



SHOWCASE 2021

A virtual event
highlighting senior design
projects and student
achievements

[Click here](#) for full schedule and Zoom link.



Department of Biosystems
& Agricultural Engineering
MICHIGAN STATE UNIVERSITY



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 this incredibly challenging year, 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.

Dr. Dana Kirk, PE
Assistant Professor

Dr. Luke Reese
Associate Professor

2020-21 PROJECTS



Raina Gregg, Nathan Lorence, Joe Riordan, & Iana Wolff

Reduction of Anaerobic Conditions in an Industrial Wastewater Pumping Station

Team Abbott Labs

Sponsor: Abbott Labs (project under non-disclosure agreement)

Faculty Advisor: Dr. Steve Safferman, PE

Abbott Nutrition's facility in Sturgis, Michigan pretreats industrial wastewater before discharging to the local municipal treatment plant. The pumping station for Abbott's pretreatment plant has experienced anaerobic conditions, which lead to hydrogen sulfide production, resulting in additional costs associated with pH neutralization. Team Abbott Labs evaluated multiple opportunities to improve the system, including adding baffles to the wet well, modifying or replacing the outlet pumps, and using a reverse osmosis system to treat boiler feedwater. The team recommended adding baffles and pump extensions and installing a reverse osmosis system. The payback periods of these designs are under two years.



Gus Aburto Vazquez, Emma Dester, Brandon Driscoll, & Drew Smith

Design of a Small-Scale Food Waste Anaerobic Digester

Team FireKeepers

Sponsor: FireKeepers Casino Hotel

Faculty Advisor: Dr. Yan "Susie" Liu

FireKeepers Casino Hotel in Battle Creek, Michigan wants to implement a small-scale anaerobic digester for their pre-, and post-consumer food waste. The primary goal is to divert food waste away from landfill to beneficial reuse as feedstock for anaerobic digestion to generate energy and electricity. The team began by analyzing food samples from FireKeepers in order to size the digester. Then they developed a basic process flow diagram, approximated land requirements, and performed an economic analysis of the capital and operational costs, and maintenance costs and benefits.



Anthonee Caston, Nate Ciaravino, Daniel Kagerer, & Raymond Lesiyon

Production of Methane via Carbon Dioxide

Team Methanation

Sponsor: Consumers Energy (project under non-disclosure agreement)

Faculty Advisor: Dr. Dana Kirk, PE

Due to the intermittent nature of renewable energy generation, a storage method for excess energy is necessary to balance supply and demand timing issues. Methanation provides a way to store excess energy as carbon-neutral gas. Methanation combines the use of waste carbon dioxide with hydrogen gas to form methane. Hydrogen gas is obtained from an alkaline electrolysis process and is powered with the energy generated from renewable energy. With the combination of these technologies, it is possible to store renewable energy.



Noah Carlson, Scott McCallum, Lindsey Moran, & Vincent Nguyen

Designing a System to Create Renewable Natural Gas from the South Campus Anaerobic Digester

Team CMS - RNG

Sponsor: Consumers Energy (project under non-disclosure agreement)

Faculty Advisor: Dr. Dana Kirk, PE

The team worked with Consumers Energy (CMS) to design a refinement facility utilizing the biogas produced from MSU's South Campus Anaerobic Digester to produce renewable natural gas (RNG). This project aids the client in achieving net zero carbon emissions and meeting 90% of Michigan's energy needs with clean resources by 2040. The design utilizes membrane permeation to bring biogas with a methane content of 65% to 97%. Following refinement, the RNG will be injected into CMS' existing natural gas pipelines.



Deryk Atkins, Andrew Joseph, & Brandon Lippert
(Not pictured, Mackenzie Cook)

Weyerhaeuser Thermal Oil Filtration

Weyerhaeuser Thermal Oil Team

Sponsor: Weyerhaeuser (project under non-disclosure agreement)

Faculty Advisor: Dr. Ajit Srivastava, PE

Weyerhaeuser is a timberland company located in Grayling, Michigan. They use thermal oil to heat resins for their oriented strand board (OSB). Repeated bearing failure in the thermal oil pumps has required Weyerhaeuser to incur significant costs for bearing replacements. This reoccurring issue has caused our team to evaluate Weyerhaeuser's oil quality, leading to a proposed solution of a kidney loop filtration unit to be attached to the system's reservoir.



Meg Curtin, Miriam Kaburu, Kiran Lantrip, & Liam Parlmer

Feasibility Study of Utilizing Hog Fuel for Onsite Heat Production

The Woody Wonders

Sponsor: Weyerhaeuser (project under non-disclosure agreement)

Faculty Advisor: Dr. Dawn Reinhold

Weyerhaeuser is a multinational lumber company that manufactures oriented strand board (OSB) at their mill in Grayling, Michigan. The mill produces a large amount of hog fuel, a waste stream comprised mostly of chipped wet bark, as a byproduct. The Woody Wonders have been tasked with determining a suitable outlet for the hog fuel that is economically viable and environmentally friendly. After evaluating several biomass combustion technologies and offsite mulching opportunities, the team chose to implement an on-site fluidized bed boiler that burns the hog fuel for heating Weyerhaeuser's thermal oil. This boiler was evaluated for feasibility.



