SHOWCASE 2023

A hybrid event highlighting senior design projects and student achievements

MICHIGAN STATE UNIVERSITY
Department of Biosystems and Agricultural Engineering

The Biosystems Engineering (BE) Showcase is a long-standing highlight of the BE calendar. The feature of the day is the presentation of final design reports from our two-semester senior capstone design projects: these projects are the culmination of our students' undergraduate program. Showcase brings together the entire BE community — student teams, project clients, our Industry Advisory Board, faculty, other BE students, and friends and family — to get a brief glimpse of the final design reports from these projects.

In a year that has continued to involve special challenges, we are proud of our students for persevering in their coursework, especially in senior design. I also want to express my deep appreciation to Drs. Dana Kirk and Luke Reese for managing senior design, to all the faculty advisors for the project teams, to the project clients for supporting our program, and to our Industry Advisory Board – whose expert insights, support, and evaluation of the projects are mission-critical to our overall program success and meeting our accreditation requirements.

Thank you!

Bradley Marks, Ph.D., P.E.

Professor and Department Chair

BE Senior Design is a unique, two-semester experience that prepares students for successful careers solving challenging problems in food, energy, environment and health. In Senior Design, teams of three to five students are paired with real-world clients to work on an actual issue the client is facing. With the help of a BE faculty mentor, these teams work with their client to come up with a solution for the problem using the technical knowledge they've accumulated during their time at MSU. Students also develop skills in teamwork, project management and communication.

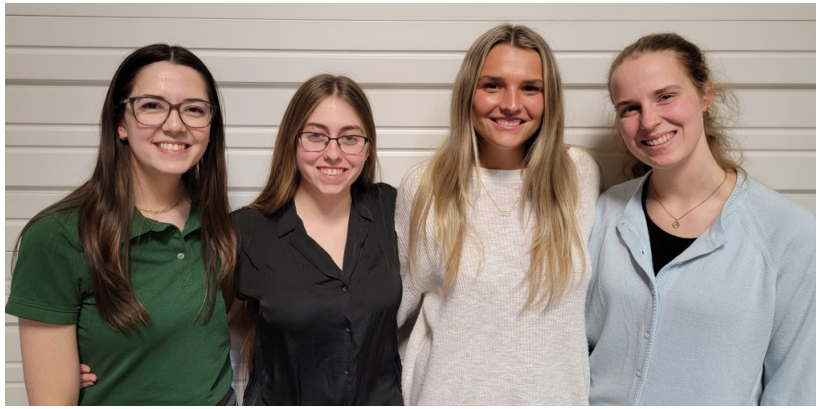
The nature of the two-semester structure allows students to take a deeper dive into a project and establish a stronger relationship with their team and client, similar to an industrial co-op. The extended time on the project allows the students to become more knowledgeable about the specific problem and solutions they're working to address. In addition, students experience a more realistic ebb and flow of team and client dynamics that prepare them for the start of their professional career. As an instructor, there's nothing better than seeing your students' hard work come to fruition. It's always exciting when our Senior Design students see their work implemented by clients — and sometimes, receive job offers from them. We're honored to lead this course and eager to share all of the hard work our students have put into their projects over the course of this year.

Dana Kirk, Ph.D., P.E.

Associate Professor

Luke Reese, Ph.D.

Associate Professor



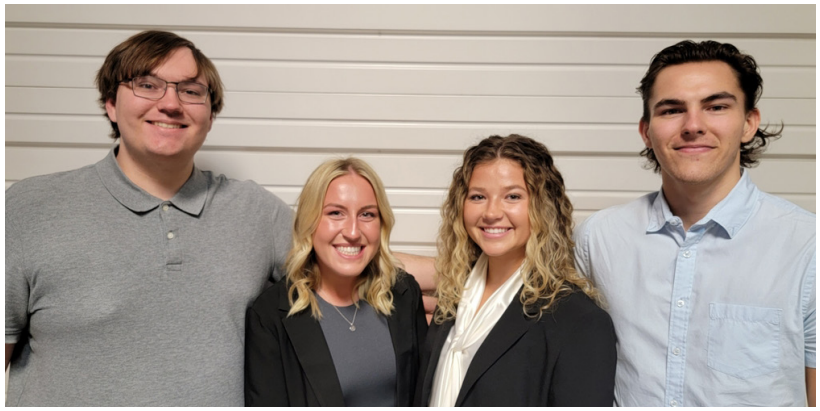
(L to R) Christina Berels, Chloe Zaborney Kline, Jordyn Gerdes, & Anna Burgess

Optimizing Ultrasonic Aspirator Settings to Maximize Viable Cell Extraction

Team Stryker 1

Sponsor: Stryker (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Vangie Alocilja & Dr. Ilce Medina Meza

Brain tumors affect over 25,000 adults annually, with a 5-year survival rate of only 36%. Early and accurate pathological diagnosis is essential to a successful fight against cancer. An ultrasonic aspirator is commonly used to resect brain tumors. It is designed to fragment, emulsify, and aspirate tissue using a handpiece with a vibrating tip. Stryker desired to investigate using the device for the dual purpose of resection and viable tissue extraction for pathology. The design goal was to measure these settings on the viability of resected tissue. Preliminary tests were done on oranges, chicken livers, and pig brains, mimicking important aspects of brain tumors.



