



MICHIGAN STATE
UNIVERSITY

Biosystems Engineering 2011 Biosystems Design Project Showcase

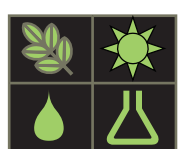
April 21, 2011
Kellogg Center
Michigan State University

Biosystems Engineering

Biosystems engineers integrate and apply principles of engineering and biology to a wide variety of social important problems. The MSU biosystems engineering program prepares graduates conduct the following:

- Identify and solve problems at the interface of biology and engineering, using modern engineering techniques and the systems approach.
- Analyze, design, and control components, systems, and processes that involve critical biological components.

MSU biosystems engineering graduates are having a positive impact on the world, working in areas such as ecosystems protection, food safety and biosecurity, bioenergy, and human health.



BIOSYSTEMS

and Agricultural Engineering

Integrating Engineering and Biology Since 1906

Participants / Agenda

Biosystems Design Project Participants

Asmaa Abdel-Azim	Drew Coatney	Jennifer Jury	Samuel Prentice
Qudus Ahmed	Catherine Dudgeon	Kevin Koryto	Ryan Rochelle
Spencer Beatty	Alyse Egnor	Cody Kurzer	Drew Selden
Bridget Bednark	Kyle Fischer	Blake Loughheed	Stephanie Shaulis
Ryan Black	Cassie Giacobassi	James MacLellan	Jason Smith
Ellen Bornhorst	Shannon Henderson	Shaun Madsen	Nicholas Steo
Megan Buhl	Michael Holly	Hanna Miller	Andy Tran

A Showcase of the Program and Students

April 21, 2011

Presented by
Faculty and Students in the Biosystems Engineering Program
College of Engineering
College of Agriculture and Natural Resources
Michigan State University
East Lansing, MI 48824

PROGRAM The Kellogg Center at Michigan State University

Red Cedar A & B

2:00 - 2:15 p.m. Industry Briefing on Program Assessment
2:15 - 2:30 p.m. Break

Big 10 Room A

2:30 - 4:30 p.m. Senior Student Design Presentations (scheduled at 15 minute increments)

- Bio-Fuel Source Optimization through Torrefaction
- Urban Aquaculture Modeling and Feasibility
- Wastewater Treatment System Upgrade for a Small Cheese Producer
- Best Management Practice Recommendation for *Escherichia coli* in the Red Cedar Watershed
- *Escherichia coli* Source Identification and Detection in Recreational Waters
- Sustainable Heat Systems: Investigating the Feasibility of Corn Drying using Biomass Combustion
- Developing Process Alternatives to Produce Consistent Meatless Burgers across Multiple Production Lines
- Site Evaluation and Design Plan for a Created Forested Wetland

4:30 - 4:45 p.m. Break
4:45 - 5:45 p.m. Concurrent Project Review Panels
5:15 - 6:30 p.m. Reception/Student-Industry Interaction and Engineering Analysis of Biological Systems (BE 230)
Poster Presentation

Lincoln Room

6:45 - 8:30 p.m. Dinner

2011 Scholarship Recipients

Undergraduate Awards

F.W. Bakker-Arkema Endowed Scholarship
Alexa Jones

A.W. Farrall Scholarship
(presented at the CANR Honors Banquet)
Lauren Deitz
Michael Huarng
Gretchen Suehr

Clarence & Thelma Hansen Scholarship
(presented at the CANR Honors Banquet)
James Burns
Michael Herman
Nathan Jandernoa

Howard & Esther McColly Scholarship
Bridget Bednark
Jessica Emery
Matthew Gammans

George & Betty Merva Scholarship
Hanna Miller

DeBoer Family Scholarship/Fellowship Fund
Lara Ejups
Miranda Sperry
Michael Zanotti

Graduate Awards

Outstanding BE Research Fellowship & Fitch H. Beach (3rd Place) Award
Edith Torres-Chavolla

Most Outstanding BE Graduate Student Fellowship & College of Engineering Most Outstanding BE Graduate Student
Sean Woznicki

Merle & Catherine Esmay Scholarship
Jade Wu-Haan

Bill & Rita Stout Scholarship
Ibrahim Greiby

Galen & Ann Brown Scholarship
Mark DeKleine
Irwin Donis-Gonzalez
Ahmed Rady



MICHIGAN STATE
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"Spring"
A.W. Farrall Hall

Team Projects

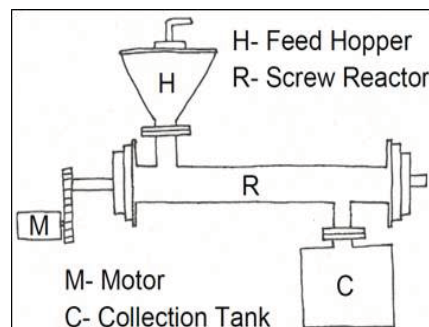
Bio-Fuel Source Optimization through Torrefaction

Michigan legislation calls for displacement of coal in power plants, requiring a percentage of energy be produced from renewable sources. Burning biomass is an option; however, biomass has a lower energy value than coal.