Armani Altomonte, Rachel Shapin, Mary Squire, & Elaina White

Portable Electrocoagulation Unit for Wastewater Treatment on Remote Army Bases

Team Clean Drinking

Sponsor: Department of Defense
Faculty Advisor: Dr. Wei Liao, PE

The Department of Defense (DOD) wants to employ a small-scale wastewater treatment system on remote U.S. Army bases. Team Clean Drinking designed an electrocoagulation unit, which is the initial step in wastewater treatment. This unit precedes the ultrafiltration advanced membranes treatment to convert wastewater into water that meets the EPA treated wastewater discharging standard. The system needs to be portable within a skid and serve up to 150 soldiers. The system was designed to be set up quickly and operate in a wide range of climates with minimal labor.



Akash Divecha, Chelsea Keane, Sophie Nowak, & Ethan Tobiczky

Lifecycle Assessment of PET with Multiple End-of-Life Scenarios for BIGGBY® COFFEE

Just Brew It

Sponsor: BIGGBY® Coffee (project under non-disclosure agreement)
Faculty Advisor: Dr. Chris Saffron

The team worked with BIGGBY® COFFEE, a coffee company headquartered East Lansing, Michigan with franchises across the Midwest. Team Just Brew It worked to determine the ecological footprint of BIGGBY's® cold cups composed of the plastic polyethylene terephthalate (PET), which will aid the company's sustainability efforts. A lifecycle assessment was performed on four different end-of-life alternatives, including landfilling, physical recycling, chemical recycling, and combustion, to quantify the company's ecological impact and determine the optimal disposal method.



Emily Dettloff, Aleah Hahn, Kieron Moller, & Eli Toliver

Cleaning Koppert’s Bee Bottles to Recycling Requirements

Bee-duce, Bee-use, Bee-cycle

Sponsor: Koppert Biological Systems, Inc.
Faculty Advisors: Dr. Dan Guyer & Mr. Phil Hill

Koppert, located in Howell, Michigan, raises bumblebees for commercial-scale pollination and is looking to reduce their environmental footprint. Koppert feeds their bees a sugar solution from high density polyethylene (HDPE) bottles. Due to the sticky nature of the sugar and bee residues, the bottles are not meeting the requirements of the local recycler. Through research and experimentation, a pressurized water system was developed. Based on experimentation, the process cleans 97% of the bottles with a single pass. After installation and final adjustments, 100% of Koppert’s bottles will be clean enough for recycling.



Alex Kravaritis, Brandon Laird, Kelsey Pabin, & Katie Simon

Shelf-Life Extension of Sweet Cider to Achieve Clean Label Status

Blake’s Cider Fighters

Sponsor: Blake’s Hard Cider
Faculty Advisor: Dr. lice Medina Meza

Blake’s Hard Cider tasked Blake’s Cider Fighters with modifying the production of their sweet cider to extend the shelf life from 28 days to 45 days. To achieve a clean label, design solutions were constrained to meet natural label standards. The team considered diverse options for meeting Blake’s Hard Cider’s needs. The final project design included sourcing, preliminary implementation, and an economic analysis. This shelf-life extension allows the company to expand its supply chain and provide sweet cider to a wider array of customers.



Neil Kauffman, Brianna Lemmink, Matthew Smith, & Cooper Van Maele

Industrial Compressed Air Optimization and Automation to Achieve Energy Reduction

Team Perrigo

Sponsor: Perrigo (project under non-disclosure agreement)

Faculty Advisor: Dr. Pouyan Nejadhashemi

Perrigo is an over-the-counter pharmaceutical manufacturing company based in Allegan, Michigan. Each of Perrigo's manufacturing plants uses compressed air for automation, quality control, and bottle orientation purposes. Compressed air can be inefficient because of its poor energy conversion, leakage, and continuous run time. Team Perrigo analyzed compressed air use in air knives for one production line at the Allegan facility. The team identified visible compressed air waste, collected data on compressed air usage, and developed system autonomy to reduce air consumption when the line was not operating. Future system autonomy suggestions were provided to enable further savings.



Quinn Marchie, Narindra Randriamiarintsoa, Walter Will, & Sarah Yee

Improvement of a Potato Storage Ventilation System Using Modified Air Cup Design

Team Techmark

Sponsor: Techmark, Inc.