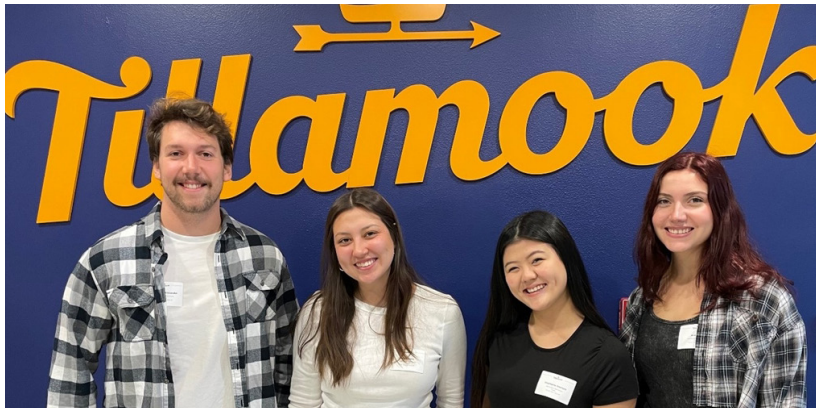
(L to R) Adam Easter, Emeline Pioch, Mary Borowski, & Jack Westerkamp

Tissue Pathology Viability Testing After Ultrasonic Aspirator Extraction

Team Stryker 2

Sponsor: Stryker (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Ilce Medina Meza & Dr. Vangie Alocilja

700,000 Americans are currently living with a brain tumor. Stryker 2's design objective was determining the best kit for determining and quantifying the viability of resected cell levels. An experiment was constructed using two kits in tandem to first extract cell DNA, and second to determine cell viability based on the DNA state. A series of experimental treatments condensed and isolated the DNA before the use of reagents to further promote DNA extraction. A final reagent was added to react with the three major types of guanines, which are released upon a cell's death. This was mixed and prepped with an orbital shaker before being analyzed. Using this data, it can be determined if the cells were still viable from each sample. This data provided Stryker 1 with the efficacy of performance for both the tips and settings used. The final design for this process used the protocols defined in the kit with some minor modifications.



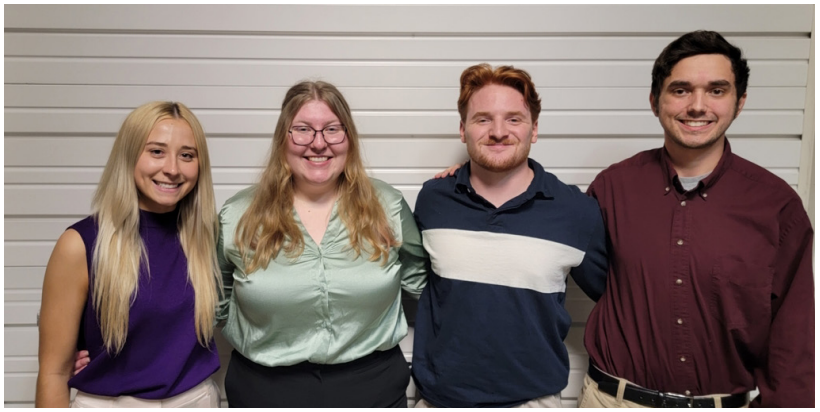
(L to R) Ben Alexander, Kate Mann, Stephanie Nomoto, & Ava Borri

Whey Protein Concentration Process Evaluation and Predictive Modeling to Control Yield

Team Tillamook

Sponsor: Tillamook (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Bahar Aliakbarian

The team partnered with Tillamook to evaluate their whey protein concentrate (WPC) process line. Cheesemaking produces a liquid whey (LW) byproduct, which is filtered and dried to produce WPC. The fundamental goal of this project was to improve the efficiency and consistency of WPC yields by identifying causes of variation and optimizing the concentration process. The team performed a mass balance over the entire LW to WPC process. A regression analysis on each variable determined that the LW's initial protein content was the best indicator of final yield. Using 2020 data, the team developed Visual Basic code to automate features of a predictive model on MS Excel. Operators can use the model to make faster and more informed adjustments to machine settings instead of the traditional "guess-and-check" system.



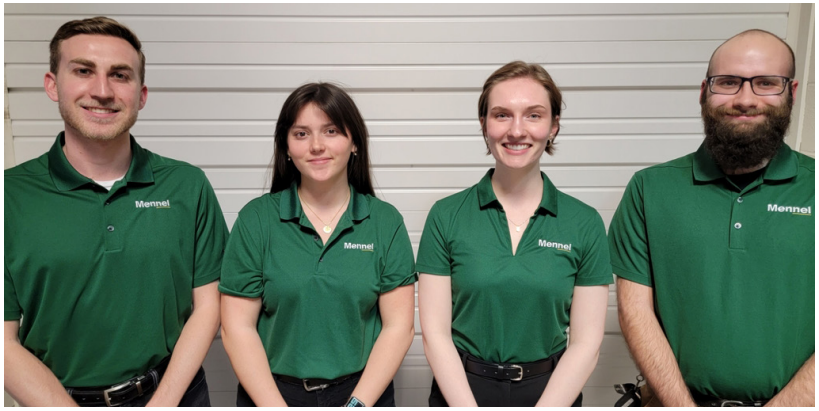
(L to R) Claire Kolar, Kate Wernicke, Marshall Humphrey, & Ryan Eberline

Regulatory Feed Sampling Process and Ergonomics Improvement

Team MDARD

Sponsor: Michigan Department of Agriculture and Rural Development
Faculty Advisor: Dr. Tim Harrigan

The Michigan Agricultural and Rural Development Division (MDARD) tasked the team to redesign their solid feed sampling procedure. Inspectors currently use a sampling cup that is too heavy to gather a representative sample. Additionally, there are climbing restrictions set by the Occupational Safety and Health Administration and standards set by the Association of American Feed Control Officers. The team designed a lightweight, portable solid feed stream sampling tool that improved the ergonomics and safety of inspectors while maintaining sample accuracy. The final design included lightweight, extendable cantilevered poles, a harness, and a gyroscopic-leveling sampler requiring no ladder use.