Torrefaction is a biomass pretreatment process which leaves 90% of the energy in 70% of the original mass. Additionally, producing torrefied biomass close to the point of collection concentrates the energy reducing shipping costs per unit amount of energy produced.

There is a lack of experimental systems to test the torrefaction of biomass feedstocks. The project objectives were to design, fabricate, and test a pilot-scale torrefaction reactor. A protocol to test and compare the energy content of the torrefied biomass, raw biomass, and coal using a streamlined life cycle analysis also was developed.

A screw conveyor reactor was selected. Biomass is introduced to the system through a feed hopper and then proceeds through the reactor where torrefaction occurs. Torrefied biomass falls into a collection tank where it is allowed to cool. Thermocouples are used to monitor temperature at various points within the system.



Team Members (L to R)

Spencer Beatty, Harbor Springs, MI
Ryan Black, Battle Creek, MI
Ryan Rochelle, Brighton, MI
Jason Smith, Pigeon, MI

Sponsor/Mentor

Chris Saffron, BAE



Faculty Advisor

Christopher Saffron
MSU BAE

Team Projects

Wastewater Treatment System Upgrade for a Small Cheese Producer

A small-scale cheese producer who uses milk from local Amish dairies plans to expand production and thus produce a greater amount of wastewater. To be proactive in accommodating the increase in wastewater, the company desires a new treatment system. Of great importance to the owner is to respect the Amish way of life and to maintain a less automated, more manual treatment system.

Wastewater can pose serious human health risks and contribute to environmental degradation. Effluent from food processors typically have a high organic content, as indicated by biological oxygen demand (BOD).

Based on factors such as cost, treatment effectiveness, maintenance, energy requirements, and land use, a lagoon with an open sand bed gallery was selected as the treatment system. A lagoon is a shallow constructed pond that treats waste by sedimentation and bacterial activity. An open sand bed gallery contains small particles with high surface area in contact with the wastewater where a biofilm is cultivated. To design the system, several techniques were used, including a topographical survey, soil testing, wastewater characterization, and mathematical models. The completed design will be approved by Larry Stephens, a professional engineer, and then constructed on site.



Team Members (L to R)

Megan Buhl, West Bloomfield, MI
Shannon Henderson, Harrison Twp., MI
Stephanie Shaulis, Engadine, MI



Faculty Advisor
Larry Stephens
Stephens Consulting

Sponsor/Mentor

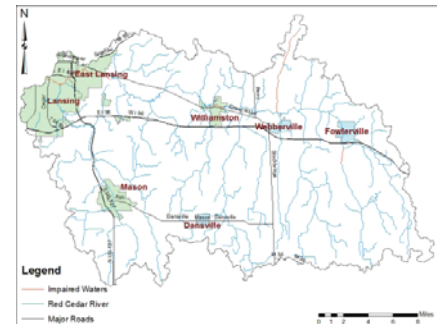
Small independent cheese processor - Due to the proprietary nature of the industry the actual processor will remain anonymous.

Best Management Practice Recommendation for *Escherichia coli* in the Red Cedar Watershed

Parts of the Red Cedar River do not meet water quality standards because of impairment with *E. coli*. The Ingham County Health Department requested a strategic plan that will restore the Red Cedar River to regulatory limits. This project determined point and non-point sources of excessive *E. coli* and developed a plan that will ultimately improve water quality.

Determining the cause of pollution in the Red Cedar requires accounting for sources in the entire Red Cedar watershed. The project used statistical analysis and watershed models to determine which areas likely contributed to high *E. coli* levels. This technique simulates hydrological processes and tracks the transport and die-off of bacteria throughout the watershed.

Best management practices, such as riparian buffers and rain gardens, are used to mitigate bacterial pollution before it reaches the river. These devices were entered into the watershed models to predict improvements to river water quality.