Faculty Advisor: Dr. Wei Liao, PE

Techmark, Inc. is a multi -industry agricultural corporation based in Lansing, Michigan that specializes in root crop storage. Techmark, Inc. designs conditioned air handling systems at a specified velocity through a piled potato storage facility. Improper ventilation contributes to pressure bruising causing product (food waste) and revenue loss. The hypothetical cause is shearing forces at sharp-edged orifices at air cup inlets. The team performed a computational fluid dynamics (CFD) analysis of a single air duct with 28 air cups using 4 design alternatives. Design alternatives to the air cup inlet that increased air velocity and prevented pressure bruising were analyzed.

INDUSTRY ADVISORY BOARD

The MSU Biosystems Engineering Industry Advisory Board continuously works to improve the BE program by ensuring its curriculum is addressing relevant industry needs. Industry Advisory Board members meet with faculty and students in the BE program to share, brainstorm and listen to ideas on how to address industry priorities through teaching, research and outreach.

BOARD MEMBERS

Ms. Holly Bowers (Chair), Consumers Energy
Ms. Janelle Boosi, Kellogg
Ms. Jessica Bruin, Nestlé Nutrition
Ms. Lisa Buchholz, Corteva Agriscience
Mr. Matt Burt, AbbVie
Ms. Shelley Crawford, Jiffy
Ms. Michelle F. Crook, PE, Michigan Department of Natural Resources
Ms. Laura Doud, PE, Michigan Department of Agriculture and Rural Development
Ms. Cassandra Edwards, Tillamook Creamery
Mr. Gene Ford, Standard Process
Mr. Jeremy Hoeh, PE, Michigan Department of Environment, Great Lakes and Energy
Mr. Eric Iversen, PE, LSG Engineers and Surveyors
Mr. Kevin Kowalk, PE, TEA Engineering, Science, and Technology, PLC

Mr. Jeffrey Mathews, Ph.D., PepsiCo Global Beverage R&D
Mr. Mitch Miller, General Mills (Yoplait)
Mr. Eric Van Middendorp, MSE, Spectrum Health Innovations, LLC
Mr. Nate Wood, Perrigo
Mr. Rob Yoder, BDI, Inc.

(EX-OFFICIO)

Mr. Larry Walker, Ph.D., Cornell University emeritus faculty
Mr. Michael Wozniak, PE, Michigan Department of Agriculture and Rural Development

PROJECT EVALUATORS

Regular and adjunct board members also serve as external project evaluators for MSU biosystems engineering capstone projects.

Mr. Matt Barnhart, Weyerhaeuser
Mr. Mike Clark, Weyerhaeuser
Mr. James Dusenbury, Ph.D., U.S. Army
Mr. Sam Effa, Techmark, Inc.
Mr. Todd Forbush, Techmark, Inc.
Mr. Gaurav Hosur, Consumers Energy
Mr. Nathan Hough, Abbott Labs
Mr. Nick Jennings, Koppert Biological Systems
Mr. Matt McAlpine, Blake's Hard Cider Co.
Mr. Steve Radke, JBT FoodTech
Mr. Ian Sanwald, BIGGBY® COFFEE
Mr. Jordan VanDyke, FireKeepers Casino Hotel



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.

DeBoer Family Scholarship

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

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.

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.

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.

2021-2022 UNDERGRADUATE SCHOLARSHIP RECIPIENTS

F.W. Bakker-Arkema Endowed Scholarship

Yassah Bah-Deh
Emily Hamilton
Kase Nelson
Alayna Peterson
Dipankar Roy
Amari Selby

DeBoer Family Scholarship/Fellowship Fund

Emily Gorr
Andrew Kearney
Jack Kivi
Greg Rouland
Yashasvi Vaidya
Chloe Zaborney Kline

A.W. Farrall Scholarship

Annaliese Marks
Alexandria Seybold

Clarence & Thelma Hansen Scholarship

John Grivins
Michael Kaven
Aaron Newberry
Chris Wentworth
Jacob Willsea

Howard & Esther McColly Scholarship

Anna Burgess
Taryn Hanses

George E. and Betty L. Merva Endowed Scholarship

Erica Peer

John & Julianna Merva Scholarship

Emma Savage

George A. Mynsberge Experiential Learning Fund for Research

Ian Chesla

ASABE Michigan Section

Annaliese Marks
Alexandria Seybold

2020-21 Freshmen

Robert J. Gustafson Scholarship

Jacob Cabana

Alfred & Mary Murray Scholarship

Chole Zaborney Kline
Amelia Haley



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.

College of Engineering Outstanding BE Graduate Student Fellowship

Ryan Julien

Outstanding BE Research Fellowship & Fitch H. Beach Award

Ian Hildebrandt

Galen & Ann Brown Scholarship

Oznur Caliskan-Aydogan
Carly Gomez

Katherine and Merle L. Esmay Fellowship

Sami Shokrana

Mynsberge Experiential Learning Scholarship

Saad Asadullah Sharief

Special thanks to all the alumni, faculty, staff, friends and companies who make our department scholarships possible through their kind and generous gifts.

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.



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