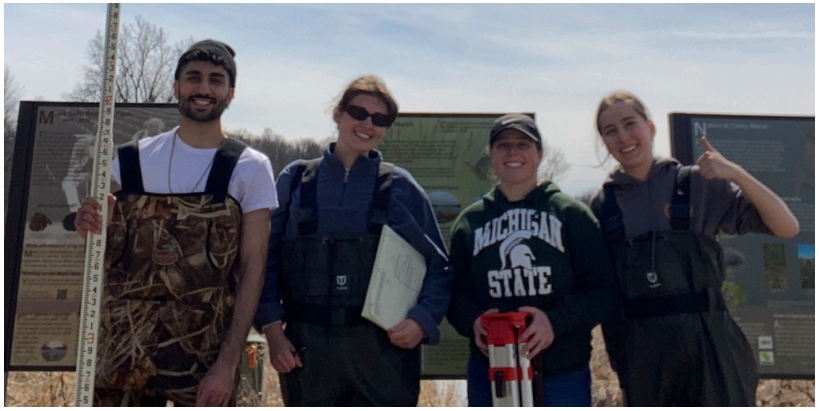
(L to R) Ryan Danaj, Rachael Lewallen, Lindsey Hassel, & Aaron Newberry

Assessment of Commercial Innovative Technologies to Reduce Microbial Load in Wheat

Team Mennel Milling

Sponsor: Mennel Milling Company (project under Non-Disclosure Agreement)
Faculty Advisor: Carly Gomez & Dr. Yan "Susie" Liu

Consuming unsafe-to-eat raw flour products, such as cookie dough or cake batter, can lead to foodborne illness outbreaks. By treating the water used for tempering wheat grain, milling companies can reduce any pathogenic load on their products and minimize the risk of illness for consumers. The Mennel Milling Company requested the evaluation of four different treatment technologies against a baseline control already in place. Treatments were evaluated on their ability to reduce *Salmonella* and *E. coli* populations on wheat grain, their cost per hundredweight (cwt) of flour produced, any related health and safety concerns for workers, and their ease of implementation. An MSU-certified lab ran the experiments and analyzed the raw data from the experiment. The team met with the treatment technology suppliers to calculate the economics of their products.



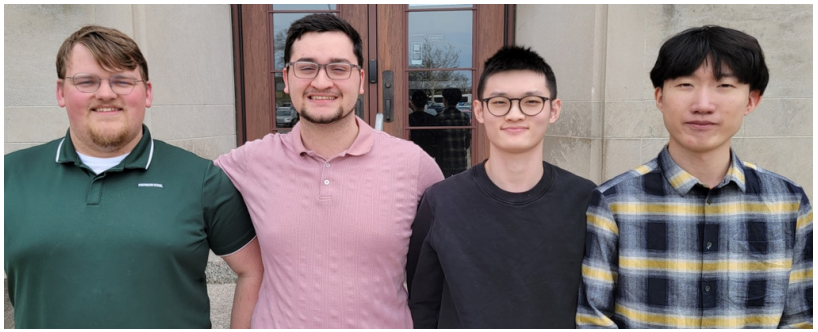
(L to R) Ali Ahmad, Katie Dailey, Lauren Falzarano, & Allison Smith

Wetland Restoration for Improved Natural Function, Research, and Educational Use

Team Corey Marsh

Sponsor: Corey Marsh Ecological Research Center
Faculty Advisor: Dr. Dawn Dechand

Team Corey Marsh was tasked with designing a wetland restoration for the Corey Marsh Ecological Research Center in Laingsburg, MI. A prior wetland, the 400-acre site owned by Michigan State University (MSU), was converted into a research muck farm in 1941. In 2012, the farming operations were shut down and left unmaintained. The site is covered with invasive species and serves little function to MSU or the surrounding community. The team designed a restoration site plan that provides research opportunities on wetland restoration and invasive species management. Using survey data, the site was divided into research units to evaluate management strategy effectiveness, strategic placements of berms and dikes, invasive removal, and native species reintroduction.



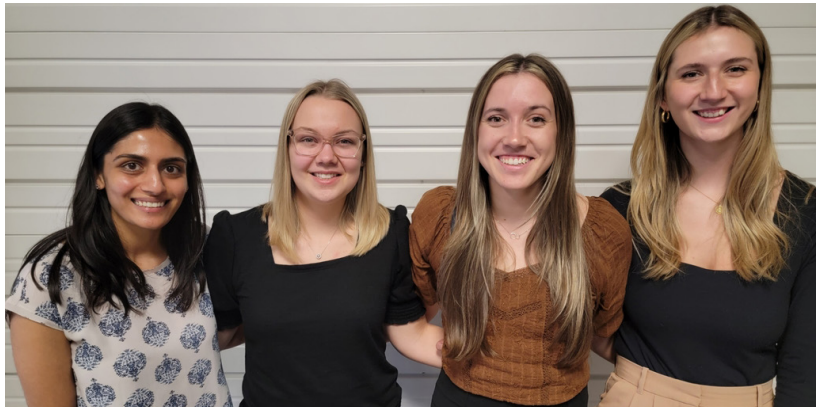
(L to R) John Grivins, Gregory Rouland, Yangcheng Gao, & Xiaoheng Lyu