Sponsor/Mentor
Jim Wilson, Ingham County Health Department



Team Members (L to R)
Jennifer Jury, St. Johns, MI
Cody Kurzer, Sebawaing, MI
Catherine Dudgeon, Rochester Hills, MI



Faculty Advisor
Pouyan Nejadhashemi
MSU BAE

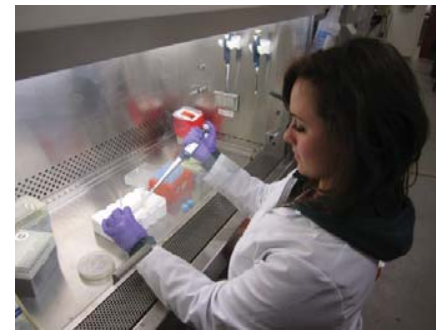
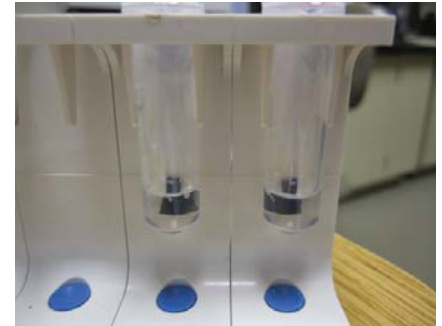
Team Projects

Escherichia coli Source Identification and Detection in Recreational Waters

Escherichia coli (E. coli) is a bacteria used to indicate the presence of fecal matter. Using the standard detection protocol, Ingham County Health Department reports that E. coli levels have exceeded the current Michigan Department of Environmental Quality safety limits of 300 colony forming units per 100 mL of sample within sections of the Red Cedar River.

The objective of this project is to develop a low cost protocol that can be used to find the likely sources of E. coli impairment so that preventative techniques (best management practices) can be instituted. Identifying the source of the impairment will require that a substantial number of samples be collected and analyzed but the standard, regulatory method is expensive and requires substantial resources, limiting the number of samples that can be collected and analyzed. With the data from the simplified method, a statistical analyses can be conducted to determine likely locations of the impairment.

Consequently, this project entailed developing a protocol with the following three components: 1) water filtration to remove debris and concentrate bacteria, 2) E. coli detection using an antibody-based biosensor, and 3) statistical analysis of the data to determine impacted regions of the Red Cedar River.



Sponsor/Mentor
Jim Wilson, Ingham County
Health Department



Team Members (L to R)
Drew Coatney, Clarkston, MI
Asmaa Abdel-Azim, Niskayuna, NY
Bridget Bednark, Onaway, MI



Faculty Advisor
Evangelyn Alocilja
MSU BAE

Sustainable Heat Systems: Investigating the Feasibility of Corn Drying using Biomass Combustion

On-farm corn drying in the Midwest is primarily accomplished using propane as a heating fuel. The main objective of this project is implementing a biomass combustor to work in conjunction with a small-scale propane drying system (less than 60,000 bushels per season).

The project design is divided into four components: 1) biomass combustion, 2) heat transfer, 3) grain drying, and 4) emission filtration. Heat leaves the combustor at an average temperature of 1400°F and enters an indirect contact heat exchanger. Clean air warmed to a fixed grain drying temperature enters the dryer. After heat transfer is achieved through a heat exchanger, combustion gases pass through a cyclone separator system to remove particulate.

Economic analysis revealed a substantial capital investment and extended payback period for the dual fuel system. Corn is dried for 3-4 weeks after fall harvest and the drying season cannot be increased without causing a substantial decrease in the quality of the corn. However, two possible ways to reduce the payback period are: investigating off-season uses for the combustor and qualifying for government incentive programs. As propane prices increase this project becomes more attractive.



Sponsor/Mentor

Larry Klope, Bioenergy Alternatives



Team Members (L to R)

Sam Prentice, Novi, MI
Shaun Madsen, Oxford, MI
Kyle Fischer, Grosse Ile, MI
Nick Steo, Rochester, NY



Faculty Advisor
Ajit Srivastava
MSU BAE



Faculty Advisor
Phil Hill
MSU BAE

Team Projects

Developing Process Alternatives to Produce Consistent Meatless Burgers across Multiple Production Lines

According to a North American Consumer Goods Company, alternatives to meat products such as meatless, soy-based, burgers are gaining popularity. Currently, our sponsor's company utilizes a co-manufacturer for the production of meatless burgers on two processing lines. Line 2 produces burger batter with an acceptable quality while line 1 does not pass quality control standards for regularity. To utilize line 1, additional ingredients are required to give the wet batter a consistency comparable to the acceptable batter, resulting in \$80,000 of additional costs each year. An alternative solution to achieve acceptable, consistent products from both lines utilizing the originally specified formulation is desirable. The objectives of this project were to characterize both production lines, identify potential causes for differences in product characteristics, and recommend process line modifications to enable the company to utilize the original meatless burger formula on both lines.

