3-D printable filament.

Innovation Showcase 2018 Floor Plan by Department



DEPARTMENTS

Chemical Engineering (ChE)
Civil and Environmental Engineering (CEE)
Computer Science (CS)
Electrical and Computer Engineering (ECE)
Manufacturing and Engineering Technology (MET)
Mechanical Engineering (ME)