Sulfur Compound Removal From Tail Gas CO_2 for Methanation

Team Quantalux

Sponsor: Quantalux (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Wei Liao, PE

Renewable natural gas (RNG) is derived from renewable sources such as landfills and anaerobic digesters. RNG is primarily methane, and serves as a drop-in replacement for natural gas derived from fossil sources. The market for RNG is predicted to increase nine-fold by 2028 as demand grows for more sustainable energy options. Methanation is a well-known reaction in which hydrogen (H_2) and carbon dioxide (CO_2) react to produce methane (CH_4) in the presence of a catalyst. A major challenge to implementing methanation catalysts is the prevalence of hydrogen sulfide (H_2S) and other contaminants. The MSU team evaluated design options through a decision matrix process, ultimately selecting a specialized activated carbon media to remove trace gases. A bench-scale sulfur removal system was constructed to determine effectiveness. The system is technically feasible, and a cost analysis was completed for a full-scale application.



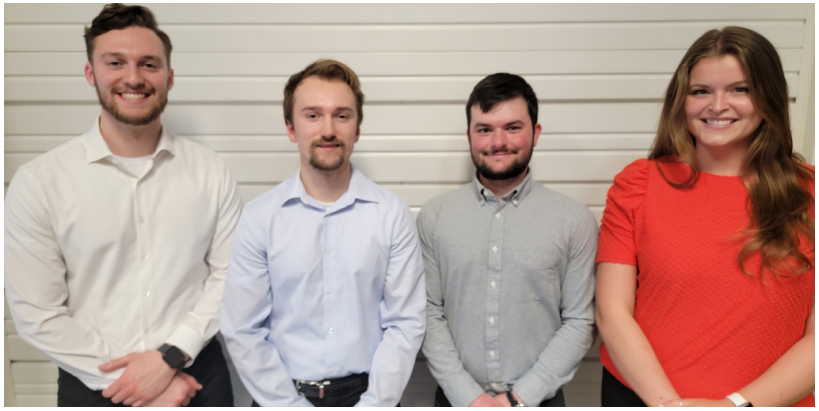
(L to R) Reema Patel, Katie Jensen, Megan Baechle, & Emily Hamilton

Promotional Baked Pastry Process Line Improvement

Team Kellogg's

Sponsor: Kellogg's (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Kirk Dolan

Kellogg's design team was tasked to redesign a pilot plant baked filled pastries line to increase efficiency and produce salable promotional products. Pastry cooling requires 12 minutes of drying to prevent icing from sticking and ruining the printed image. The pilot plant line only has 10 minutes of cool time before packaging. The team explored four design alternatives: cooling tunnels, additional spiral cooling towers, icing modifications, and additional spiral cooling towers plus icing modifications. Evaluating drying time, quality standards, space required, cost, and ease of implementation, led to the design team proposing modifying the icing recipe. From an economic analysis, modifying the icing recipe is the least expensive design and requires the least space.



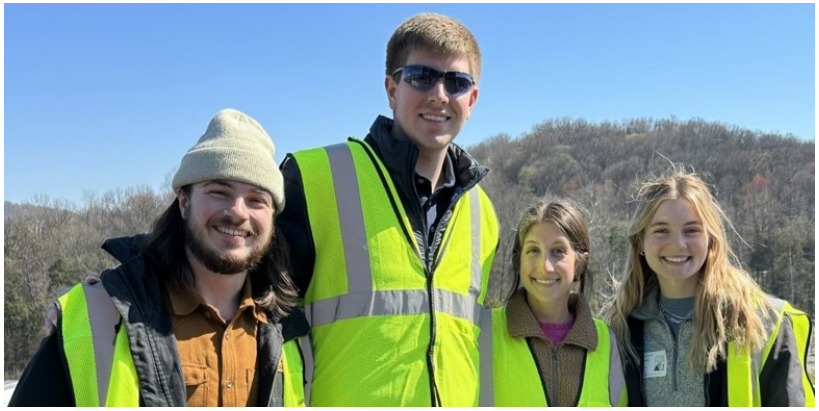
(L to R) Jarod Williams, Kevin Mozel, Robert Gurecki, & Emily Gorr

Reinspection Using AI Vision Sensor

Team Clemens

Sponsor: Clemens Food Group (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Narendra Das

Clemens Food Group (CFG) is the fifth largest pork processor in the U.S. and an industry leader in providing premium quality pork products for retail, foodservice, and further processors. CFG's cornerstone is to "never compromise on food safety." CFG worked with an MSU BE Senior Design Team to develop a design to further expand and automate foreign object detection by exploring and leveraging smart camera technology. The goal was to utilize and train Keyence smart cameras for the trim/blend line to detect small potential foreign objects commonly used in all food processing plants such as personal protection equipment (PPE). In addition, manual labor could be reduced. Tests were completed to identify the ideal detection tool, its foreign object detection accuracy, and size limitation with a Keyence smart camera. Using the optimal detection method, the number and layout of Keyence cameras and recommended belt attributes formed the final design evaluated for cost analysis.