In order to accomplish these goals, the team visited the manufacturing plant to characterize both production lines. Pilot-scale mixing experiments were then performed at Michigan State University to determine the relationship between processing parameters and burger batter moisture content, water activity, and texture.

After determining relationships between processing parameters and batter characteristics, recommendations were proposed to improve the consistency of meatless burgers produced on line 1. A trial was conducted at the manufacturing plant to test the recommendations to produce meatless burgers that meet quality control standards.



Team Members (L to R)

Drew Selden, DeWitt, MI

Ellen Bornhorst, Houghton, MI

Cassie Giacobassi, Litchfield, MI

James MacLellan, Walled Lake, MI



Faculty Advisor

James Steffe

MSU BAE

Sponsor/Mentor

Major Food Processor - Due to the proprietary nature of this industry the actual company and product names will remain anonymous.

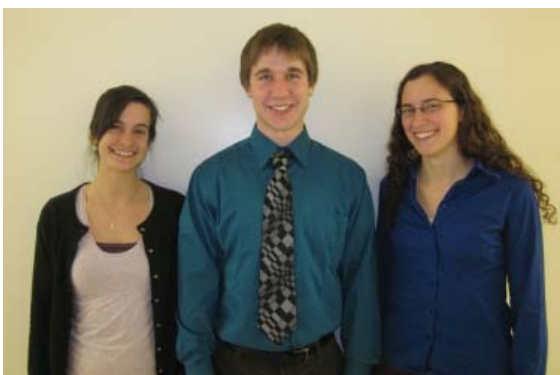
Site Evaluation and Design Plan for a Created Forested Wetland

The Michigan Department of Transportation (MDOT) is deficit for wetland mitigation credits in the Maple River Watershed due to construction of the St. Johns Bypass on US 127. MDOT requested design plans for the creation of a forested wetland that is cost effective, innovative, and fits within the landscape.

Through ArcGIS mapping and field surveys, the construction site was characterized to determine hydrology, topography, and soil classification. In order to determine the hydrologic regime of the system a water balance Microsoft Excel model was developed to predict inundation period and daily water height. Site design was optimized to minimize excavation, maintain wildlife usage, and ensure vegetative establishment.

Results of the water balance indicate sufficient water for a forested wetland ecosystem. Stop-log control structures and an earthen berm constructed from on-site soil are utilized to facilitate the necessity for precise water depths. The design includes small areas of emergent and scrub-shrub wetland to promote ecological diversity.

AutoCAD design drawings depict plan, cross-sectional, and structural component views. Specifications are provided for construction of the site with details on required grading, vegetation planting, wildlife structures, and long-term monitoring.



Team Members (L to R)

Alyse Egner, Burton, MI

Kevin Koryto, East Lansing, MI

Hanna Miller, Midland, MI



Faculty Advisor

Dawn Reinhold

MSU BAE

Sponsor/Mentor

Michael Pennington, Michigan
Department of Transportation

2011 Alumni Awards



Biosystems Engineering 2011 Distinguished Alumni Award

Dirk E. Maier

Dirk E. Maier is Professor and Head of the Department of Grain Science and Industry at Kansas State University where he is responsible for leading the department's teaching, research and outreach programs. He serves as the Director of K-State's International Grains Program which aims to educate foreign business leaders, industry professionals and government officials about U.S. grains and oilseeds through technical training and assistance programs in storage, handling, milling, marketing and processing. He also serves as the Director of the GEAPS-KSU Grain and Biorefinery Operations Distance Education Program which provides continuing education to grain industry professionals around the world. Dr. Maier is a registered professional engineer, and a member and officer of several academic, professional and scholarly societies. He has served on two EPA FIFRA Scientific Advisory Panels related to the assessment of genetically modified grains. He has traveled extensively throughout the world as a speaker and participant in many national and international industry meetings and scientific conferences.

Prior to joining Kansas State University, he was Professor, Associate Head and Extension Agricultural Engineer at Purdue University (1991-2008), where he was the co-founder of the Purdue Grain Quality Team, key initiator and director of the Purdue Post-Harvest Education and Research Center, and director of the Purdue Grain Quality Laboratory. He received his B.S., M.S. and Ph.D. degrees in agricultural engineering from Michigan State University.