(L to R) Chance Poulos, Grant Gmitter, Megan Mancina, & Madison Pritchett

Maintaining Natural Water Supply Requirements for a Distilled Beverage

Stream Team

Sponsor: Distilled Beverage Manufacturer, (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Steve Safferman, PE

Stream Team's project goal is to provide a temporary solution for the client's seasonal water quality challenges and a set of natural practices that can help remediate Lake X over time. Potential design alternatives included filtration/adsorption methods to remove phosphorus from Lake X by means of iron oxide sand or Phoslock technology or removal of geosmin and 2-MIB by activated carbon filtration. The team ultimately decided that a Model 6 activated carbon system with Filtrasorb 400 carbon from Calgon Carbon was the best solution for the client. The Model 6 can facilitate the necessary flow rate of approximately 116,000 gallons per day, and the Filtrasorb 400 carbon filters out geosmin and 2-MIB. In combination with the activated carbon filtration system, natural practices, including removing invasive honeysuckle, performing a hydrogeological survey of the watershed, and surveying septic tanks within the watershed should be performed.

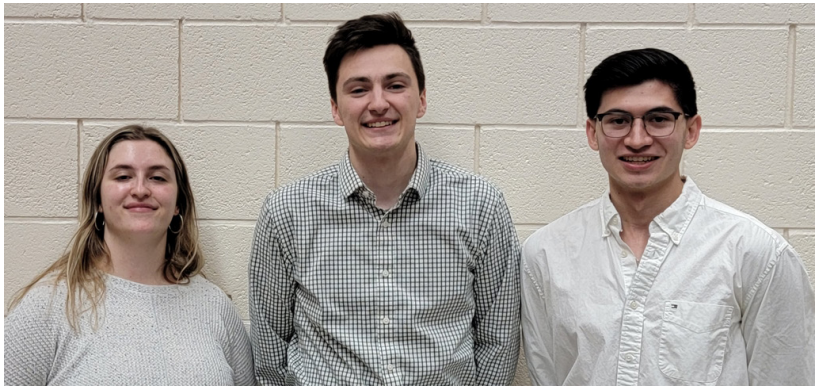
(L to R) Mitchell Wojtowicz, Alec Christy, Lexi Szurna, & Christina Abel

Energy Audit Decision Support Tool For MDNR Facilities

Team MDNR

Sponsor: Michigan Department of Natural Resources
Faculty Advisor: Dr. Truman Surbrook & Al Go

The Michigan Department of Natural Resources (MDNR) is looking to improve the energy efficiency within its buildings. Team Energy Efficiency Crew was tasked with developing an energy audit tool to supply insight into energy efficiency improvement possibilities. The team conducted a trial audit at the MDNR Rose Lake state game area field office. The audit focuses on heating, ventilation, and air conditioning (HVAC); insulation (windows and doors); lighting; and water heating. Employees will input basic information such as operation time, type of component, energy source and consumption, efficiency ratings, etc., for each category. The tool compares the current unit to a high-efficiency unit and calculates savings. This tool can be used to prioritize upgrades with the highest potential of energy and cost savings.



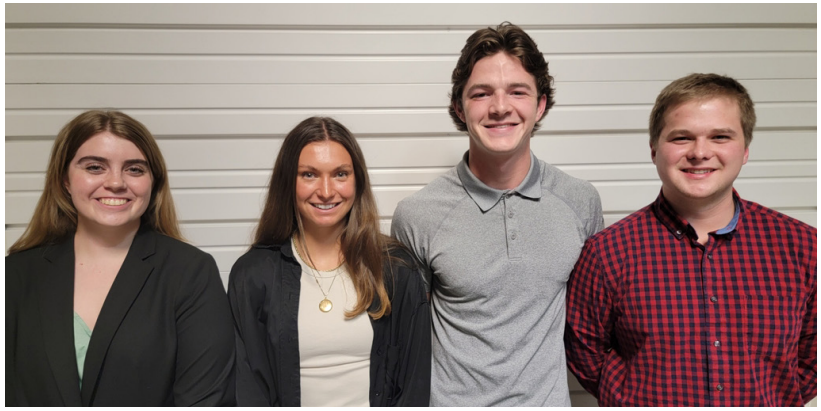
(L to R) Savana Bellows, Andrew Kearney, & Andres Lanzas

Process Line Sanitation Optimization for Cooked Meat Products

Team Grobbel

Sponsor: EW Grobbel (project under Non-Disclosure Agreement)
Faculty Advisor: Dr. Sanghyup Jeong, PE

EW Grobbel, a meat processor in Detroit, MI, tasked the team with optimizing their ready-to-eat (RTE) meat process. The team used a stepwise approach to design, with three design alternatives interrelated. These alternatives aimed to optimize and extend the RTE process within the constraints of a zero-tolerance policy for Listeria monocytogenes, a deadly foodborne pathogen associated with RTE meats. The three design alternatives quantified Listeria growth within RTE meats, assessed the current sanitation methods to improve efficiency, and evaluated alternative sanitation methods for potential utilization by EW Grobbel. An economic study was conducted to analyze the costs of production for EW Grobbel, as well as the potential profits of running a second shift taking into consideration the growth study results.



(L to R) Grace Dempsey, Hannah Gruber, Jake Crippes, & Jake Willsea

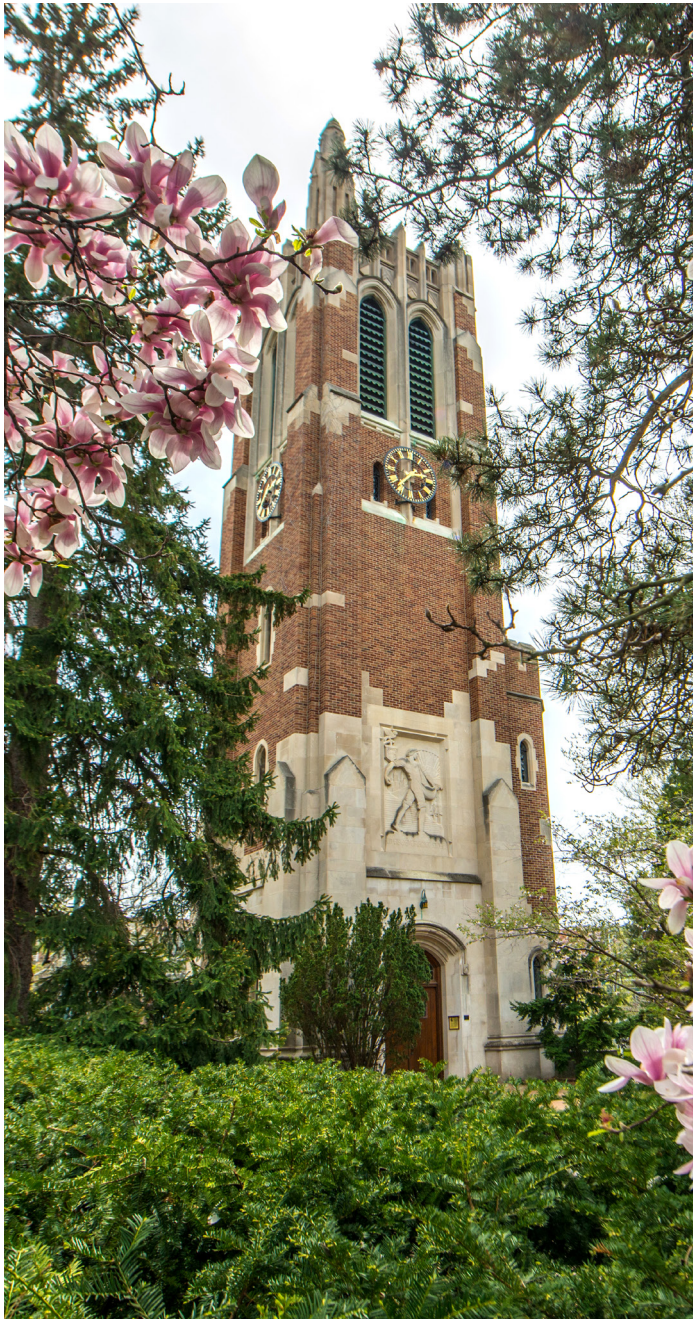
Apple Trellis Post Structural and Economic Evaluation

Team Clarksville

Sponsor: MSU Clarksville Research Station
Faculty Advisor: Dr. Dan Guyer & Phil Hill

Team Clarksville focused on the analysis of trellis systems in apple orchards. The purpose of a trellis is to provide support for fruit-bearing trees by balancing above ground forces (loads) with below ground forces (foundation) through a desired material. The team's goal was to evaluate other options for trellis poles in addition to the current red pine. Steel and fiberglass posts filled with cement and foam were plausible designs.

A four-point loading test was performed on each material to measure material strength and stiffness. Each post was tested and loading vs. deformation data was collected. A weighted decision matrix was used to rank designs based on cost, strength, ease of installation, and ability to be organically certified. Red pine outperformed all other designs in the cost and strength categories.



The Advisory Board

The purpose of the Industry Advisory Board is to facilitate the exchange of ideas between Board members, faculty, and students of the BE program. Its function is to improve continuously the BE program quality by keeping it current and relevant to industry needs. Regular and adjunct board members also serve as external project evaluators.

Board

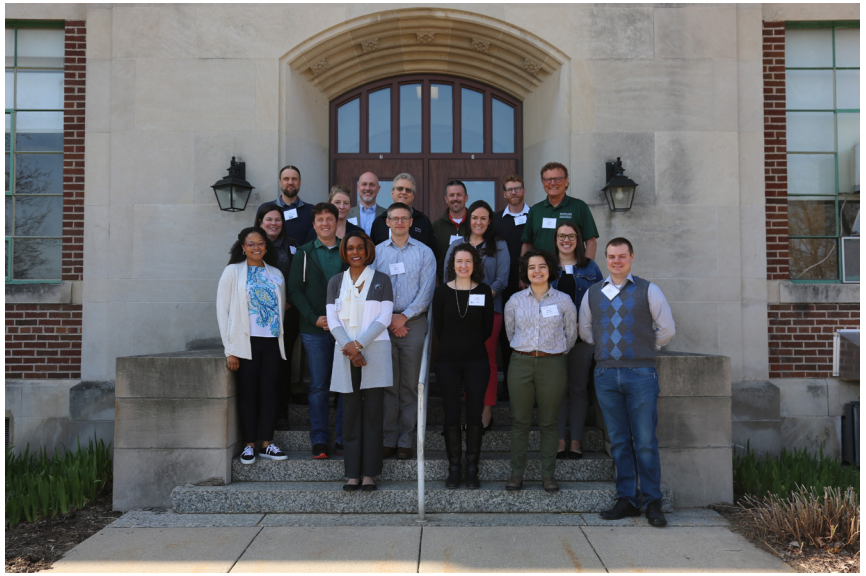
Janelle Barnes (Chair) ~ Target
Holly Bowers ~ Consumers Energy
Jessica Bruin ~ Nestlé Nutrition
Lisa Buchholz ~ Corteva Agriscience
Matt Burtt ~ AbbVie
Shelley Crawford ~ Jiffy
Michelle Crook, PE ~ MDNR
Laura Doud, PE ~ MDARD
Cassaundra Edwards ~ Tillamook Creamery
Gene Ford ~ Standard Process
Jeremy Hoeh, PE ~ EGLE
Eric Iversen, PE ~ PEA Group
Kevin Kowalk, PE ~ EA Engineering, Science, and Technology (MI) PLC
Jeffrey Mathews, PhD ~ PepsiCo
Mitch Miller ~ General Mills-Yoplait
Steve Radke ~ John Bean Technologies (JBT)
Linnea Riddell ~ Kellogg's
Nate Wood, PE ~ Perrigo
Rob Yoder ~ BDI, Inc.