Biosystems Engineering 2011 Outstanding Alumni Award

Paul E. Forton

Paul Forton graduated from MSU in December 2004 with a B.S. degree in Biosystems Engineering. During his time at MSU, he worked as a student assistant in the Fruit Pathology Department, a research assistant for Drs. Harrigan and Northcott, and was Assistant Site Manager for Ag Expo as well as a Teaching Fellow with Dr. Marks. In the fall of his junior year, Paul began working part-time at Spicer Group as a co-op in the drafting area for their St. Johns office.

Upon graduation, Paul was offered a full-time position at Spicer Group as a Design Engineer in the Water Resources area. He has since been promoted to Project Manager and oversees a variety of projects from conception to implementation. During his time at Spicer Group, he has utilized his watershed management skills on projects involving pond and wetland design, stream restorations, agricultural conservation practices, floodplain management, storm sewer system design, and soil erosion and sedimentation control projects. His experiences include managing a broad range of projects from designing small private ponds to serving as the construction administrator for an \$18 million watershed restoration project. Over the course of his career, he has formed lasting relationships with both private and municipal clients across the state of Michigan completing work in over 55 townships in 22 different counties.

Paul received his Professional Engineer License and is also a Certified Professional in Erosion and Sediment Control. He currently resides in DeWitt Township with his wife of five years, Melissa, and their son, Jack. They are expecting the arrival of their second child in April.



2011 Biosystems Engineering Showcase Sponsor



Abbott is a global, broad-based health care company devoted to discovering new medicines, new technologies and new ways to manage health. Their products span the continuum of care, from nutritional products and laboratory diagnostics through medical devices and pharmaceutical therapies. Abbott has sales, manufacturing, research and development, and distribution facilities around the world, close to where their customers need them to be. Throughout their 120+ year history, Abbott people have been driven by a constant goal: to advance medical science to help people live healthier lives. It's part of Abbott's heritage. And, it continues to drive their work. Abbott's revenue in 2010 was \$35.2 billion, and has more than 100 facilities and 90,000 employees worldwide sharing the passion for "Turning Science Into Caring." Thank you Abbott for your generous support of Showcase 2011.

2011 Biosystems Engineering Case Studies

Case studies are incorporated into the two capstone design classes to emphasize core Biosystem's Engineering specializations and critical design concepts essential for our students' careers. Each case study was matched to one specialization and one design concept, as listed below. Also listed is the faculty member that coordinated the case study, to whom we express our appreciation.

Case Study 1: Bioenergy specialization and engineering cost estimation concepts – Wei Liao

Case Study 2: Food specialization and mathematical modeling concepts – Brad Marks

Case Study 3: Ecosystems specialization and plans and specification concepts – Steve Miller

Case Study 4: Biomedical specialization and applied research concepts – Evangelyn Alocilja



Design Project Instructor
Steve Safferman
BE 485/487



Technical Advisor
Luke Reese



Design Project Instructor
Steve Miller
BE 485/487



Showcase Event Coordinator
Barb DeLong

Industry Advisory Board 2010-2011

Steve Richey (Board Chair) is Director, Process Engineering at Kellogg Company, the world's leading producer of cereal and a leading producer of convenience foods. Steve holds B.Sc. and M.Sc. degrees in Agricultural Engineering.



Kevin Evans (Chair Elect) has 20 years of R&D and Process Engineering experience with Frito-Lay, Sara Lee Bakery, Tropicana, and Gatorade and is currently Director of R&D Engineering and Commercialization for PepsiCo Beverages. Kevin holds B.Sc. and M.Sc. degrees in Biosystems and Agricultural Engineering, holds two patents and has served as the Advisory Board Chair.



Michelle Crook, P.E., is an Engineering Specialist in the Environmental Stewardship Division of the Michigan Department of Agriculture. Michelle provides engineering assistance to the livestock and food processing industry and holds a B.Sc. in Environmental Engineering.



Chad D. Ducey, P.E., is CEO of e-biofuels, LLC a 25 million gallon per year capacity biodiesel plant in Middletown, IN. Chad holds a B.Sc. degree in Civil Engineering with a minor in Environmental Engineering.



Cassandra Edwards is Senior Research Engineer at Kraft Foods, the world's second largest food company with annual revenues of \$49.2 billion and 127,000 diverse employees around the world. Cassandra holds a B.Sc. degree in Food Engineering and a M.Sc. degree in Mechanical Engineering.