Board (Ex-officio)

Todd Forbush, Techmark, Inc. (ASABE MI Section)

If you are interested in sponsoring a BE 485/487 capstone project for the 2023_24 Senior Design teams, please contact Dr. Dana Kirk at kirkdana@msu.edu or Dr. Luke Reese at reesel@msu.edu.

Full descriptions, and project posters are at: www.egr.msu.edu/bae/SS23NewsBEShowcase



UNDERGRADUATE SCHOLARSHIPS

F. W. Bakker-Arkema Endowed Scholarship
F.W. Bakker-Arkema was a professor of agricultural engineering at MSU for over 30 years. His scholarship recognizes students that contribute to the cultural and intellectual diversity of biosystems engineering through their leadership experiences.

Agah Endowed Scholarship
The Agah Endowed Scholarship is awarded to students who look to make a difference as to how the world's food and water supplies are used, restored, and preserved.

A.W. Farrall Scholarship
The Farrall Scholarship is the most prestigious undergraduate scholarship awarded by the Department of Biosystems and Agricultural Engineering. It is named in honor of A.W. "Doc" Farrall, who chaired the department from 1945-1964 and helped establish the first agricultural engineering Ph.D. program in the nation. Farrall Scholars excel both academically and professionally, and are leaders in the biosystems engineering community.

Mynsberge Experiential Learning Scholarship
See Gradute Scholarships

Clarence and Thelma Hansen Scholarship
The Clarence and Thelma Hansen scholarship is awarded to Michigan natives and U.S. students who have demonstrated academic achievement, leadership, and experience working in agriculture.

George E. and Betty L. Merva Endowed Scholarship
Dr. George Merva was a faculty member in the Department of Biosystems and Agricultural Engineering for 30 years. This endowment, named in his and his wife's honor, recognizes upperclassmen who have demonstrated leadership and academic success.

John and Julianna Merva Endowed Scholarship
Dr. George Merva's father, John, was an immigrant from Slovakia, who, despite receiving no formal schooling and working full time in ore mines, was able to teach himself three languages. In this spirit, the John and Julianna Merva Scholarship is awarded to an undergraduate student who has balanced leadership and academic success, while also working to cover their educational expenses.

DeBoer Family Scholarship
The DeBoer Family Scholarship is awarded to students who excel academically and demonstrate a passion for biosystems engineering.

Howard F. and Esther L. McColly Scholarship
The Howard F. and Esther L. McColly Scholarship honors Dr. Howard McColly, who served on the faculty of the Department of Agricultural Engineering for more than 21 years, and his wife, Esther. The scholarship is awarded to students who have demonstrated academic achievement, leadership and service to the profession.

Michigan ASABE Section Scholarship
The Michigan Chapter of the American Society of Agricultural and Biological Engineers (ASABE) awards a scholarship to one college freshman and one college sophomore each year. Recipients must be registered as pre-professional members of ASABE.

FRESHMEN SCHOLARSHIPS

Robert J. Gustafson Scholarship
The Gustafson Scholarship is awarded to students with a high academic ability and/or financial need, with a first preference for incoming freshmen students.

Alfred & Mary Murray Scholarship
The Murray Scholarship is awarded to students with a high academic ability and/or financial need with a first preference for incoming freshmen students.

2022-2023 Undergraduate Scholarship Recipients

Agah Endowed Scholarship
Lexi Szurna

F.W. Bakker-Arkema Endowed Scholarship
Amari Selby

DeBoer Family Scholarship/ Fellowship Fund
Megan Baechle
Matthew Demartini
Andrew Kearney
Andres Lanzas
Summer Shunia

A.W. Farrall Scholarship
Chloe Zaborney Kline

Clarence & Thelma Hansen Scholarship
Brett Dumaw
John Grivins
Jacob Willsea

Howard & Esther McColly Scholarship
Anna Burgess
Andrew Kearney

George E. and Betty L. Merva Endowed Scholarship
Emily Gorr

George A. Mynsberge Experiential Learning Fund for Research
Ben Adams
Summer Shunia (working with Dr. Safferman)

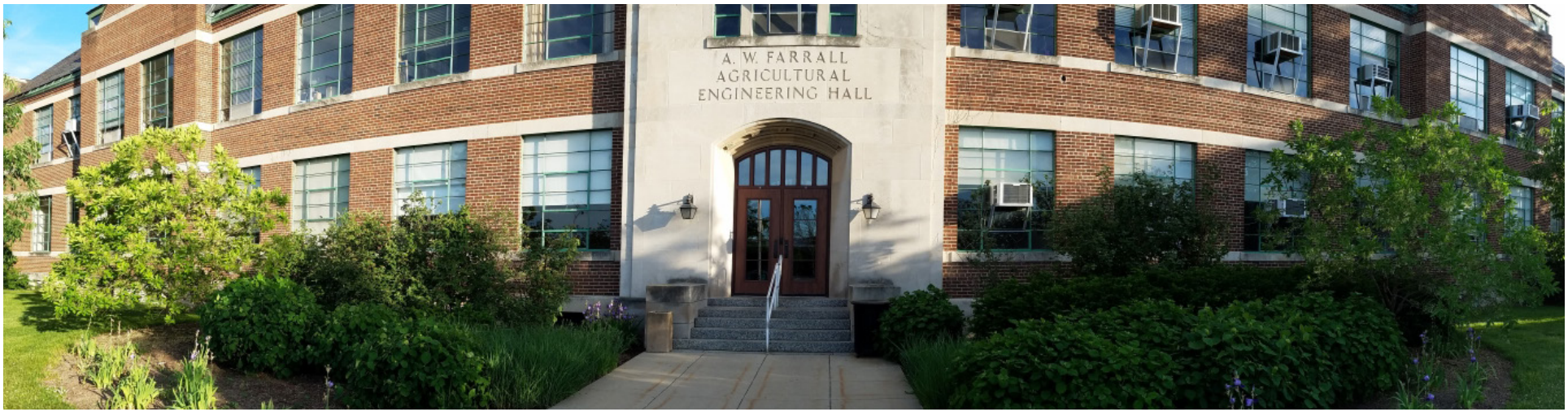
Jimmy Butts Memorial Scholarship (ASABE Michigan Section)
Summer Shunia
Yashasvi Vaidya

2022-2023 Freshmen

F.W. Bakker-Arkema Endowed Scholarship
Gillian Kuehnle

Robert J. Gustafson Scholarship
Sophie McCowan

Alfred & Mary Murray Scholarship
Nicholas Bray
Josie Cayen
Katherine Heinecke
Leah Jarmolowicz
Summer Luick



2022-2023 Graduate Scholarships

Outstanding BE Research Fellowship & Fitch H. Beach Award
The Outstanding BE Research Fellowship & Fitch H. Beach Award is presented to one of the top Ph.D. students in the BE graduate program who has excelled in research productivity, and whose work suggests a high-level of direct impact on society. The recipient represents at the college level against similar nominees from other disciplines in the College of Engineering. Funding is based on placement in the competition at the college level and is funded by the College of Engineering and the BAE Endowment for Graduate Studies.

Most Outstanding BE Graduate Student Fellowship
The Most Outstanding BE Graduate Student Fellowship is awarded to top students in the BE graduate program. It recognizes their recipients' breadth of excellence and direct and indirect contributions to the BAE Department through professional productivity, service to the department and university, and contributions to the extended community. This honor is funded by the BAE Endowment for Graduate Studies, which was from former and current BAE faculty and other donors wishing to support graduate education.

Galen & Ann Brown Scholarship
The Galen & Ann Brown Scholarship supports graduate students working in the engineering domains that can be related or applied to the fruit and/or vegetable industries, a field to which Dr. Galen Brown dedicated his career. This scholarship is funded by the family of Galen and Ann Brown and others who respected and/or worked with Galen.

Katherine & Merle Esmay Scholarship
The Katherine & Merle Esmay Scholarship supports international graduate students with a clear passion and plan to return to their home country to implement their knowledge gained through their MSU BAE degree. It is funded by the family of Merle and Katherine Esmay and others who have the passion to make a difference around the globe, like Merle did.

Mynsberge Experiential Learning Scholarship
Candidates for the Mynsberge Experiential Learning Scholarship must conduct experiential learning research/outreach in water resource recovery, water quality, and/or wastewater treatment. The selected student(s) will work with a BAE faculty member for the experiential learning experience. The award has an expectation that the student presents their experience at a research conference hosted by MSU or a professional society.

M. Kent Taylor Assistantship Fund
The M. Kent Taylor Assistantship Fund supports graduate students in the academic pursuit of alternative, sustainable energy technologies to reduce the carbon load on the atmosphere and oceans.

Graduate Scholarship Recipients

College of Engineering Outstanding BE Graduate Student Fellowship
Ian Krupp

Outstanding BE Research Fellowship & Fitch H. Beach Award
Kara Dean

Galen & Ann Brown Scholarship
Michael Kaven

Katherine and Merle L. Esmay Fellowship
Narindra Randriamiarintsoa

Mynsberge Experiential Learning Scholarship
Enid Banda (working with Dr. Nejadhashemi)

M. Kent Taylor Assistantship Fund
Mervis Chikafa
Hoda Razavi

Interested in supporting scholarships for Spartan biosystems engineers? Click here to make a donation.

About the MSU Biosystems Engineering Program

BE graduates are expected to succeed in diverse careers where they integrate and apply principles of engineering and biology to globally important problems in food, energy, environment and health. This success is attained through a curriculum that focuses on:

- Identifying and solving problems at the interface of biology and engineering, using modern engineering techniques and systems approaches.
- Analyzing, designing, and controlling components, systems and processes that involve critical biological components.
- Demonstrating vision, adaptability, creativity and a practical mindset when solving problems.
- Developing communication skills for technical and non-technical audiences.
- Working with diverse, cross-disciplinary teams.
- Integrating sustainability into all facets of biosystems engineering
- The importance of continued professional growth and ethical conduct.

MICHIGAN STATE UNIVERSITY | Department of Biosystems and Agricultural Engineering

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