David A. Hamilton, P.E., is Chief of the Water Management Section, Water Resources Division, Michigan Department of Environmental Quality. He oversees many of the Division's engineering functions, including the Hydrologic Studies, Dam Safety, Lake Level Engineering, Floodplain Management, and Transportation Project Review Programs. David holds a B.Sc. degree in Agricultural Engineering and a M.Sc. degree in Civil Engineering with emphasis in Hydrology and Water Resources.



Rebecca Leaper is Divisional Vice President for Quality at Abbott Laboratories, a global, broad-based health care company devoted to discovering new medicines, new technologies and new ways to manage health. Rebecca holds a B.Sc. degree in Mechanical Engineering.



Juanita McCann, P.E., is Agricultural Engineer for USDA - Natural Resources Conservation Service. She works with landowners in the design and installation of Animal Waste Storage Facilities, Agrichemical Handling Facilities, Mortality Composting Facilities, waterways, and grade stabilization structures. Juanita holds a B.Sc. degree in Agricultural Engineering.



Scott Millsap is International Project Manager at JBT FoodTech, a leading supplier of integrated food processing solutions. Scott holds B.Sc. and M.Sc. degrees in Biosystems Engineering and a MBA degree.



Industry Advisory Board 2010-2011

Valerie Novaes, is Project Engineer in the Water Resources Department for Tetra Tech, a leading provider of consulting, engineering, and technical services worldwide. Valerie holds a B.Sc. degree in Biosystems Engineering and is currently completing a M.Sc. degree.



Ferhan Ozadali, Ph.D. is Senior Manager of Corporate Quality at Ocean Spray Cranberries. Ferhan holds B.Sc. and M.Sc. degrees in Food Science and Engineering and a Ph.D. in Food Science and Chemical Engineering.



Mike Potts, P.E. is the Plant Technical Manager for the General Mills-Yoplait Plant, Reed City, Michigan. General Mills is among the world's largest food companies with U.S. shoppers on average placing at least one General Mills product into their shopping cart each time they visit the grocery store. Mike holds a B.Sc. degree in mathematics and computer science, a M.Sc. degree in Mechanical Engineering in addition to a MBA.



Dave Prouty is President of Heat Transfer International which manufactures custom designed process equipment, specializing in biomass gasification/ electric power generation systems that convert solid and semisolid biomass into a combustible syngas. Dave holds a B.Sc. degree in Mechanical Engineering.



Steve Steffes, P.E., is Director of Liquid Operations with Perrigo, the world's largest manufacturer of over-the-counter store brand pharmaceutical products. Steve was a commissioned officer in the U.S. Army Corps of Engineers. Steve holds a B.Sc. degree in Chemistry and German and a M.Sc. in Environmental Engineering.



Paula Steiner is a Civil Engineering with the United States Department of Agriculture – Natural Resources Conservation Service. Paula holds B.Sc. and M.Sc. degrees in Biosystems Engineering.



Larry Stephens, P.E. is owner of Stephens Consulting Services, P.C., a 30+ year old engineering firm located in Haslett, MI. Larry holds a B.Sc. degree in Civil Engineering and a M.Sc. in Environmental Engineering. Larry has been very active in the decentralized wastewater treatment industry in Michigan on both the regulatory and the private sides for nearly his entire career.



Paul J. Eisele (ex-officio) is a consultant to the Kitchen Cabinet Manufacturers Association and Masco Corporation. Paul is an industry representative to state and federal advisory committees and industry groups dealing with both environmental and occupational health. Paul holds a Ph.D. in Environmental Health Sciences, specializing in toxicology.



Andrew Granskog, P.E. (ex-officio) is State Engineer for USDA Rural Development Community Programs which finances \$50 million in rural water and sewer infrastructure projects per year in Michigan. Andrew has been at USDA for eleven years, was in private consulting for ten years prior and holds B.Sc. and M.Sc. degrees in Agricultural Engineering.





BE Industry Advisory Board

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Chad Ducey, e-biofuels
Cassandra Edwards, Kraft Foods/Oscar Mayer, R & D
David A. Hamilton, Michigan Department of Environmental Quality
Rebecca Leaper, Abbott, Medical Products Group
Juanita McCann, USDA - NRCS
Scott Millsap, JBT FoodTech
Valerie Novaes, Tetra Tech, Inc.
Ferhan Ozadali, Ocean Spray
Mike Potts, General Mills - Yoplait
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Paula Steiner, USDA - NRCS
Larry Stephens, Stephens Consulting Services, P.C.

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